Smart Combination of Legal Rules and Geo-Information to Support Spatial Development Projects

Vincent VAN DIJK, The Netherlands and Rick BLEEKER, the Netherlands

Key words spatial planning, legislation, digitalization, business rules management, business rule engine

SUMMARY

In 2021 a new environmental planning law, the 'Omgevingswet', is planned to go into effect in The Netherlands. This is a major legal operation which replaces many existing laws. A new smart solution - the 'Digitaal Stelsel Omgevingswet (DSO)' - is set up to support citizens, companies and government with planning and management of the physical environment. Rijkswaterstaat is one of the development partners. It is a Dutch governmental organization, part of the Ministry of Infrastructure and Water Management. DSO combines legal rules, business rules and geometry in a system of software components and services. These concepts are used to provide end users – citizens and companies – answers to the question if they need permission from the government for their activities with impact on the environment (like building, demolishing, draining waste water). DSO also supports the application for a permit, based on the relevant business rules for the specific planned activity on a specific location.

One of the main innovations is the integration of geo-information with business rules management. Also an innovation is the concept that local government not only need to set up land use regulations in legal documents, but they are also responsible to set up business rules based on these regulations. Business rules are based on a new decision management standard based on the Decision Model and Notation (DMN) standard. The business rules are used by the system's rule engine to provide end users with a decision. Legal rules and business rules can share concepts like activities and geometry. When executing the business rules, the geometry information object attached to the legal rules is used to provide the end user in the DSO portal a decision based on the legal requirements at a particular location.

DSO will need facts to come to a decision. To ask questions and gather answers the system needs input (facts): location with the intended activities defined by the Omgevingswet. The location can either be an address, a point on a map or even a polygon. Some facts are only known by the end user and they will be collected through questions smartly generated by DSO. Some facts can be deduced because the facts are already known from one of the registers of the government. Facts, which are dependent on a location as indicated in law, can also automatically be deduced. For example, if a legal rule states that is prohibited to cut down a tree in a nature reserve, then this fact can automatically be used by the business rule based on this legal rule. A challenge to this system is when the location polygon of the development site only touches a part of the legal location. Then further business rules are used to be able to come to a correct decision. This will be done in interaction with the end user.

DSO will enable citizens and companies to plan their development activities and guide them through the permit application process with minimum effort, using automated decision making combining both legal rules and geo-information.

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1 INTRODUCTION

1.1 Introduction Omgevingswet

In 2021 a new environmental planning law, the 'Omgevingswet', is planned to go into effect in The Netherlands. The main goal of the Omgevingswet is to simplify and combine many legal rules concerning spatial development. The new law combines 26 laws into 1 and the 5000 articles in these laws are reduced to merely 350 (Louwsma, 2018). In the legislative process many other improvements will be implemented:

- Alignment of rules on spatial development, environment and nature protection.
- Stimulation of sustainable projects.
- Shift from nationwide regulations to more local regulations. These local rules can be adapted to specific local circumstances and objectives.
- 1 (digital) place to apply for permits and one government body for further processing.

To achieve these goals a digital platform is needed. Through this platform everyone can have the same information and apply for a permit if necessary. This platform is called the 'Digitaal Stelsel Omgevingswet', which we further on refer to as 'DSO'.

1.2 *Introduction DSO-LV*

DSO is a new smart solution to support citizens, companies and government working with the Omgevingswet. DSO consists of many components on national and local level. The national part of DSO is referred to as DSO-LV (LV means 'Landelijke Voorziening' or 'National Facility').

DSO-LV combines legal rules, business rules and geometry in a system of software components and services. These concepts are used to provide end users – citizens and companies – answers to the question if they need permission from the government for their activities with impact on the environment (like building, demolishing, draining waste water). DSO also supports the application for a permit, based on the relevant business rules for the specific planned activity on a specific location.

1.3 About Rijkswaterstaat

Rijkswaterstaat is part of the Dutch Ministry of Infrastructure and Water Management (I&W) and responsible for the design, construction, management and maintenance of the main infrastructure facilities in the Netherlands. The legislative process of the Omgevingswet was initiated at the ministry of I&W. As the implementing body of the Ministry of I&W, Rijkswaterstaat became one of the development partners of DSO.

2 THE SET UP OF THE SMART SOLUTION

2.1 Software components and services

DSO combines legal rules, geometry, information and decision rules in a system of software components, portals and services. DSO operates on the basis of the architecture principle "everything is a service". Where a service runs, is not important; as long as the service is built according to service standards and is connected to DSO's central hub. Portals are the framework where general information and specific applications are exposed for end users, administrators and developers. These applications are standalone applications, which run in a shared portal and have the same look and feel. Applications make use of available services through the central hub.

The component containing the decision rules supports the delivery, registration and execution of decision rules. Therefore, this component also offers decision services and gives an answer to the question whether end users need permission from the government for their activities with impact on the environment (like building, demolishing, draining waste water, etc).

The end user application supports the application for a permit, based on relevant decision rules for a specific planned activity on a specific location, provided by the decision services. Also, third parties are able to use these services to set up their own smart solution.

2.2 The rule system of DSO

2.2.1 Legal rules

Legal rules as part of land use regulations are the basis for the rule system of DSO. Together with the new smart solution, the way legal rules are drafted and publicized by both central and local governments is also an innovation. It includes the means to deliver machine-readable legal texts. This will be implemented by annotating information in the legal texts. Annotating is the process where information is added to parts of legal texts, such as a chapter, paragraph, individual article or even a sentence. To make the best use of the machine-readable features, a limited list will be used to make annotations.

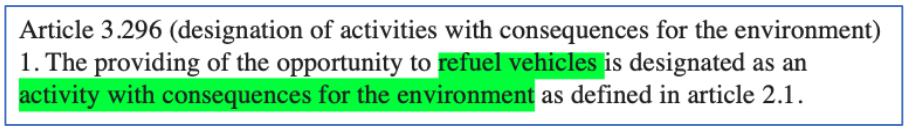

Figure 1: Annotating legal text

This will result in a set of characteristics, which can be used in a software application. For instance, to filter texts or to present legal information on a map. These characteristics are available in the system as objects. A registry of objects can be called by DSO components and the decision service uses this information to come to a decision.

Not only annotations as activities or functions will be made, but also geo-information will be attached to legal texts. With this extra information, a user can quickly find what legal rules are relevant for the activity he or she likes to deploy on the specific location. In the DSO this is

done with the help of a component, the Legal Mapviewer. The Legal Mapviewer only displays the legal rules that are relevant for the given location.

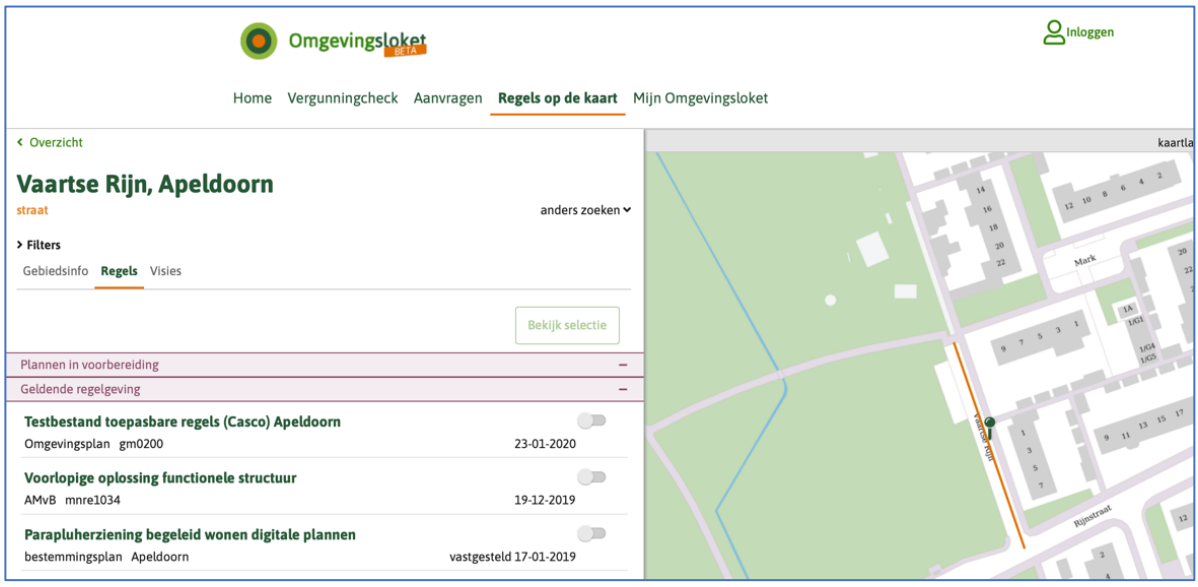

Figure 2: The Legal Mapviewer: based on the location (right), the relevant legal rules (left) are shown.

Not only are these machine-readable characteristics of use for a user of the Legal Mapviewer to find information on a certain location, but they can also be used in the execution of decision rules. This creates a direct relation between legal rules and decision rules, which can be used to automatically answer location related questions.

2.2.2 Decision management

Decisions are an important feature of DSO. A decision is *"the act of determining an output value from a number of input values, using logic defining how the output is determined from the inputs."* [Silver, 2016]

With the use of decisions, the end user can be supported and steered in finding an answer to his or her questions (*Do I need a permit to perform my activity? Am I eligible to apply for a permit?*), without all non-relevant aspects.

Decisions are made on the basis of prevailing circumstances. This can be seen as all the information that is required to be able to take a decision. In decision management words, these are known as facts. Facts may be either decisions in itself or information taken from the end user or other sources such as registrations. A fact can also be the location of the user's activity. Decisions as such are not part of the legal body of a regulation, but they are based on the regulation. This is best illustrated by the way both legal rules and decision rules are used. Where a user of legal rules, the above-mentioned user of the Legal Mapviewer, is interested in a specific section of a legal text, the non-legal users are more interested in finding an answer to their (legal) questions. In other words, they need a decision on their question.

2.2.3 The relation between legal and business rules

Decisions and facts are based upon legal rules, such as land use regulations. In a large part of rule driven solutions, legal rules are only the specifications for decisions and there will be no further relation. Some traceability between decisions and legal rules is an exception. However, in DSO legal texts are drafted as machine-readable texts and therefore legal rules and decision rules have the possibility to automatically share concepts like activities and geometry. There are three object types that are shared between legal rules and decisions: activities, location and reference (Van Bergen et al., 2019).

Activity: the legal activity, which is regulated by legal rules. An activity is every human conduct, or every human omission, that will have effect on or will lead to a change in the environment. For instance: building a house, setting up a fueling station or cutting down a tree. In the legal system activities are set up as a structure of activities. This can best be seen as a taxonomy:

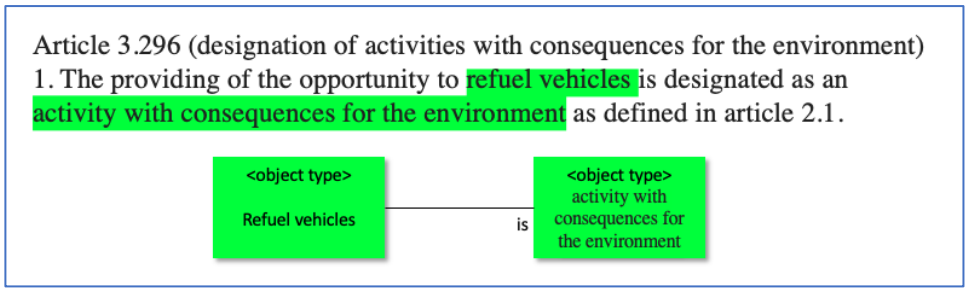

Figure 3 Activity taxonomy

This taxonomy of activities is used by the decision management component to store all decision rules from all rule setting authorities with the relevant activity. Therefore, exactly the same activity as defined in the legal text is used in providing the end user with an answer to his questions. This needs to be a very strong relation between the legal text and the decision management system. Without the machine-readable activity object, it is not possible to deliver decision rules to the system and thus not possible to take automated decisions.

Location: the spatial delimitation of a rule or of any other object type, described in a rule. A location can either be an area or a group of areas, consisting of specific geometric information described in geography markup language (GML). For instance: “The Netherlands”, “the old centre of Amsterdam” or “nature areas near the river Maas”. A location can be attached to any other object in the legal rule system, such as an activity or a legal rule.

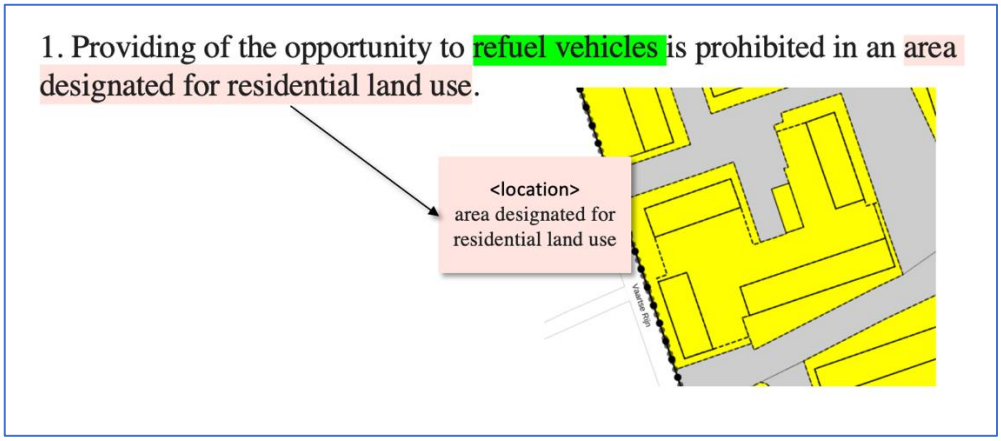

Figure 4 Location, including the gml, attached to the legal text

When executing a decision based on the legal rules, the location as a geometry information object attached to the decision rules, can automatically be used to provide the end user in the DSO portal a decision based on the legal requirements at that particular location. Decision rules which are not relevant for the given location will not be taken into consideration by the rule engine. The same accounts for activities; an end user will only be able to choose an activity, that is relevant for his location. This will be elaborated below in the section on the end user application.

Reference: the legal document or a part thereof, that is the legal source of the decision and the decision rules. The reference will provide a trace between the legal rules and the decision rules that are used by the decision management system.

2.2.4 Ownership of decision rules

Another aspect of the DSO is that central and all local governments are not only responsible to set up machine readable legal regulations, they are also responsible to set up decision rules based on these regulations. For this to work, they need to include geometry objects in the legal regulations, which will be used when executing decision rules. This is a major task for these administrations, as they usually will not have experience and knowledge about decision management.

For the DSO as a national facility, it is a challenge to be able to process all the different decision rules from all governments, in total almost 400 (1 central government, 12 provinces, 21 water authorities and 355 local communities). Combined with the low level of knowledge of decision management this will not be possible without prescribing a way to set up decisions. Prescriptions and requirements are set by the standards of the DSO.

2.3 Standards of the DSO

DSO sets three new standards which are explained in this paragraph. The second standard STTR is most relevant for this article and will be explained in more detail.

2.3.1 STOP

The STandard for Official Publications (STOP) together with a number of profiles for several kinds of legislation (TPOD) set the standard for all land use regulation, both for the central government as for all local governments. This standard supports all legislative functions such as drafting, adaptation, publication and making legal texts available. The standard also consists of information models, which inter alia contains the definitions of the above-mentioned object types (Geonovum, 2020).

2.3.2 STTR

To have the certainty that decision rules from all different governments can be executed in the rule execution system of the DSO, a new standard on decision rules (STTR) will be implemented. If the decision rules are set up according to the STTR and the accompanying information model (IMTR), the system will be able to semantically and syntactically understand and execute the decision rules, even if they originate from almost 400 different government bodies (Rijkswaterstaat, STTR, 2020).

Pillars of the STTR standard

The standard consists of three basic pillars. Basis for the decision rule logic is the internationally adopted standard on decision modeling, the Decision Model and Notation (DMN). DMN is one of the standards of the Object Management Group (OMG). DMN is a modeling language and notation for the precise specification of business decisions and business rules (OMG, 2019). DMN is easily readable by the different types of people involved in decision management. DMN is not only a standard, it is also vendor independent. The ‘and’ between Model and Notation emphasizes the distinction between the metamodel – the formal definition of the model elements and their relationships – and the notation, the graphical depiction of both Decision Requirements Diagrams and the decision logic, including decision tables and other forms of boxed expressions (Silver, 2016, p. 20).

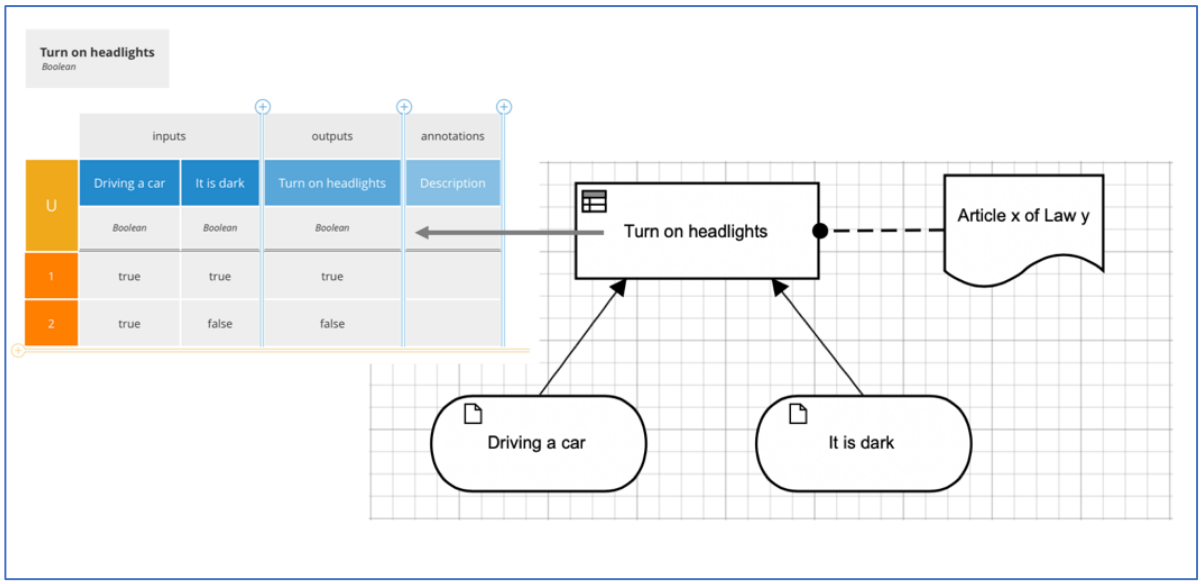

Figure 5: overview of a Decision Requirements Diagrams and decision logic

The second pillar is the model of layers of the STTR. The layer model recognizes the fact that there are different types of decision rules:

Logic: the translation of the logic of the legal rules into a DMN decision model, including decisions and decision rules. This model states the legal logic and does not contain any rules needed for implementation purposes. The decision model can therefore be seen as isomorphic.

Data: legal rules use legal grounds. A rule can state that if it is dark, you must turn on your headlights. Dark can be seen as the legal ground for the obligation to turn on the headlight. The determination if is dark must be taken from real world knowledge. Such a fact ("it is dark") must be provided from an outside agent. In system terms, this can be a question to the user ("is it dark?") or be taken from the system's clock. With the data layer it can be defined where the facts can be taken from. A question for the end user can be specified. Also, it can be specified that a fact must be obtained from a registry like the Registry of Buildings and Addresses. Within the Netherlands, a framework of authentic registers exists, some of which are spatial, like the Building and Address Register (Coetzee et al., 2018). A specific location can also be seen as a fact, as this fact determines if a decision rule is valid on that specific location. This will be elaborated further below.

Conversion: the format in which data is available does not always meet the format of the legal ground. With this layer it is possible to convert the data to a format the rule engine can use. For instance, a date input (mm-dd-yy) can be converted to a boolean ground ("is it later than mm-dd-yy?").

Interaction: the desired behavior of the end user application. This overwrites the rule engine's declarative behavior. The sequence of questions as presented as an outcome of the inference logic of the rule engine, does not need to be a logic sequence for an end user. Therefore,

priority on questions can be set with this layer. Another option to structure the questions for the end user is grouping of questions.

Content: content is not a rule, but extra textual or visual information, to be used as explanation to end users.

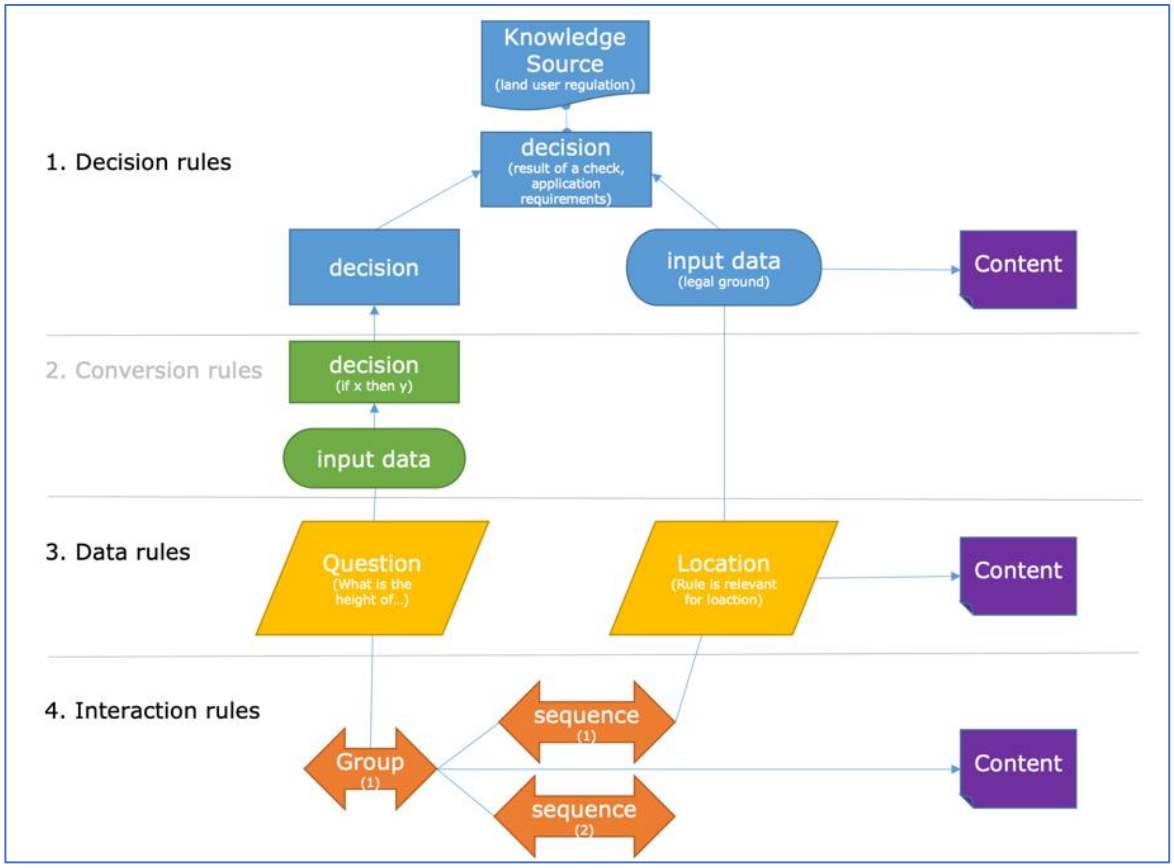

Figure 6 The layer model

The third pillar of STTR is the extension to the DMN model. The metamodel of DMN provides the means to add extensions to the standard. As DMN has a declarative character, it is not possible to specify any interaction requirements. Next to this, DMN only uses an input data concept as the input of a decision. It is not possible to specify different sources of data input. Therefore, the concepts of the standard used for the data and interaction layer are expressed in the extension elements; in terms of STTR, the DMN+ part. The DMN+ part uses the default DMN mechanisms, to add extra XML structures to a DMN file.

2.3.3 STAM

The third standard of the system is a very important standard for the processing of the application by a receiving body, the government agency responsible for issuing permits. The standard for application and notification (STAM) and the accompanying information model IMAM set the standard for the delivery of applications and notifications (Rijkswaterstaat, STAM, 2020). This standard is not relevant for the scope of this paper.

2.4 Execution of business rules

2.4.1 Rule engine

The decision rules are used by the system's rule engine to provide end users a decision. The rule engine executes the decision rules, based on the land use regulations of all the different (local) governments. For this task the open source Drools business rules engine is used. As explained above, the logic will need facts to come to a decision. When all the relevant facts are known, the rule engine can make a decision for the end user, which can also be seen as a fact. Some facts are only known by the end user and they will be collected through questions in the end user application. The height of a new building will only be known by the one who plans to build it. Some facts can be deduced because the facts are already known from one of the authentic registers of the government. If a user is known – because he logged on – the user's information can be gathered from a register. Also, the location indicated by the user may help in the execution of decision rules as will be explained in the next paragraph.

2.4.2 The importance of a location

The location of the end user provides one of the most important facts. A location can be a point location or a polygon. The location is a fact for the rule engine. With this fact, the rule engine can deduce if activities are relevant**.** Also, the rule engine uses the location to execute certain decision rules which are part of a relevant activity. It is not needed to ask the end user if certain rules on a location are relevant, because rules based on a location will automatically be executed if the location of the user's activity will touch the location of the decision rule. For example, if a legal rule states that is prohibited to start a facility for refueling vehicles in an area designated for residential land use, then this fact can automatically be used by the decision rule based on this legal rule and attached location. It is not needed to ask the user if he will deploy his activity in an area of living, the system already has that knowledge as the same location that is part of the legal rule, is attached to the decision rule:

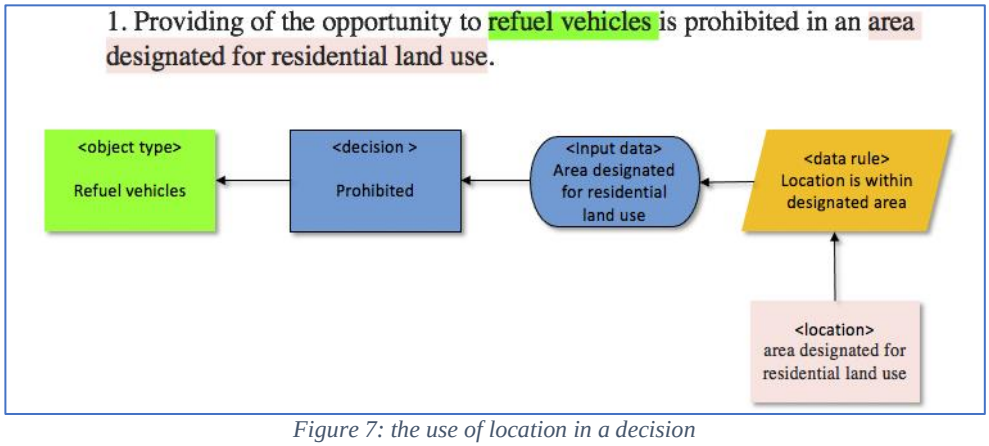

Figure 7: the use of location in a decision

This has the advantage that before there is any interaction with the end user, it can already be decided that certain decision rules are relevant or not. However, in some cases it is not always possible to make this deduction. To elaborate on this challenge, it is first needed to explain a little more of the end user application as provided by DSO.

3 END USER APPLICATION

3.1 General set up of end-user applications of DSO-LV

DSO-LV contains multiple end-user applications all of which are accessible via a portal:

- 'Permit check' – where a user can check whether permits or notifications are necessary to be allowed to carry out a project.
- 'Apply for a permit'- speaks for itself.
- 'Measures check' – for many activities in the Omgevingswet, there are rules applicable. The initiator should take certain measures to comply to these rules. This application suggests measures to comply with the legal rules.
- 'Legal Mapviewer'- shows which legal rules apply on a selected location.

Three of these applications use the smart application of decision rules and geo-information. Only 'Legal Mapviewer' does not. For this paper, we zoom in on the permit check, because this application shows the advantage and challenges of the smart solution best.

3.2 Driven by services

All end-user applications are fully driven by services. The application itself contains no business logic. It uses the services described before and only adds presentation logic, partly based on the interaction layer. The advantage of this is that the end-user application does not need to be adapted when there is a new insight concerning the business logic.

3.3 Permit check and geo-information challenges

The permit check is based on tasks instead of activities. The difference between these two is that that tasks are defined in the legal rules, while tasks are in easy understandable language. DSO transforms the tasks to activities to execute decision rules based on activities. The advantage for the end user is he does not need to know the activities defines in the legal rules to use the permit check.

To perform a permit check, the user must go through four steps:

1) Select a location
2) Select one or more tasks to be performed on the project
3) Answer questions about the tasks
4) Get the conclusion whether one or more permits and/or notifications are needed for the selected tasks on the selected location.

3.3.1 Select a location

The user can select a location in a number of ways: through their address, cadastre code of the location, by entering coordinates or by drawing the location on a map. See figure 8, where the user has drawn a polygon, representing the area he wants to redevelop.

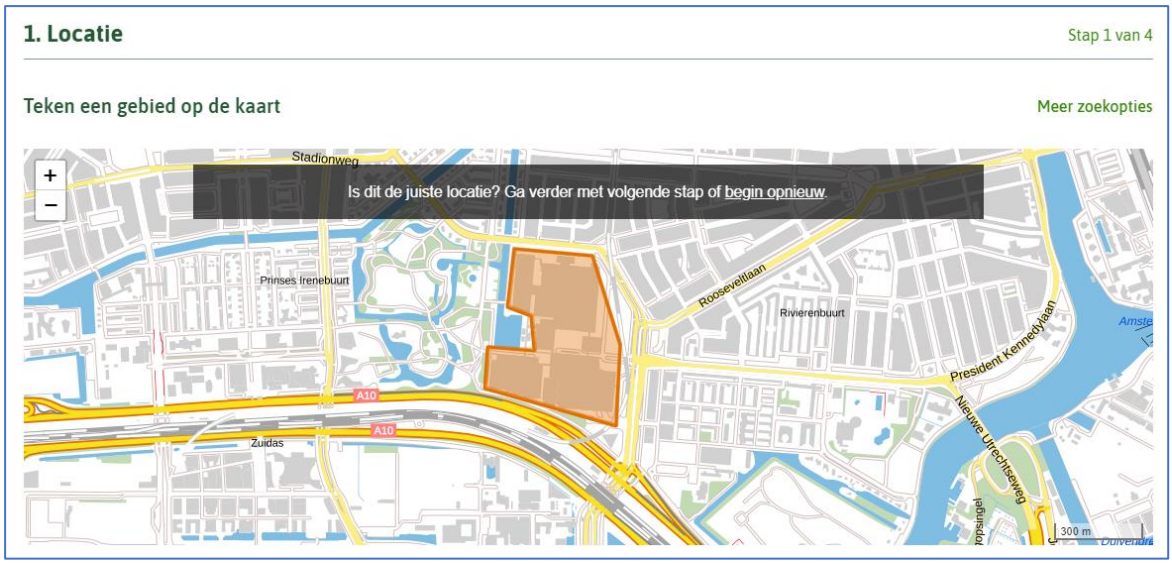

Figure 8: Permit check step 1: select location

3.3.2 ***Select one or more tasks***

After selecting the location, the next step is to choose one or more tasks (see figure 9: constructing a fuelling station)

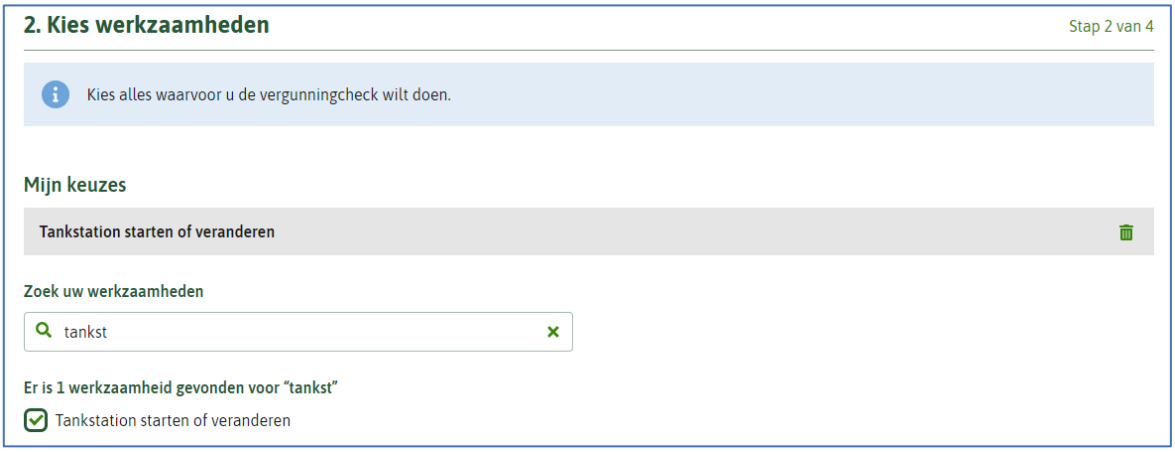

Figure 9: Permit check step 2: select tasks

3.3.3 Answer questions

The third step is to answer questions on the selected tasks for the selected location (dimensions of buildings, type of materials used, etc.). Most questions will be about the chosen task and are quite straightforward for the system. It gets much more interesting when the question is not only based on the task, but also on the location. In this situation, the user needs to be able to see the chosen location and the area where certain rules apply:

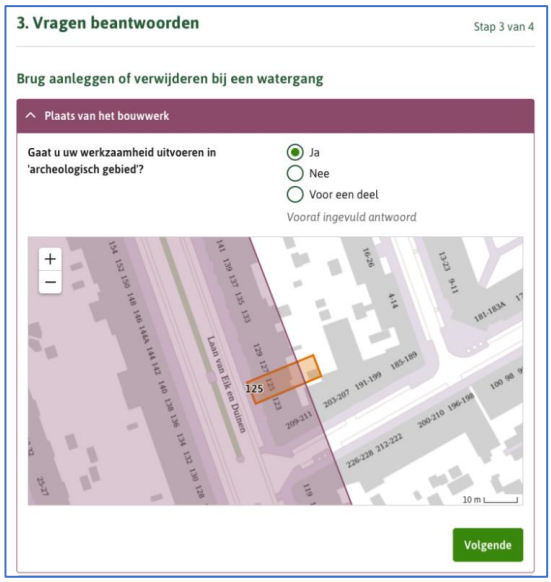

Figure 10: Permit check step 3: answer questions

Figure 10 shows the location the user selected (the red square area in the middle) and the area where the decision rule (as based on the legal rule) is applicable (the purple area on the left, for example an area designated for residential land use). The user is asked whether the tasks are planned inside, outside or partially inside the purple area. In the next sections, we explain how this affects the different services and which challenges this brings up for the smart solution.

3.3.4 Permit check: final conclusion

This is the last step of the permit check where the end user gets the result: whether he needs to apply for a permit or not. In case a permit is needed, the user will be prompted to navigate to the 'Apply for a permit'-application.

3.4 Geometry options

As we described under the 'answer questions' step of the permit check, things get interesting for the smart solution when the end user has selected a polygon. As an example, we use the case described in figure 7. The legal rule states: 'Providing the opportunity to refuel vehicles is prohibited in an area designated for residential land use. The corresponding question is the decision rule: 'Are you going to refuel vehicles in an area designated for living?' with a boolean answer 'yes' or 'no'.

3.4.1 Challenge: boolean question and with three situations

A challenge to this system is when the location polygon of the development site only touches a part of the legal location. Then further business rules are used to be able to come to a correct decision.

There are 3 possible situations which can occur when combining the area where the rule applies and the location of the user. These are shown in Figure 11Figure 8.

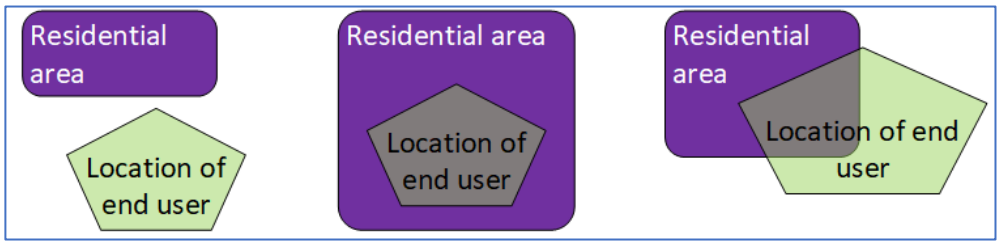

Figure 11: Combinations of location of end user and legal rule.

The first is the situation (on the left side in Figure 11): the location of the end user does not intersect with the location of the legal rule and thus the location of the decision rule. This means the rule is not relevant to the end user. The rule engine automatically answers the question with 'no' and the permit check does not show the question.

The second situation is also quite simple. The location the end user selected lies fully inside the location of the legal rule. The system prefills the answer to the decision rule question with 'yes' and the permit check shows the question with the prefilled answer.

The third combination is the most interesting. In this case the location of the user intersects with the location of the legal rule. Therefore, the answer should be 'partially'. The challenge is that the system has a question with only boolean answer options 'yes' or 'no'. In the decision rules a conversion needs to be specified. This conversion states whether 'partially' converts to 'yes' or to 'no'. The government writing the decision rules has to make the choice which conversion is the safest option. It is not desirable for the permit check to give a result 'no permit is necessary' when this is incorrect. The other way around is that the end user applies for a permit and the government will answer that a permit is not needed. This leads to less problems in law enforcement. The conversion is done by the system, but not shown in the permit check. The user only sees the prefilled answer 'partially'.

3.4.2 Solution

The real solution can only be found in collaboration with the end user. In many cases the location drawn by the user is the entire area where the project will be carried out. The location of the specific task as a part of the development project is usually much smaller. Figure 12 shows an example of the possible location of the fuelling station. In case the system prefilled the answer with 'partially', the end user has the option to change the answer. This will overrule the prefilled answer by the rule engine.

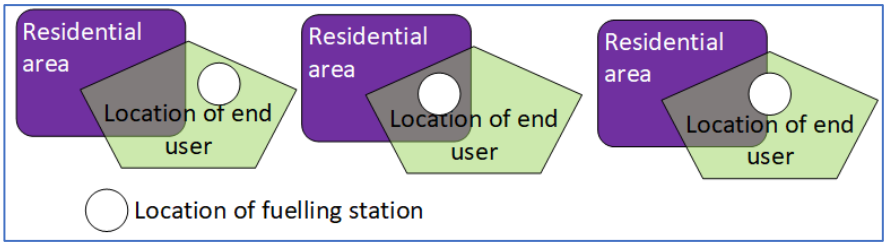

Figure 12: Specific location of the fuel station in the location of the end user

When changing the prefilled answer, the end user has three options: 'yes', 'no' and 'partially'. If the answer remains partially, the conversion will remain and reason towards a safe outcome.

4 CONCLUSION

One of the main innovations of DSO is the incorporation of geo-intelligence throughout the process of spatial development planning and control. Geo-information is applied and automatically processed in three ways:

- User input: the location of the area to be developed by point or polygon.
- The geo-information objects which are linked to the legal rules from various sources (law, land use zoning plans, protected areas, etc).
- Spatial authentic registers maintained by the government, like the Buildings and Address Register.

The examples in this paper show that the inclusion of geo-information facilitates the user by making the process more transparent and by avoiding asking unnecessary questions.

DSO will enable citizens and companies to plan their development activities and guide them through the permit application process with minimum effort, using automated decision making combining both legal rules and geo-information. The use of geo-information is one of the main innovations within the domain of development planning and control. DSO also helps governments, because they have to setup business rules only once, instead of having to answer many questions citizen and companies concerning permit applications.

REFERENCES

Coetzee, S., Odijk, M., van Loenen, B., Storm, J. and Stoter, J., 2018. Stakeholder analysis of the governance framework of a national SDI dataset – whose needs are met in the buildings and address register of the Netherlands?, International Journal of Digital Earth, DOI: 10.1080/17538947.2018.1520930.

Geonovum, 2020. https://www.geonovum.nl/geo-standaarden/omgevingswet.

Louwsma, M., 2018. Towards a new legislative framework for spatial planning – the Environment and Planning Act. FIG Congress 2018 Istanbul.

OMG (Object Management Group), 2019. Decision Model & Notation (DMN). https://www.omg.org/dmn/.

Rijkswaterstaat STAM, 2020. Specificatie STAM: Koppelvlakbeschrijving Aanvragen en Meldingen, Programma Implementatie Omgevingswet.

Rijkswaterstaat STTR, 2020. Specificatie STTR, Beschrijving Standaard Toepasbare Regels, Programma Implementatie Omgevingswet.

Silver, B., 2016. DMN Method and Style. Cody-Cassidy Press.

van Bergen, L., de Horde, L., Janssen, P., Jansen, N., 2019. Conceptueel Informatie Model Omgevingswet (scope DSO) 0.98-kern. Amersfoort, Geonovum.

BIOGRAPHICAL NOTES

Vincent is a senior advisor on rule driven solutions and has almost 20 years of experience in the triangle composed of rules, processes and data. His legal background and extensive experience with IT projects help Vincent to understand both the business domain and implementation aspects in organisations with complex rules or information architecture. In the context of DSO, he has the role of product owner for the business rules management solution, as described in this paper.

Rick works for Rijkswaterstaat as a senior advisor. He fulfils the role of product owner for the end user applications of DSO ‘Measures check’, ‘Permit check’ and ‘Apply for a permit’. In this role he is responsible for the development of these three applications is in line with the wishes of all stakeholders: citizens, companies and all government bodies in the Netherlands. Rick has a strong focus on end user value in combination with good quality software which he and his team develop incrementally.

CONTACTS

Vincent van Dijk
Rijkswaterstaat
PO BOX 2232
3500 GE Utrecht
THE NETHERLANDS
Tel: +31615072027
Email: vincent.van.dijk@rws.nl

Rick Bleeker
Rijkswaterstaat
PO BOX 2232
3500 GE Utrecht
THE NETHERLANDS
Tel: +31646935701
Email: rick.bleeker@rws.nl