LEGAL EXPERT SYSTEMS

EXPERTS OR EXPEDIENTS?

The representation of legal knowledge
in an expert system for Environmental Permit Law

Dr. Mr. C.N.J. de Vey Mestdagh
University of Groningen, Faculty of Law, Department of Legal Theory
Section Legal Information Science & Information Law
P.O. Box 716, 9700 AS Groningen, The Netherlands
tel. + 31 50 3635790 fax. + 31 50 3635635
e-mail sesam@rechten.rug.nl
homepage http://jurix.rechten.rug.nl

Summary

This paper contains an overview of a study into the incorporation of legal knowledge in an expert system, the substantiation of the model of legal knowledge used to build the system and the qualitative and quantitative improvements in legal practice that may be expected of such a system. The concept of legal knowledge is given a theoretical foundation, formalised by means of inferential logic (the Logic of Reasonable Inferences), and operationalised with IT techniques. The resultant Argumentator legal expert system shell has been filled with information concerning Environmental Permit Law to create the Legal Expert System for Environmental Permit Law (ESM). The system has been tested against forty cases that were ruled on in the past. This test indicates that the ESM is a good description of legal practice and may also have an important supplementary function. The supplementary function rests on the ESM's more comprehensive collection of relevant data and more thorough application of the relevant rules, and on its ability to indicate the scope for decision-making, to provide better arguments for the decisions it makes, and to provide better information to the parties involved in Environmental Permit Law procedures.

Introduction

In the past years the section Legal Information Science of the University of Groningen has studied two main questions. Can applicable legal knowledge be represented in a legal expert system? And if so, can the legal expert system be used to improve the quality of the application of legal knowledge in legal practice? Answering the first main question required answering a number of subsidiary questions first. What is legal knowledge? What is a legal expert system? How may legal knowledge be represented in a legal expert system? Is it possible to check that the legal expert system contains applicable legal knowledge? In order to answer the first main question, its subsidiary questions and the second main question a series of research has been carried out. Firstly a theoretical basis with respect to legal knowledge was outlined. Secondly the theoretical basis was described as a formal model (the Logic of Reasonable Inferences) and as the computer program based on this (Argumentator a legal expert system shell). Thirdly knowledge from the field of Environmental Permit Law was acquired and entered into the legal expert system shell. Finally the resulting Expert System for Environmental Permit Law (ESM) was tested against 40 cases from legal practice.

This paper gives an overview of the research and its results, concentrating on the test results and the usefulness of the expert system in legal practice.

Legal knowledge

The law is characterized by normative judgements both special and general in nature, in other words by normative qualifications of actual situations, and by legal rules. The concept of legal rules must here be understood in a very broad sense. The rules of material and formal law play an important role in the interpretation of the rule of law, but in practice they are supplemented by rules of a less formal character such as generalizations from jurisprudence and administrative decisions, legal principles, the interpretation rules and policy rules of executive bodies, the individual normative interpretations of persons and legal entities potentially holding legal rights, and general social interpretations.

Legal rules create a link between the observation of an actual situation and an action that consists of the normative qualification of this actual situation. Legal rules may therefore be regarded as (mental) instructions to act. Instructions to act do not deny the acting person the possibility of acting in a different way. They do create a certain expectation as regards the effect of the action under certain concrete circumstances. This could be a reason for actively following the instructions. Legal rules, therefore, constitute a theory about the actions (interpretation of the rules of law) of people (those holding legal rights and lawyers) within the legal system. The reasons behind whether or not the legal rules are applied are no different from the reasons for following rules that do not usually belong to the domain of law, such as rules of play, technical instructions and moral principles.

Legal knowledge may consequently be regarded as an instrument for the formulation and evaluation of (various) interpretations of the normative characteristics of actual situations. This instrument may be regarded as both descriptive (a description of the legal decision-maker) and prescriptive (an instruction for the legal decision-maker). For the creation of a computer model this difference is of no importance. The instrument must be able to describe the various individual perspectives of the law and must be able to compare these perspectives with each other, and on the basis of this be able to provide a general perspective.

The theoretical basis differentiates the following primitive elements and functions of legal knowledge. The *question (of law)* into the normative qualification of the actual situation provides legal knowledge with a purposeful character. The answering of the question of law takes place with the help of *factual knowledge, functional knowledge* and *meta-knowledge*. Factual knowledge concerns individual interpretations of facts and rules. Functional knowledge concerns the processes of reasoning and problem-solving used to formulate individual interpretations. Meta-knowledge concerns the process of decision-making by which various individual interpretations are evaluated and compared. The metarules may be classified as validation rules, exclusion rules and preference rules. The structure and application of metarules have been examined in more detail. Rules and metarules turn out to have a similar structure (general statements about phenomena) and a similar effect (a relative one), thus they may be applied in the same way, using the same procedure (purposeful reasoning). They differ only in their subject (a formulating and an evaluating observer respectively) and object (facts or rules respectively).

In Vey (1997) the theoretical basis is described and elaborated in a number of draft decisions for the legal expert system.

The formalization and making operational of legal knowledge

In Vey (1989, 1991 and 1997) the formalization and making operational of the theoretical basis is described, that is to say the specification and the development of the legal expert system shell. Legal rules and the interpretation of the rules of law are described here in a formal way (Logic of Reasonable Inferences). Particular attention is paid to the (shortcomings of) various existing methods for the formalization of rules, metarules and interpretation of rules of law. The Logic of Reasonable Inferences is a non monotonic logic like Default Logic but distinguishes itself by two features which are essential to the definition of (the application of) legal knowledge given above. Firstly, in the Logic of Reasonable Inferences all rules are formally defined as default rules (a rule can never conclude to a fact). This feature expresses the perspective bound character of all legal rules. Secondly, in the Logic of Reasonable Inferences the solutions (extensions in Default Logic) can contain uninstantiated rules (and not just ground instances as in Default Logic). This property prevents solutions from being based on inconsistent general opinions. The formal description serves as a specification for the legal expert system shell, the computer program into which the nature and the effect of legal rules have been represented (Argumentator). This program is able to record actual circumstances, rules and metarules, apply these rules and justify and explain its conclusions. Argumentator has been developed under MS-Windows95 with C++, Delphi and ODBC. Standard software was used wherever possible. Data can be stored and consulted with ODBC. This means that all (existing) internal databases of executive and enforcement agencies that may be accessed with ODBC can be used by Argumentator. The rules stored are applied by means of an inferential logic program written in C++. The user interface was developed with Delphi. Help files are available through Windows Help. Argumentator operates under MS Windows 95, both on stand-alone computers and on networks. The central databases containing the data and rules may be shared by several agencies and accessed simultaneously by several users.

The techniques employed to formalize legal knowledge and make legal knowledge operational necessitate an exact definition of the phenomena being investigated (legal rules, interpretation of the rules of law) and provide a product, the expert system shell, that is able to serve as a model for legal knowledge and as a test instrument (hypothesis made operational) for the theoretical basis.

Acquisition and representation of Environmental Permit Law

In Vey (1997) the knowledge domain, the knowledge acquisition and the knowledge representation are described, that is, the collection and introduction of specific legal knowledge concerning a subsection of the law into the general legal expert system shell Argumentator. The legal expert system shell Argumentator is a general model of legal knowledge as described in the theoretical basis. In order to be able to ascertain whether it is possible to represent legal knowledge in a legal expert system, specific legal knowledge must be collected and introduced into the system. The research has of necessity confined itself to a subsection of the law, *Environmental Law* and to a certain context of decision-making, the *granting of permits*. The rules (legislation, implementation rules, jurisprudence, and policy rules) and the actual implementation of Environmental Permit Law have been researched and the legal knowledge encountered has been introduced into a data model and a rules model of Environmental Permit Law. These models have been included in Argumentator and have resulted in the Expert System for Environmental Permit Law (ESM).

The Expert System for Environmental Permit Law (ESM)
ESM contains a model of corporate data and a model of the rules of Environmental Permit Law. These models enable the user to gather all relevant corporate data and apply all relevant environmental regulations. The corporate data model contains administrative information (about companies, their business premises and legal procedures) and data concerning processes, installations, chemicals, emissions, technical directives, and information relevant to policy implementation (e.g. environmental indices). The rule model contains rules of law, implementation rules, jurisprudence, and policy rules. The ESM indicates the scope for decision-making by listing all alternative decisions that can be based on the rules and indicating which alternatives should prevail on the basis of the policy rules.

Testing the Expert System for Environmental Permit Law (ESM)
In order to ascertain whether the legal knowledge contained in the ESM in the field of Environmental Permit Law is a good description of the application of legal knowledge in legal practice, and whether the ESM could have a qualitative supplementary effect, the ESM has been tested against 40 environmental cases, 35 of a general nature (petrol stations) and 5 of a complex nature (secondary aluminium smelteries).

Each of the 5 complex cases consisted of 9 separate decisions and their justifications and each of the 35 general cases consisted of 11 separate decisions and their justifications. So, a total of 430 decisions and accompanying justifications in 40 cases have been examined.

The testing was conducted in two ways. Firstly, an investigation was made of which rules the expert system applies and which conclusions it draws if it starts with the same data as the cases from legal practice (*descriptive mode*). This investigation made it possible to draw conclusions about the expert system as a model of actual implementation by comparing the rules employed and the conclusions drawn. Secondly, an investigation was made of which rules the expert system applies and which conclusions it draws if it not only considers the case data but is also enabled to apply all the known rules and to collect independent data (*supplementary mode*). This investigation made it possible to draw conclusions about the expert system as a (normative) model of the rules in force within Environmental Permit Law. The expert system and the tests were controlled by 18 independent assessors. In Vey (1997) the test research and the independent assessments are described.

Test results

Descriptive mode
In descriptive mode the ESM succesfully (re)constructs 425 of the 430 examined decisions. So, only 5 mismatches were encountered, 3 of them in complex cases and 2 of them in general cases. In case of 4 of the 5 mismatches an invalid rule was applied in the actual cases. The 5th mismatch could be accounted for by the application of an unusual local rule in the actual case.

The test research confirms the theoretical basis. The utilization of legal knowledge when issuing environmental permits may be modelled as the administering of subsidiary collections of known rules and metarules to known facts and rules. The legal expert system is a good model of the use of legal knowledge in legal practice because it can (re)construct these subsidiary collections and apply them with a result that is in agreement with legal practice.

Supplementary mode
The rules and their implementation in practice turn out to contain a number of drawbacks. The legal expert system in supplementary mode is an instrument for measuring these drawbacks and at the same time a possible solution for the problems arising from them:

1. Incomplete collection of data and application of rules
Legal decision-making in legal practice turns out in every case to be based on subsidiary collections of known rules and metarules from within the legal system. The expert system is able to (re)construct these subsidiary collections (descriptive mode) and at the same time to apply all the known rules and metarules (supplementary mode) and thus provide an overview of the scope for decisions (alternatives) and of the reasons for using this scope (choosing from alternatives) in a certain way. The expert system thus provides pointers to the reasons behind the use of subsidiary collections instead of the complete collection of known rules and metarules.

In the 5 complex cases 30 (66%) of the 45 decisions were amended by the ESM: 9 (20%) of the 45 examined decisions were revised (contradicted), furthermore 11 (24%) of the 45 examined decisions turned out to be subject to competition of legitimate (contradicting) alternatives, which were not taken into consideration in these cases, and 10 (22%) of the 45 examined decisions qualified for legitimate extensions.

In the 35 general cases 315 of the 385 decisions turned out to be based on insufficient gathering of data. As a consequence of this and the erroneous or non application of valid rules according to the ESM 104 (27%) of the 385 decisions should be amended: 7 (2%) of the 385 decisions should be revised, 34 (9%) of the decisions are certainly subject to the competition of legitimate alternative (contradicting) decisions, 31 (8%) of the decisions are subject to the competition of legitimate alternative (contradicting) decisions depending on the content of unknown additional data and 32 (8%) of the decisions should be extended.

In both complex and general cases the legitimacy of the decisions proposed by the ESM has been judged to be in accordance with Dutch law by the independent assessors.

The first clue to the reasons behind not fully applying the known rules and metarules is the lack of legally relevant data in the case descriptions. Given the nature and the context of the data that are present, which appear to be determined by the demands placed by the rules applied in the case in question with regard to the gathering of data, and the presence of the missing data in other cases in which the rules were applied, it is likely that the rules for the collection of the missing data were unknown to the decision-maker or were considered (in error) to be inapplicable. This assumption was confirmed by the closer investigation of a number of instances. The incompleteness led to omissions in all of the instances investigated, and in a few instances to the wrong conclusions. The legal expert system is capable of drawing all the conclusions required by the complete collection of rules and of collecting all the data needed for this.

The second clue to the reasons behind not fully applying the known rules and metarules is the occurrence of conflicts between rules, in which the rules actually applied were usually not legal rules but rather interpretation and policy rules. In other words the legal rules prompt a different conclusion than their implementation in practice. In certain instances this means that defects perceived in the legislation in practice due to the application of individual interpretation and

policy rules can be repaired, and in other instances that the rules are unknown. This indication was able to be confirmed by a number of instances. The legal expert system is capable of generating all (conflicting) solutions and thus revealing the defects in the rules and the implementation.

2. Insufficient justification for decisions
Another drawback in the implementation of the rules in legal practice that has been revealed by the comparison with the ESM is the almost total lack of grounds for the decisions investigated. In general, the justification could only be reconstructed by means of the record of the laws applied in general and of the data gathered. The legal expert system is capable of justifying the connection between the data gathered, the rules applied and the conclusions drawn, and to explain them.

Conclusion
It has turned out to be possible to make a computer model of legal knowledge as it exists and is used among practising lawyers (a practical model, the descriptive modus of the ESM). The practical model has a descriptive, explanatory and possible supportive significance. Further, with the help of the computer model it is possible to improve the application of legal knowledge in practice in a qualitative sense (a normative model, the supplementary mode of the ESM) by the more complete collection of data, the application of a more complete collection of rules in force and a better justification for decisions. The normative model is an instrument that can analyse shortcomings and possibly improve quality.

Implications for legal practice

Which Environmental Law tasks can the ESM support?
The ESM is a system for collecting data, for applying rules to this data, for drawing conclusions and giving arguments for them, for formulating administrative orders, and for providing directives for action. The conclusions may be legal conclusions (which rights and obligations apply to a case) but also administrative conclusions (which directives should be imposed; are any directives being violated; which implementation or enforcement actions should be taken). Because the ESM has these features, it can fulfil implementation, enforcement, and advisory tasks.
As far as *implementation* is concerned, the ESM's corporate data model may serve as an electronic questionnaire (systematic gathering of all relevant information), as a decision support system (systematic application of all rules, indicating the scope for decision-making and the policy considerations for using this scope), and as an executive administrative apparatus (monitoring legal procedures, calculating legal dues, formulating administrative orders based on the corporate data gathered, the applicable rules, and the selected technical directives).
As far as *enforcement* is concerned, the ESM's corporate data model may serve as a detection tool (which companies in a particular region use or produce certain chemicals), and, in combination with the rule model, as an enforcement tool (which directives apply to a particular company; what information should be gathered for enforcement purposes; has the company observed the directives; which enforcement actions should be taken).
Finally, the ESM can fulfil *advisory* tasks because it can show companies involved in decision-making about new business premises or innovations whether a permit is required, which technical directives will accompany the permit, and thus what investments will have to be made

in technology. In addition, a corporate environmental care system (description of relevant corporate data, permits, directives, and measures to be taken) can be based on the ESM.

The influence of the ESM on the application of Environmental Permit Law
The ESM can improve the quality and efficiency of environmental law implementation and enforcement, increase legal security, and improve the flow of information. This will mean better environmental protection, a streamlining of implementation and enforcement, and more and better information available to the companies involved and other interested parties.

Improving the quality and efficiency of implementation and enforcement
Quality improvements may be expected in terms of better new administrative orders and better reviewing of old orders, since the ESM enables more thorough data collection, applies the rules better, and provides better arguments for the administrative orders it suggests. Enforcement may be improved also, as the ESM can improve detection (which companies use which chemicals) and provide enforcement directives (which enforcement actions should be taken).

Quantitative improvements may be expected in terms of information-sharing, faster issuing of administrative orders, faster reviewing of old orders in the light of new facts, and bulk reviewing of old orders in the light of new rules. Implementation and enforcement tasks fulfilled by different agencies usually require the same basic data set (administrative, technical, and legal data). Using shared databases will mean that data needs to be collected and stored only once and that implementation and enforcement agencies will be able to use each other's information. It will take less time to deal with new permit applications (less exceeding of terms) and review existing permits (determining the consequences of new regulations for all companies of a particular type).

Increasing legal security
The rule model that is part of the ESM contains legislation, implementation rules, jurisprudence, and policy rules. Thus, the ESM provides a clear picture of the legal decisions that may be expected and the considerations on which these decisions will be based. Making local policies explicit need not limit the local scope for decision-making and negotiation. However, any deviations from formulated policies will have to be supported by better arguments. Apart from the fact that better arguments as such are an improvement, they may also prevent legal conflicts (objections and appeals).

Improving the flow of information
The ESM indicates which rights and obligations apply to a particular case. The system can explain its conclusions by listing the data and the rules on which it has based them, but also by giving the user direct access to the relevant legal sources (rules, jurisprudence, and policy) and explanatory texts. The legal sources and explanatory texts are part of a help system. These sources and texts can be connected by means of hyperlinks, so that the user is referred to implementation rules from within the text of a law, for example, or to jurisprudence from within a legal concept that is part of legislation. The ESM can therefore serve as an information source for companies and interested parties, and answer queries concerning both the legal sources and specific cases. Such queries may relate to the implementation or enforcement of environmental law, but also to specific rights and obligations of companies and interested parties.

Conclusion
The ESM has been successfully tested against forty cases from actual legal practice (petrol stations and secondary aluminium smelters). The system appears to be a good model for the executive practice and to have an important supplementary function. This supplementary function rests on the ESM's more comprehensive database, its ability to apply rules more thoroughly, and its better arguments for the administrative orders suggested. ESM's decisions and arguments have been checked by eighteen independent assessors. The ESM is operational and a straightforward demonstration can be consulted at http://jurix.rechten.rug.nl

Further research
The theoretical basis provides points of departure for further jurisprudential research into the nature and effect of legal rules and interpretation of the rules of law, which may be formalized and made operational by further research into legal information science directed towards the refining and expansion of the Logic of Reasonable Inferences and the expert system shell Argumentator.

The test research gives rise to further legislative-technical and implementation-technical research into the occurrence and prevention of defects in the rules and their implementation. The legal expert system appears to be a useful instrument for this, not only for the detection of omissions, concurrence, contradictions, and logically unnecessarily complex linguistic constructions in the rules, but also for the ascertainment of shortcomings in the gathering of data, the application of rules, and the provision of justification in actual practice.

Finally, further research should be directed towards the wider testing of the Expert system for the Environmental Permit Law in instances in which there are several or conflicting solutions to legal problems, towards the possibilities of supporting and improving decision-making in legal practice, and towards making the expert system for Environmental Permit Law suitable for use in actual practice.

References

Vey Mestdagh, C.N.J. de, Bos, G. (1989). Conflicting legal opinions, a model for legal knowledge systems. In: Martino, A.A. (red.). *Pre-proc. of the 3rd International Congress on Logica Informatica Diritto* (2 vols.), pp. 217-241. Florence: Consiglio Nazionale delle Ricerche, Instituto per la documentazione giuridica.

Vey Mestdagh, C.N.J. de, W. Verwaard, J.H. Hoepman (1991). The logic of reasonable inferences. In: Breuker, J.A.P.J., R.V. de Mulder, J.C. Hage (red.). *Legal Knowledge Based Systems, Model-based legal reasoning*, pp. 60-76. Vermande, Lelystad.

Vey Mestdagh, C.N.J. de, (1997). Juridische Kennissystemen, Rekentuig of rekenmeester? Het onderbrengen van juridische kennis in een expertsysteem voor het milieuvergunningenrecht (PhD Thesis). 386 pages. Kluwer, Deventer, 1997, ISBN 90 268 3146 3. English summaries and demonstration pages can be consulted at http://jurix.rechten.rug.nl

The references corroborating the original research are incorporated in the publications above.