Using KPIs to measure and achieve data quality of cadastral data

Leikny GAMMELMO, Norway

SUMMARY

Cadastral data is an important part of many, preferably digital, processes. In 2021, we wanted to address the fact that the cadastre is not of the calibre to fulfil its purpose as part of the land registration system in a digital world and play a key role in land management. We suggested different quality dimensions and parameters for measuring data quality.

This year we will present what we can say is one-step forward to work in a unified direction in Norway, when it comes to the quality of cadastral data. The objective of this paper is to define key performance indicators for measuring quality of cadastral data. This is one of many results from the project "Masterplan cadastre", a task given to the Norwegian Mapping Authority in the Award Letter from the Ministry of Local Government and Regional Development. The task in 2022 is to achieve a measurable quality improvement of cadastral data.

We have developed eight Key Performance Indicators (KPI) and target figures of where we want to be at the end of 2025. The cadastre includes data about cadastral units, addresses, and buildings, the KPIs measure the quality of all three of them with the following focus:
- Cadastral unit's register with boundaries and parcels and within the timeframe regulated by law.
- Named road addresses are the preferred addresses in the cadastre.
- Buildings register within the timeframe and with the data regulated by law.

The KPIs are all built up with a quality dimension, measuring parameters, description of how to measure, a description/name of the KPI and target figures.

To improve the quality different tasks must be performed. We ended with a long action plan containing possible tasks. To decide which one to use, the goals of the data quality strategy and the KPIs give the framework and direction. In 2022 the work of operationalization of the data quality strategy starts. This paper presents the KPIs. Furthermore, their quality dimensions and parameters, status and how we measure. It also gives examples of how to connect tasks to improve the data quality with the KPIs and strategic goals. Together this will answer how we have started the journey to achieve a measurable quality improvement of cadastral data.

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1. INTRODUCTION

Since 1 January 2010, we all knew that the cadaster had gone into a new phase, in Norway. We now had one register, which all municipalities updated in real time. The time where we had a specified number of updates during a year, was history. A new regime had come into force. Actors around us now had the opportunity to get data "right away", in real time. They even could see the new cadastral parcel in the map just after the person who registered the new boundaries had finished his or her registration. From this day, everyone could see the lack of information and the lack of accuracy. All the work not registered in the "old" digital property map (DEK) by hard-working employees, became visible. Some of, what we today call cadastral data, was registered on paper maps, stored in paper based archives. Cases from the land consolidation court should be registered in the register, but for some reason, not all of them were.

According to the cadastre act (which came into force 1 January 2010), section 1, the purpose is to "ensure access to important land information by means of a uniform and reliable register (the cadastre) that will be kept of all real property in the country, and by a clarification of boundaries and property-related matters". In the order to fulfill this purpose, good work has been carried out; still we are not there. "Some key data – such as real property, building and address data from the cadastre – must be of very high quality, since many processes are dependent on this data" (KMD 2018:13). The Norwegian cadastre has, from 1 January 2010 been a register of land information with two parts; the register part with written information and the cadastral map. It is parcel-based, and should be up-to-date. Using the cadastral number, the cadastre is linked to the land register (in Norwegian "Grunnbok"). Together this is the land registration system.

The organization and responsibility for the cadastre in Norway is shared between the Norwegian Mapping Authority (the central cadastral authority) and the municipalities (the local cadastral authorities). The local cadastral authorities perform the cadastral registration and are responsible for carrying out cadastral surveying (Cadastre Act, Section 5a). When it comes to improving data quality, the Norwegian Mapping Authority will provide data and guidance, but the municipalities have to carry out most of the work, due to their role as local cadastral authorities.

Task number four in the action plan of the National geospatial strategy towards 2025 (Kartverket 2021b) has been to establish a program for quality improvement of the cadastre: "Establish an overall quality strategy to meet priority needs through an improvement process, based on development of business cases" (KMD 2018). In December 2021, the data quality

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strategy was completed and now the work of implementing the vision, and goals, and the way of thinking has begun.

The research methodology is a combination of literature search, hypothesis testing, and involving different people in workshops and discussions. We have carried out different analysis on cadastral data, tested and revised them, and published reports on internet. Involving users and professionals has been important. The strategy was sent on an open hearing during the summer of 2021.

2. A NEW ORDER OF THINGS

The ambition of the data quality strategy for cadastral data is for the cadastre to have the right data content and data quality necessary for processes that use cadastral data and for user needs (Kartverket 2021a). The process also includes a capability for supporting digital processes. To support and operationalize the vision three strategic goals have been set:

1. A common practice for cadastral registration in all municipalities.
2. Improving the quality of priority areas or data fields.
3. Streamlining the processes for collecting and updating cadastral data.

The strategy is not a revolution, but it carries a clear message: now we, where "we" includes the whole of the professional community, walk in the same direction towards the same goals. Where rules have not been followed, then a new practice has to be formed. So in this context it feels familiar to quote Machiavelli (1952:49-50) in the sight of introducing a new order of things:

It must be considered that there is nothing more difficult to carry out, nor more doubtful of success, nor more dangerous to handle, than to initiate a new order of things. For the reformer has enemies in all those who profit by the old order, and only lukewarm defenders in all those who would profit by the new order, this lukewarmness arising partly from fear of their adversaries, who have the laws in their favour; and partly from the incredulity of mankind, who do not truly believe in anything until they have had actual experience of it.

As stated in the FIG 2021 article, "we need a uniform definition of data quality suitable for our purpose. The foremost reason is to know if we are heading in the right direction, to see whether the measures we initiate actually improve the quality of cadastral data. Then we need to find a way of determining how to measure the data quality and which measurement parameters to use" (Gammelmo 2021).

This article section 3 introduces the concept of key performance indicators (KPI). Before section 4, 5 and 6 introduces the result; the key performance indicators, chosen quality dimensions and parameters, and target figures. The KPIs must not be considered static, when we get more knowledge and experience they can be changed. Chapter 7 gives examples and a

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connection between the strategic goals and initiatives to reach them. When it comes to choosing quality initiatives, the strategy is important. Using the strategic goals and the KPIs the actors can prioritize which data fields they should improve and which initiatives to take.

3. KPIs - KEY PERFORMANCE INDICATORS

The cadastre in Norway is defined as "the official national register of land information, including buildings, dwellings and addresses" (Cadastre Act section 3). In the search of a way to measure the data quality we need to cover the three parts; cadastral units, addresses and buildings. We also need understandable descriptions and meaningful target figures. We wanted to develop Key Performance Indicators (KPI) for this pourpose. According to Marr (2012) the "KPI development has to start with your strategy and the objectives the business is aiming to achieve". Our strategy is the "strategy for improving data quality of the cadastre". Many others, thru the years, also state the need of improved data quality, the importance of the cadastre, and the need of standards and ways of measuring.

It is said that "KPIs represent a set of measures focusing on those aspects of business performance that are most critical for the current and future success of your business" (Adama 2015). According to Aguilar the "KPIs can be financial, operational, behavioral, customer satisfaction-al, or something entirely new and different." In our case it might be in the category of "something entirely new and different". And "performance (...) stand in for any and all of these (...). Performance is a statement of results compared to a goal, target, or standard. Whether the performance turns out to be good or bad depends on the target" (Aguilar 2022). A KPI is what we want to pay attention to so we can gauge the "health of" the data quality and the right KPIs are said to be "the ones that measure progress toward a specific mission – not just whatever measurement is available" (Aguilar 2022).

The indicators in our case should describe the quality of cadastral data and be possible to measure. Finding the KPIs was not easy, foremost because what we think we want to measure is not always possible to measure, and secondly the trap of choosing "whatever measurement is available" is easy to fall into. In the search of relevant KPIs some questions can be handy to have in mind (Marr 2012):
 – Why is this indicator important?
 – How do I measure it? E.g. collection method, formula, frequency and source of data
 – Cost/effort in collecting data
 – Target setting or benchmarks

In the following chapters we will present the KPIs we have chosen for data quality, their quality dimension, how we measure it, and the target figures for 2025. We will also present some possible benchmarks on the way. All of our KPIs are also connected to one or two quality dimension. For obtaining relevant measurement parameters two dimensions are chosen as especially relevant: accuracy and completeness. In our FIG 2021 article, referring to DAMA (2013) and ISO 19157:2013, we defined accuracy and completeness as follows:

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Accuracy is the degree to which data correctly describes the real-world object. "The unit of measurement is the percentage of data entries that pass the data accuracy rules. For cadastral data it will also be of interest to measure the number/quantity. Accuracy can also be said to be the closeness of agreement between a test result or measurement result and the true value. Completeness is the proportion of stored data against the potential of 100% complete, a measure of the absence of blank (null or empty string) values or the presence of non-blank values. The range is 0–100% of critical data to be measured in any data item, record, dataset or database. The unit of measurement is the percentage. For cadastral data it will also be of interest to measure the number" (Gammelmo 2021).

4. KPI FOR CADASTRAL UNIT

KPI M1 The cadstral units; basic real property, leased land, and farm commons, have a parcel in the cadstral map.
Basic real property (in Norwegian: "grunneiendom") is the most common one. Leased land (in Norwegian: "festegrunn") is used to register a cadastral unit for the purpose of the right to lease land for a period longer than 10 years. Farm commons (in Norwegian: "jordsameie") is an old construction of real property owned by farms, which today can't be sold unless the farm is sold, or the farm common is divided into independent properties. Another name for this might be "Hamlet commons".

Quality dimension: Completeness
Parameters and how to measure: Number of cadastral units without a parcel of the total number of cadastral units (measured for basic real property, leased land and farm commons). The completeness is measured by the percentage of cadastral numbers in the register part of the cadastre that also have a parcel in the cadastral map. The indicator uses reports containing existing cadastral units without a parcel and the number of cadastral units.

Status 1 March 2022: Basic real property: 97,6% Leased land: 90,8% Farm commons: 99,0%
Target figures 31 December 2025: Basic real property: 99 % Leased land: 95 % Farm commons: 100 %

KPI M2 Implementation of "MUF" is done within the timeframe regulated by law.
MUF is an acronym for the Norwegian words "matrikulering uten fullført oppmålingsforretning", in English "registration before completing cadastral survey". This is a special case described in the Cadastre Act section 6, second paragraph: "When special reasons exist, the municipality may, upon application from the person who has requested the survey, enter a new cadastral parcel into the cadastre without completing the cadastral survey." The timeframe is further regulated in the cadastral regulations.

Quality dimension: Accuracy

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Parameters and how to measure: The number of cases marked with MUF in total, and cases past deadline for completing cadastral survey. This can be measured in number of cases and percentage.

Status 1 March 2022: Number over deadline is 3 083.
Target figures 31 December 2025: Maximum of 1 500 over deadline.

We consider revising these target figures and use percentage instead of number of cases. For instance we have had between 9 500 and 10 500 MUF the last year, if we take an average of 10 000 and a maximum of 1 500 over deadline, we will have a goal of 15%.

KPI M3 The cadastre and land register is coherent when it comes to the status of cadastral units.
Quality dimension: Accuracy and compliance
Parameters and how to measure: Comparison of cadastral units in the land register and the cadastre. How many are found in only one register or with different status, for instance deleted in one and existing in the other.

Status 1 March 2022: 1 256 deviation.
Target figures 31 December 2025: Maximum of 150 deviation.

KPI M4 Parcels have a clarified relationship to the number of cadastral numbers connected to the parcel.
Quality dimension: Completeness
Parameters and how to measure: Number of parcels with two or more cadastral numbers. Figure 1 illustrates how this is shown in the cadaster map.

Status 1 March 2022: The number is 74 161. Over time the number goes down.
Target figures 31 December 2025: Target figures not set. We need more data and experience to estimate possible target figures.
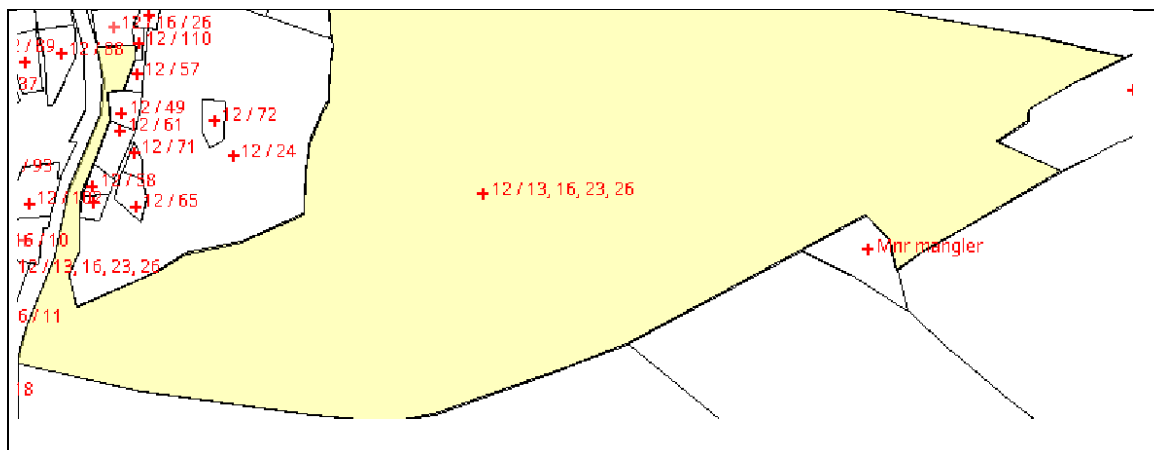

Figure 1: Cadastral parcel (yellow) with more than one cadastral number (the cadastral numbers are the red numbers).

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KPI M5 Parcel of cadastral units has property boundaries, not fictitious boundaries.
Quality dimension: Accuracy
Parameters and how to measure: Existing cadastral units with only fictitious boundaries.
The report gives the number of cadastral units with only fictitious boundaries. Illustrated in
figure 2, the fictitious boundaries are grey.

Status 1 March 2022: The number is 113 964. Over time the number goes down.
Target figures 31 December 2025: Maximum of 80 000.
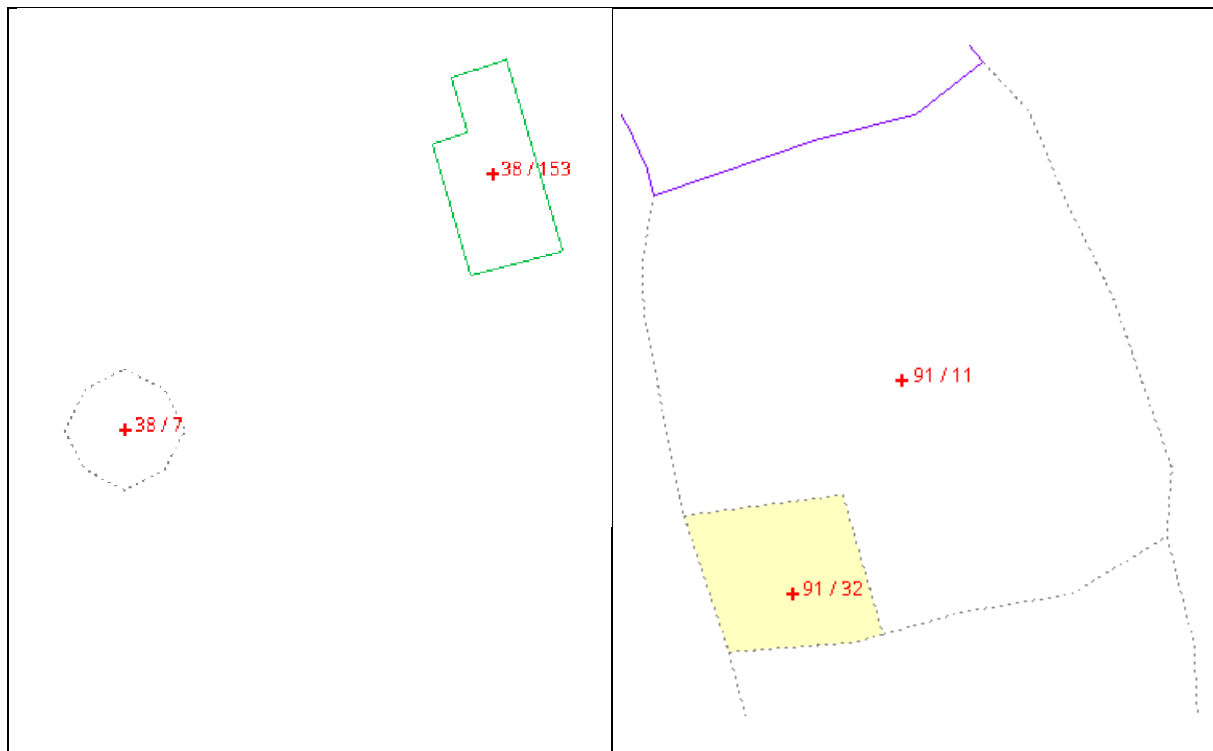
Figur 2: Cadastral parcels with only fictitious boundaries (38/7 and 91/32), with boundaries of high accuracy (38/153) and more than one fictious boundary (91/11).

5. KPI FOR ADDRESS

KPI A1 Addresses must be given by using named road address.
Quality dimension: Completeness
Parameters and how to measure: Proportion of road addresses, measured by using total
number of road addresses and cadastral addresses.

Status 1 March 2022: 97,7%
Target figures 31 December 2025: Proportion of road addresses: 99%

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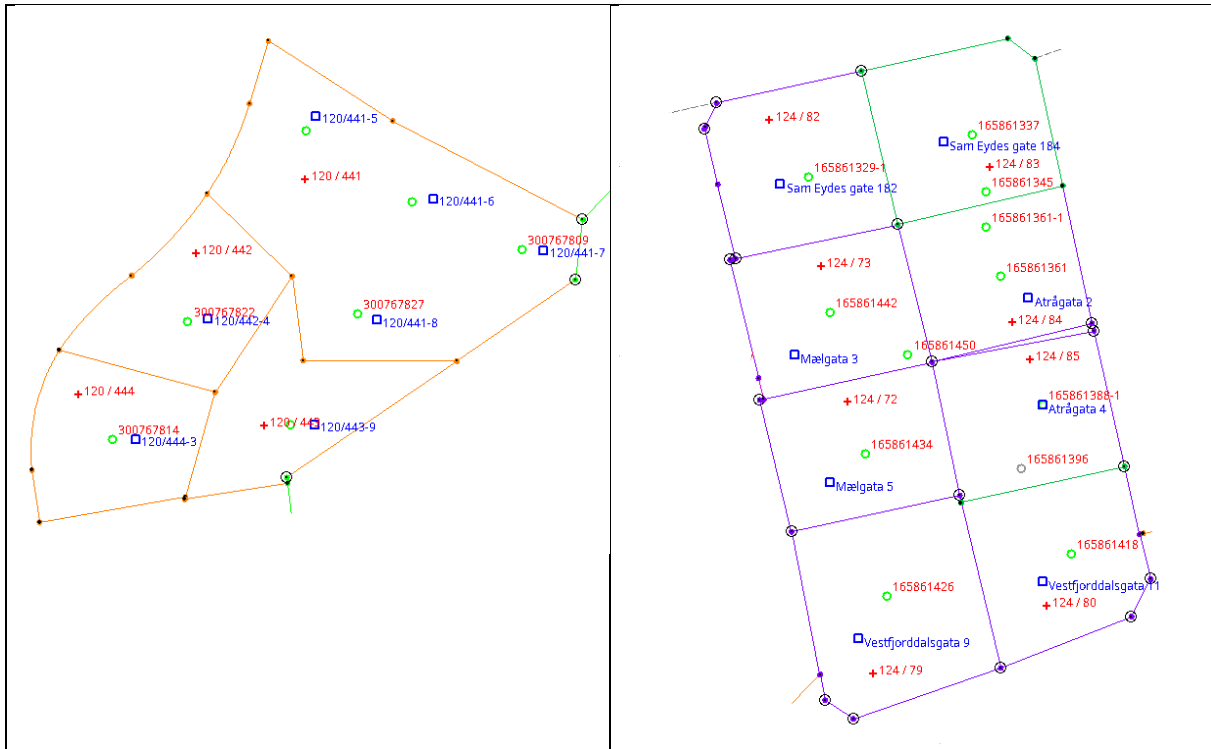Warsaw, Poland, 11–15 September 2022

Figure 3: Address given by using the cadastral number of the property (blue numbers in the left map) and address given by a named road (blue names and number in the right map).

6. KPI FOR BUILDING

KPI B1 Data on areas in buildings, as demanded by law, shall be completed for buildings registered after 1 January 2010.

For buildings, we register three different types of area; not all data fields are required for all buildings, and the data fields have come into use at different times. Therefore we use registrations from 2010 when the Cadastre Act came into force and all three areas where introduced. The calculation of areas of buildings is in accordance with the standard NS3940:2012. The three different types of area are:

        BYA (bebygd areal) = built-up area
        BRA (bruksareal) = usable area
        BTA (brutto areal) = gross area.

Quality dimension: Completeness
Parameters and how to measure: Areas in buildings with building status date f.o.m. 1 January 2010. The proportion of buildings with these areas.

Status 1 March 2022: BYA: 89,1% BRA: 95,2% BTA: 19,0%
Target figures 31 December 2025: BYA: 90% BRA: 95% and for BTA target figures not set.

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The figures for 2025 will be revised due to a bug in the analysis that made the numbers look poorer than they really were (BRA is already 95%). We will use 2022 to see the development of the status.

KPI B2 Permits for new buildings and building alterations are registered within the five-day deadline.
Quality dimension: Accuracy and compliance
Parameters and how to measure: Buildings are registered within the five-day deadline using a report of number of buildings with delays in registration.

Status 1 March 2022: 73 %
Target figures 31 December 2025: 90 %

7. CONCLUDING REMARKS

We have now started "the introduction of a new order of things". Some municipalities or other actors have done well under what we can call "the old conditions" and some might be "lukewarm defenders" because they might do well under the new. Hopefully, most of our professional actors will see the benefit of working in the same direction and learn from each other. The suggestions and measurements are not revolutionary. What is new is the way of thinking and having one strategy for the profession and the direction of improving cadastral data quality.

When it comes to initiatives to improve data quality the actors must consider which data they need, and quality they want to, or must, improve. It is also possible to use the strategic goals and KPIs to priorities initiatives. Some examples are given in the next sections.

Strategic goal 1: *A common practice for cadastral registration in all municipalities*.
To reach this goal one initiative is using the manual for registering data in the cadastre. Another side of this initiative is to improve the manual. The Norwegian Mapping Authority has a digital course for those who shall be qualified to register, and parts of this course are useful for others to increase their knowledge and understanding of the regulations and registration. These initiatives will also contribute to achieve the KPIs with connections to timeframe and other demands in the cadastre act and regulation.

Strategic goal 2: *Improving the quality of priority areas or data fields.*
This goal can easily connect to some of the KPIs. Area in buildings, for instance, is one example. The data can be found in building permits, other registries or it must be collected. When it comes to real property an example of a prioritised area can be the making of a detailed plan for a building site. The existing property situation must be in place to ensure the involvement of all parties in the planning process and before starting the changes. We might use section 26 in the cadastre act and cadastre regulation section 10 and 10b. Section 10b gives the opportunity to improve data using old documents describing the boundaries.

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The task given to the Norwegian Mapping Authority in the Award Letter from the Ministry of Local Government and Regional Development in 2022 is to achieve a measurable quality improvement of cadastral data. Out of the eight KPIs we have chosen M2, A1 and B1. The table below gives an overview of the status from 1 January and target figures of 2022.

Table 1: Choosen KPIs for focus and report to the Ministry of Local Government and Regional Development in 2022.

KPI		Status 1 January 2022	Target figures 31 December 2022
M2	Implementation of «MUF» is done within the timeframe regulated by law	3 124 or 32 %	2 700 or 27 %
A1	Addresses must be given by using named road address.	97,6 %	98 %
B1	Data on areas in buildings, as demanded by law, shall be completed for buildings registered after 1 January 2010.	BYA = 76,5 % BRA = 92,5 %	BYA = 90 % BRA = 95 %

ACKNOWLEDGEMENTS

REFERENCES

Adam, Peter 2015. *Understanding Key Performance Indicators.*

Aguilar, Norman 2022. *Key Performance Indicators Book: A Complete Guide To Using KPIs To Drive Organisational Performance.*

Cadastre Act 2010. *Act on a national register for land information* Translation for information use only accessible from: https://www.regjeringen.no/en/dokumenter/cadastre-act/id455530/?id=455530

Cadastre Act, old version in English accessible from: Act on a national register for land information (Cadastre Act) - regjeringen.no

Gammelmo, Leikny 2021 *Measuring data quality of cadastral data*. FIG Working Week 2021. Accessible from: https://fig.net/resources/proceedings/fig_proceedings/fig2021/papers/ts07.3/TS07.3_gammelmo_10964.pdf

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Gammelmo, Leikny 2017 *SHOULD PEOPLE TRUST INFORMATION FROM THE CADASTRE? - The case of public administrative usage in Norway*. Peer Reviewed Paper FIG Working Week 2017. Accessible from: https://www.fig.net/resources/proceedings/fig_proceedings/fig2017/papers/ts06f/TS06F_gammelmo_8501.pdf

Kartverket 2021a *Stratgi for datakvalitet i matrikkelen / Data quality strategy of cadastral data*. Accessible from: https://www.kartverket.no/eiendom/lokal-matrikkelmyndighet/datakvalitet/tiltak/datakvalitetsstrategi [in Norwegian language only]

Kartverket 2021b *Handlingsplanen til nasjonal geodatastrategi 2019-2025 / Action plan for National geospatial strategy*. Accessible from: https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.geonorge.no%2Fglobalassets%2Fgeonorge2%2Fny-nasjonal-geodatastrategi%2Fgeodatastrategi_handlingsplan_2021.docx&wdOrigin=BROWSELINK [in Norwegian language only]

KDD 2022 *Award Letter 2022 – The Norwegian Mapping Authority* from the Ministry of Local Government and Regional Development. Accessible from: https://www.regjeringen.no/contentassets/3617cd0bc4c8495da3b76beb0143d1a4/2022_tildelingsbrev-for-kartverket-2022.pdf [4. February 2022]

KMD 2018 *National geospatial strategy towards 2025 - Everything happens somewhere*. Originally published by: Ministry of Local Government and Modernisation. Accessible from: https://www.regjeringen.no/en/dokumenter/national-geospatial-strategy-towards-2025/id2617560/ [4. February 2022]

Machiavelli, Niccolò 1952 *The Prince* The Oxford University Press "World's Classics" translation by Luigi Ricci, New York. New translation of the quote to be found at Goodreads, Accessible from: https://www.goodreads.com/quotes/274551-it-ought-to-be-remembered-that-there-is-nothing-more [8 January 2022]

Marr, Bernard 2012. *Key Performance Indicators. The 75 measures every manager needs to know*. Pearson.

NS3940:2012 *Calculation of areas and volumes of buildings* Accessible in Norwegian from: https://www.standard.no/no/nettbutikk/produktkatalogen/Produktpresentasjon/?ProductID=529401

BIOGRAPHICAL NOTES
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