

# Improving quality of the Key registries with 3D building information models and Linked Data

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## SUMMARY

In The Netherlands there are 10 key registries, the Netherlands' Cadastre, Land Registry and Mapping Agency (in short Kadaster) is the source holder for two of them and is for three other key registries responsible for integrating the data into one registry as there are multiple source holders. The key registries in the Netherlands make it possible to improve the efficiency of the Dutch government and enable implementing the 'only once' principle (EU e-government objective). For the key registries to serve as the single source of information, high data quality is of utmost importance. Therefore multiple measures are in place to ensure that source holders provide information of high quality and find out which part of their dataset might be improved. One measure for the key registry addresses and buildings is a quality dashboard that indicates the quality of the data of each municipality and provides a way to compare the quality to other municipalities.

In this paper we discuss this successful method for improving the quality of key registries. We will however more extensively discuss new possibilities for improving the data quality by using 3D building information models (BIM) and Linked Data in the processes of municipalities that we worked on in a showcase project. In the project we have shown that 3D Building information models combined with Linked Data can provide a way to automatically fill quite a big part of the necessary information in a number of key registries. By automatically filling the key registries the data quality is further improved. It makes the registries even more useful within and outside the government. All efforts to improve the quality of the key registries not only improves the government but also helps commercial companies to continue growing their business without the need to create their own registry.

Furthermore this paper will also discuss how using 3D BIM might also improve the efficiency of the planning permit process and giving less rooms for errors both at the side of the municipalities but also at the side of contractors and architects. We expect the efficiency to save time and therefore money for the municipalities, and most probably it will also have a positive impact on the data quality.

## SUMMARY DUTCH

In Nederland zijn er in totaal 10 basisregistraties, voor twee van deze is het Kadaster de bronhouder. Voor drie andere basisregistraties is het Kadaster verantwoordelijk voor de Landelijke Voorziening welke de data van de verschillende bronhouders combineert tot één register. De basisregistraties spelen in Nederland een belangrijke rol in het efficiënter maken van de Nederlandse overheid en maken het implementeren van het ‘only once’ principe (EU e-government richtlijn) mogelijk. Om als basisregistratie de centrale bron te zijn is de kwaliteit van de data zeer belangrijk. Per basisregistratie zijn er daarom meerder methoden die ingezet worden om te zorgen dat de bronhouders data van hoge kwaliteit aanleveren en kunnen bepalen welke deel van hun dataset verbeterd kan worden. Eén van de methoden om de kwaliteit van de basisregistraties adressen en gebouwen te verbeteren is een kwaliteitsdashboard. Dit kwaliteitsdashboard geeft inzicht in de kwaliteit van de data van iedere gemeente en geeft de mogelijkheid de kwaliteit tussen gemeenten te vergelijken.

Dit artikel beschrijft deze succesvolle methode om de kwaliteit van de basisregistraties te verbeteren. We zullen echter dieper ingaan om nieuwe kansen om de kwaliteit van de data te verbeteren. Hierbij laten we de resultaten zijn van een proeftuin project waarin 3D building information models (BIM) en Linked Data gecombineerd gebruikt kunnen worden. Deze modellen kunnen namelijk gebruikt worden om uiteindelijk een groot deel van de benodigde informatie voor een basisregistraties automatisch af te leiden uit bestaande data en modellen. Dit kan bijdragen aan het verder verbeteren van de kwaliteit van de data. En hoe hoger de kwaliteit van de data, hoe geschikter de basisregistratie worden zowel binnen de Nederlandse overheid als voor commerciële bedrijven die de data kunnen gebruik in hun bedrijfsproces.

Als laatste zullen we in dit artikel ook beschrijven hoe het gebruik van 3D BIM modellen de efficiency van het vergunningverleningsproces kan verbeteren en hoe het aantal fouten teruggebracht kan worden, zowel aan de kant van de gemeenten als aan de kant van de aannemers en architecten. Wij verwachten dat de verhoogde efficiëntie tijd, en daarmee geld, kan besparen en hoogstwaarschijnlijk ook een positieve impact heeft op de data kwaliteit.

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## 1. INTRODUCTION

In the Netherlands there are 10 key registries, which together form a digital network of key information that is important for the digital government in the Netherlands. While some of the key registries are not open to all, most key registries are open registries and contain data that can also be used for commercial purposes. The 10 key registries are:

- Key registry Addresses and Buildings (+)
- Key registry Large Scale Topography (+)
- Key registry Income
- Key registry Kadaster (\*)
- Key registry Subsurface
- Key registry Persons
- Key registry Topography (\*)
- Key registry Vehicles
- Key registry Real Estate Valuation (+)
- Key registry Companies

The Netherlands' Cadastre, Land Registry and Mapping Agency (in short Kadaster) is the source holder for two key registries of them (marked with a \* in the above list) and is for three other key registries (marked with a +) responsible for integrating the data into one registry as there are multiple source holders. By integrating the data into one key registry the accessibility for government and companies is improved as they do not have to acquire the data from all source holders (in some cases all 350 municipalities in the Netherlands), but can get the data from one source.

The key registries in the Netherlands make it possible to improve the efficiency of the Dutch government and enable implementing the 'only once' principle (EU e-government objective). For the key registries to serve as the single source of information a high data quality is of utmost importance. Therefore multiple measures are in place to ensure that source holders provide information of high quality and find out which part of their dataset might be improved.

## 2. QUALITY DASHBOARD

One measure for the key registry addresses and buildings is a quality dashboard [Quality dashboard BAG, 2018] that indicates the quality of the data of each municipality and provides a way to compare the quality to other municipalities. In this paper we will provide examples of the quality dashboard for the key registry addresses and buildings. For this key registry there are two quality dashboards, one for the source holders and one for data users. In this way, the source holders have a way to find detailed errors in their data and can improve the

data. The data users have insight in the overall quality of the data and can decide whether or not they can use the data for their own purpose.

## 2.1 Dashboard for source holders

The quality dashboard for source holders provides source holders with detailed information about the quality of the data they submitted to the key registry. The starting point for the source holders is an overview of the quality of their own data (dark coloured part of the columns) compared with the average of all source holders (light coloured part of the columns). In Figure 1 a screenshot of the overview is shown. In this example the source holder is a municipality who can find out in one overview how “up to date” their information is (first column), in the second column what the quality of the data on building years, surface and usage is, in the third column how accurate the geometries of the buildings are, the fourth column how good the addresses are (this source holder scores higher than the average). The fifth column shows status conflicts and the sixth column is reserved for additional projects. This column can be used to focus on specific errors on which the source holders want to improve themselves. While the scores might have to have a large distribution, it is important to realize that the vertical axes was chosen in such a way to reveal the differences, the difference between the top and the bottom is only 5%. So even though the overall quality of the key registry is already high, there is always room to improve it to get even closer to a 100% score.

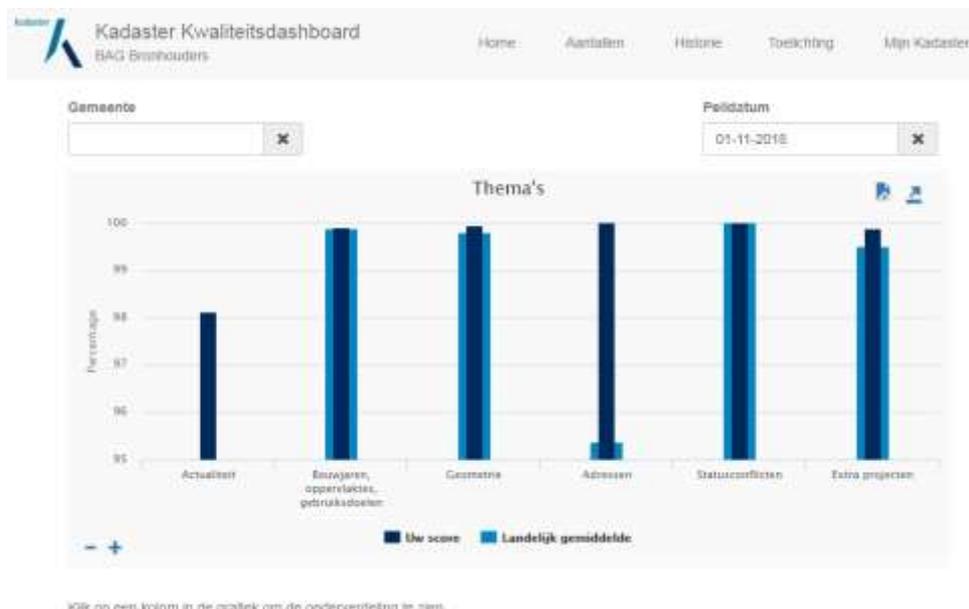


Figure 1: Overview quality dashboard for source holders

While this first overview already provides the source holders with insight in the quality of their data, it is even more useful to see the quality score on a specific theme in more detail. Source holders can therefore click on any of the columns to get more details on their score. Figure 2 shows an example of the details that are shown when clicked on the column ‘Addresses’.

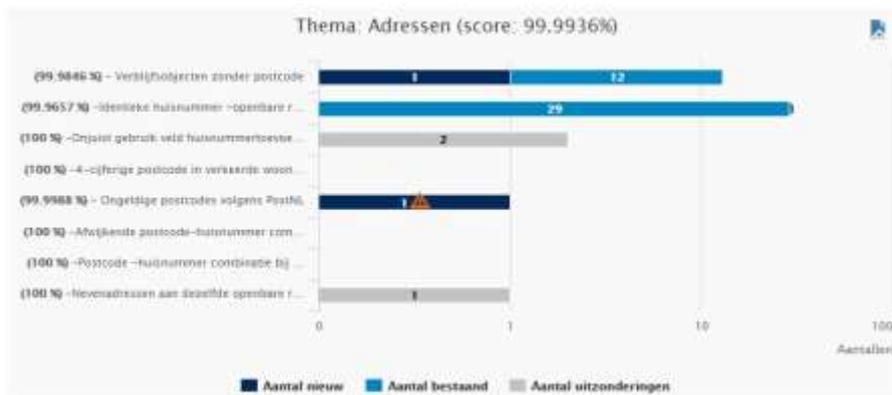


Figure 2: Address quality details for source holders

In this overview more detailed errors are shown (and the quality score of this municipality), and the municipality can even click on the numbers to find the specific addresses that contain an error. In this way it is very easy for source holders to find the errors and to correct them in their registry. They do not have to define queries, or find the errors themselves. An easy to use quality dashboard is provided and constantly updated to show the current errors and to show how the source holder has improved the quality.

## 2.2 Dashboard for data users

While the quality data and the dashboard is important for source holders to improve their registry, the same data can also be used to give data users an insight in the quality of the data they are about to use. For this reason the key registry addresses and buildings also provides a quality dashboard for data users, next to the dashboard for the source holders. This dashboard is based on the same data, but the journey through the dashboard is different. The data users start with the map of the Netherlands (see Figure 3) showing the overall address quality of the key registry per province. Just like before: it is important to look at the scale to not misinterpret the overview: the overall address quality in the whole of the Netherlands is between 99 and 100%.



Figure 3: Address quality dashboard for data users

By selecting another theme (the themes are identical for the source holders and the data users) it is also possible to get an overview of the quality of the geometries of the building in the key registry (see Figure 4), here we see more differences, but still the overall quality is very high. For the data user this is important information if he wants to use the data in another process. Depending on the quality of the data and the process the data is used in, it might be or not, necessary to do additional checks on the data before using it.



Figure 4: Geometry quality dashboard provinces in the Netherlands for data users

As the overall quality of the data could miss the required detail for the data user, it is also possible to dive into the details by first selecting a specific province (see Figure 5 in which we selected the province of Noord Brabant) and then select a specific municipality (see Figure 6 in which we selected the municipality of Eindhoven).



Figure 5: Geometry quality dashboard for a specific province for data users

In Figure 5 we see that although the overall quality of the addresses in the province are high, there are quite some differences in the quality of each municipality. In Figure 6 the data user can even find out which specific errors the municipality made. In this way the data user can find out if these errors would have an effect on the process the data is going to be used for. If not, the data is perfect for the process. The data user himself can do this, but of course the data user can also get in contact with the municipality to find out if they are already working on correcting the errors.



Figure 6: Address quality dashboard one municipality for data users

### 2.3 Dashboard conclusions and future

As the current dashboards for key registries are a big success, for both the source holders and the data users, we see more and more interest from other key registries to introduce the dashboards. And while in the end everybody is keen on also providing the data users with a dashboard, most projects start with only a dashboard for the source holders and extending this later to the data users. In the future we foresee that the dashboards will not only provide information on one key registry, but will combine data from different key registries to find even more erroneous data or provide the data user (or source holder) with a more in-depth overview of how different datasets can be improved or combined.

## 3. 3D BIM AND LINKED DATA PILOT

The latest possibility to improve the quality of the key registries at the Kadaster is the usage of 3D BIM and Linked Data. In 2018 we worked on a pilot to see whether it is possible to use 3D BIM drawings and the Linked Data concept to tie together the information already available in the building process to improve the quality of the key registries. The main target of the pilot was to investigate how the processes in the building industry can be improved and how the building processes can be integrated into the other process [Greefhorst, et al, 2018]. This all to make all process as digital as possible. What is very important is the integration of geo-information with the information about buildings as this can save a lot of money for both the building industry and the government.

These saving come from different steps in the process, which are now often done by hand instead of digital. In most of the current cases the entire process of designing a house is done digitally and the information from that process can be exchanged by using the Industry Foundation Classes (IFC) standard. This makes it possible to save a BIM as a text file, which is an open format. The problem starts at the moment this information needs to be exchanged with municipalities, as they often do not accept the file, or request 2D building drawings. The rich 3D models are brought down to 2D files that lose quite some information and are then processed by multiple departments within a municipality to check whether the building abides to all regulations. In the process additional information is required and requested which was often already available in the 3D files, or could have been combined with the information easily. There are therefore chances to improve the processes, leading to a more optimized experience, less waiting time and saving money. And furthermore it might prevent failing costs that are now a result of incomplete information.

Next to a detailed report that describes the outcome of the pilot [Greefhorst, et al, 2018] the most important deliverable of the pilot was a demonstration application that shows the combined information and the possible usage. We describe the demonstration application [BIM demo application, 2018] and the most visible outcomes in the next paragraph.

### 3.1 Demo application

Next to a detailed report that describes the outcome of the pilot [Greefhorst, et al, 2018] the most important deliverable of the pilot was a demonstration application that shows the combined information. In Figure 7 the main page of the demonstration application is shown.

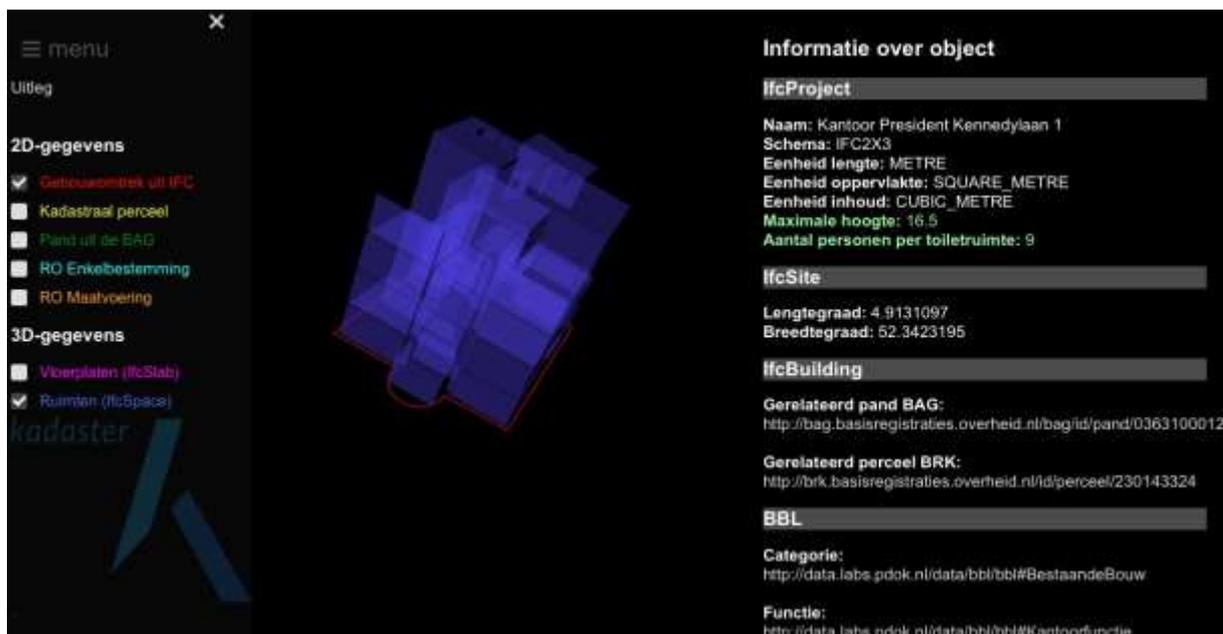


Figure 7: BIM pilot application, IFC building surrounding and spaces

On the left side of the application an overview of the available information is shown. It is possible to show the following layers of information:

- 2D: Building surroundings from IFC
- 2D: Cadastral parcels
- 2D: Building surroundings from the Key registry addresses and buildings
- 2D: Spatial planning usages
- 2D: Spatial planning surroundings
- 3D: BIM Floors
- 3D: BIM Building spaces

In the middle we see the visualization of the information layers that were selected, on the right side we see the data that is contained in the information layers and the relations with other datasets. The relations with the other datasets are based on the Linked Data principles and could only be made as the Kadaster is making more and more datasets available as Linked Data datasets. By using the relations contained in these datasets it becomes very easy to interconnect all different kinds of datasets, find errors in the datasets and to integrate data without the need to copy the data to one database.

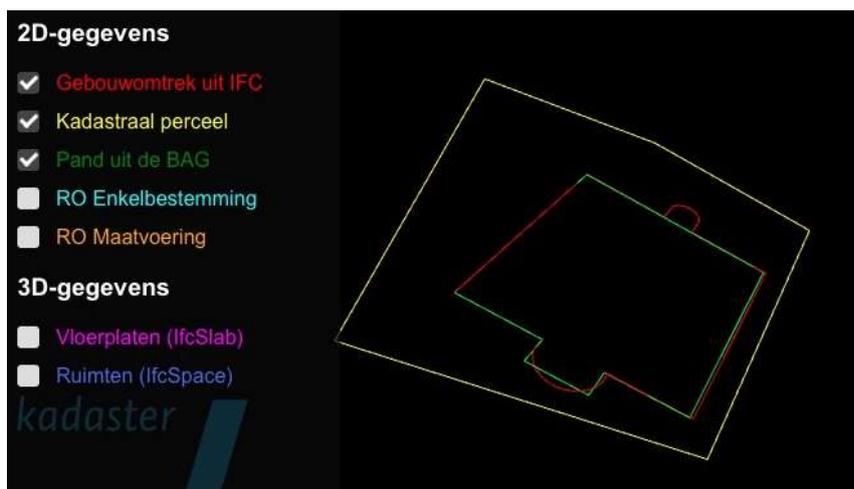


Figure 8: BIM pilot application, IFC building surrounding, Cadastral map and BAG building surrounding

In Figure 7 we only see the information contained in the 3D BIM model, and the building surrounding on the ground level. In Figure 8 we see this information combined with the Cadastral parcel information and the building surroundings as available in the Key registry addresses and buildings. As is clear from the picture, the building drawn lies fully within the parcel and the building surroundings in the Key registry addresses and buildings is almost identical. And if you know that in most municipalities the building surroundings for buildings are measured by hand and then inserted into the key registry, a process improvement can already be identified. If we manage to take the buildings surroundings from the 3D BIM model, the municipality does not have to measure it by hand, saving time and money, but we can also always check if the buildings surroundings are still correct by just validating them against the 3D BIM model.

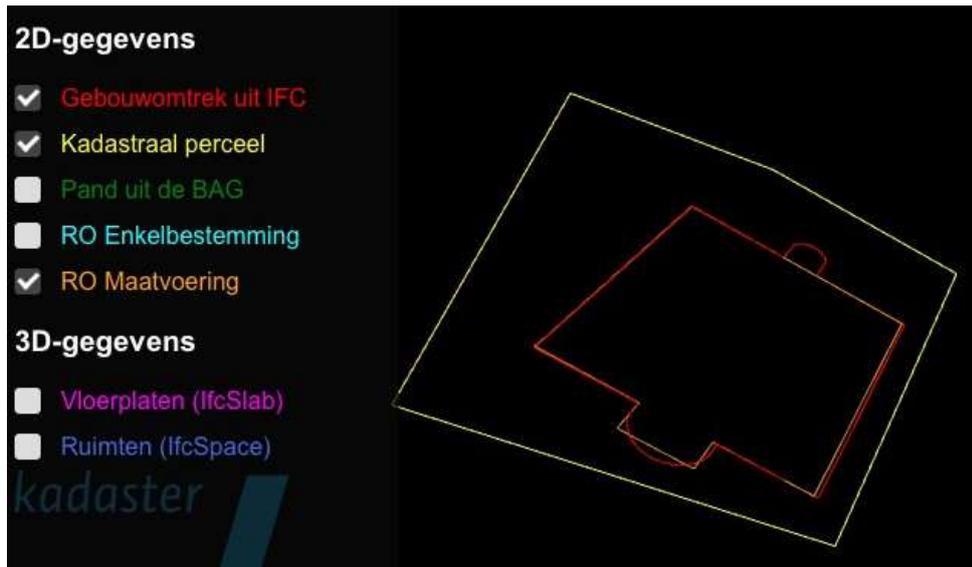


Figure 9: BIM pilot application, IFC building surrounding, Cadastral map, Spatial planning surrounding

When looking at Figure 9, the figure looks almost identical to Figure 8, with the exception that this time the surroundings from the spatial plan are drawn instead of the key registry surroundings. Again the surroundings are identical, but were also determined by hand. The municipality could again save time and money by extracting the information from the 3D BIM models, or the other way around: if the allowed surroundings are determined by the municipality, the building industry can automatically check whether their planned building fits into the designated area. This way failing cost can be prevented and as all information is digitally available, the changes for errors are much lower.

### 3.2 3D BIM AND LINKED DATA CONCLUSIONS

The usage of 3D BIM and Linked Data in the building sector and within municipalities is promising as it might save time and money. Furthermore it might have a positive impact on the entire processing time of building permits and keeping information up to date in the different key registries. Linking data together with the help of Linked Data does not immediately affect the processes, but it does provide more information as it is easier to bring together all information about a building or parcel. This leads to a better and shared information position for the building industry, the municipalities and in certain cases also the citizens.

## 4. CONCLUSIONS

While the quality of the individual key registries is already very high, we see that the quality dashboards for key registries are a big success, both for the source holders and the data users, we see more and more interest from other key registries in introducing the dashboards. And while in the end everybody is keen on also providing the data users with a dashboard, most project start with only a dashboard for the source holders while extending this later to the data users. The quality dashboards help in improving the quality, thus to more cases where the data

can be used. In the future we foresee that the dashboards will not only provide information on one key registry, but will combine data from different key registries to find even more erroneous data or provide the data user (or source holder) with a more in-depth overview of how different datasets can be improved or combined. Linked Data could be a concept that is helpful to combine the data as is also shown in the 3D BIM and Linked Data pilot.

The usage of 3D BIM and Linked Data in the building sector and within municipalities is promising as it might save time and money. Furthermore it will have a positive impact on the entire processing time of building permits and keeping information up to date in the different key registries. Linking data together with the help of Linked Data does not immediately affect the processes, but it does provide more information as it is easier to bring together all information about a building or parcel. This leads to a better and shared information position for the building industry the municipalities and in certain cases also the citizens. And this could then again increase the quality of the key registries closing the circle as less errors in the key registries lead to less failure costs in the processes using this data.

## REFERENCES

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## BIOGRAPHICAL NOTES

Jasper works for the Kadaster as a senior advisor. He fulfils the role of product owner for the Kadaster Data platform in which he is responsible for the daily operations of the data platform and for ensuring the further development of the platform is in line with the expectations of the users of the platform. Jasper has a strong focus on implementing the vision for the Data platform, while ensuring that we continuously deliver value in a sustainable pace.

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