

Change toolkit for digital building permit

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V.1.0

Table of Content

1	Executive summary	4
2	Introduction.....	5
3	Data summary	7
3.1	Existing Data from Municipalities	7
3.2	Interviews and workshop data	8
3.3	Generated and sample datasets.....	8
3.4	Change supporting tools and CHEK results	9
3.5	Other output: Software.....	10
3.6	Documentation, education and training materials.....	12
3.7	Communication and Dissemination materials.....	13
4	FAIR data	15
4.1	Making data Findable, including provisions for metadata	15
4.2	Making data accessible	16
4.3	Making data interoperable	16
4.4	Increase data re-use.....	17
5	Other Data Management Provisions	18
5.1	Allocation of resources	18
5.2	Data security.....	18
5.3	Ethics.....	18
6	Conclusions.....	19
7	References	20
	List of Tables	20

1 Executive summary

The CHEK Data Management Plan describes the data that will be used and produced within the CHEK project and the plan for their retrieval, storage and management during and after the project.

The goal of the Data Management Plan is to ensure that the data involved in the research are managed according to the best practices supporting Findable Accessible Interoperable and Reusable (FAIR) principles throughout the whole project and beyond. It allows the data to be a useful support to the demonstration of the CHEK solutions, to the uptake of them by third parties and further developments and to further research CHEK solutions beyond the scope of CHEK.

In this document, the overview of data involved in the CHEK project is summarized, according to the very different nature of the considered datasets and other outputs of the project, in particular software. The measures adopted to ensure a FAIR management of data and output within and after the project is later described.

The data will be shared as soon as ready and open as preferred option, unless any consortium partners' interest prevents it. For example, the produced software code will only partly be shared as open source, to comply with the business models of the involved companies. However, their interoperability will be supported through the use of standards and Application Programming Interfaces (APIs). In addition, a proper documentation to use the APIs will be published.

The CHEK website will publish links to all the data and outputs of the project ¹ and these will be advertised through the CHEK communication channels in order to enhance their findability.

Open standards (mainly from the Open Geospatial Consortium and buildingSMART) will be a key element both in the development of the project and in the use of data.

Within CHEK, personal or sensitive data will not be managed. However, any measure will be taken to ensure data security and respect of possible GDPR related needs.

This plan will be updated periodically during the project development.

¹ <https://chekdbp.eu> Accessed 15/03/2023

2 Introduction

The CHEK project aims at providing a toolkit supporting the stakeholders in building permits and the Architecture Engineering Construction and Operation industry towards building permit digitalization. Interoperability and Scalability are explicit objectives in CHEK. For this reason, data and output management in order to fulfil Findable Accessible Interoperable and Reusable (FAIR) principles is even more important.

The FAIR principles provide rules and criteria to improve (digital) data discoverability and reuse. A summary of FAIR principles is here reported²:

Findable

- F1. (Meta)data are assigned a globally unique and persistent identifier
- F2. Data are described with rich metadata (defined by R1 below)
- F3. Metadata clearly and explicitly includes the identifier of the data they describe
- F4. (Meta)data are registered or indexed in a searchable resource

Accessible

- A1. (Meta)data are retrievable by their identifier using a standardized communications protocol
 - A1.1 The protocol is open, free, and universally implementable
 - A1.2 The protocol allows for an authentication and authorization procedure, where necessary
- A2. Metadata are accessible, even when the data are no longer available

Interoperable

- I1. (Meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.
- I2. (Meta)data use vocabularies that follow FAIR principles
- I3. (Meta)data include qualified references to other (meta)data

Reusable

- R1. (Meta)data are richly described with a plurality of accurate and relevant attributes
 - R1.1. (Meta)data are released with a clear and accessible data usage license
 - R1.2. (Meta)data are associated with detailed provenance
 - R1.3. (Meta)data meet domain-relevant community standards

² <https://www.go-fair.org/fair-principles/> Accessed 15/03/2023 Wilkinson, M., Dumontier, M., Aalbersberg, I. *et al.* The FAIR Guiding Principles for scientific data management and stewardship. *Sci Data* **3**, 160018 (2016). <https://doi.org/10.1038/sdata.2016.18>

In this project, the use of standards is critical to develop interoperable and reusable solutions. Therefore mainly the Open Geospatial Consortium (OGC) and buildingSMART standards will be the starting point for the developments, as well as other open standards coming from further organizations, such as the World Wide Web Consortium (W3C), the Object Management Group (OMG), the International Standardisation Organisation (ISO), in order to enhance as much as possible the compliance of solutions.

For the project developments and internal collaboration and data exchange, the data are stored and exchanged within a repository in Microsoft Teams, which is based in Europe and which provides versioning and back-up systems. It is also used as the main internal communication platform by the CHEK consortium.

For the production, documentation and sharing of data and metadata, the relevant open standards will be considered as a priority. In addition, suitable documentation and specifications will be provided and linked to the data and other output, in both human and machine readable format whenever possible. Interoperability supporting tools (such as APIs) will be used to enhance interoperability and reuse, even if the data or output itself could not be shared entirely open.

Trusted and widely known repositories will be used to share the data and other project output, and the link to their source will be further shared within the project website and communicated through the CHEK communication channels to enhance findability and reuse.

Within CHEK, personal or sensitive data will not be involved. However, any measure will be taken to ensure data security and respect of possible GDPR related needs. For example, any workshop data possibly including personal data will be anonymized or pseudonymized before sharing.

This plan will be updated periodically during the project development and an annex reporting in detail the single datasets and outputs and their management and sharing details will be provided at the end of the project.

3 Data summary

In CHEK many different data will be involved. An overview is provided in the Tables 1-7, where the characteristics of each kind of dataset is reported together with the intended use within and beyond the project. During the developments of the projects and following the use, processing, production and publication of data, a more detailed spreadsheet will be filled, which will be provided at the end of the project including the specific information and references.

In the Tables 1-7 the datasets are grouped according to the kind of data or output considered. Expected size is categorised into: XS<50 MB; S 50 MB–1 GB; M 1GB–250 GB; L 250 GB–1TB; XL 1-5 TB; XXL >5 TB.

3.1 Existing Data from Municipalities

This category (Table 1) includes the data that the involved municipalities and stakeholders in the project (either directly involved as partners or in the Advisory board or in the Community of Practice) provide to support the initial analysis, requirements definition and the development themselves, including the assessment of the solutions and demonstration.

Table 1 - Existing Data from Municipalities

Data	Formats	Purpose for the project	Expected size	Origin	Data utility outside the project
Regulations documents	Documents and text	Analyze the current status and provide CHEK developments requirements	XS <50 MB	Re-used from municipality data	Current use
Process description documents	Documents		XS <50 MB		Current use
Geoinformation (Geographical Information systems, zoning maps, 3D city models, geotechnical information, protection areas maps, digital terrain models and any other kind of geodata)	Different geoinformation formats	Support data retrieval supporting design; support regulations checks based on geoinformation	M 1GB–250 GB	Re-used from municipality or national data	Current use
Other statistical data, which could be useful for KPIs measurements (e.g. number of building permits submitted per year, average time for building permit issuing, number of	Documents, spreadsheets, csv formats	Support KPIs measurements and assess the CHEK solutions	XS <50 MB	Provided by municipalities (either existing or measured for the CHEK purposes)	Current use and support other municipality decisions.

successful procedures, etc.) (including from task6.1?)					
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3.2 Interviews and workshop data

This data (Table 2) comes from the direct and personal input of stakeholders, being them the project’s partners, other people in the partners’ institutions, advisory board members, Community of practice participants or externals.

Table 2 - Interviews and workshop data

Data	Formats	Purpose for the project	Expected size	Origin	Data utility outside the project
Interview structure	Text notes	Information collection to map the building permit process	XS <50 MB	Developed and collected during the project	Re-use for further related investigations;
Interviews recording	Mp4	Support the actual status analysis and requirements definition within the project	S 50 MB–1 GB	Collected during the project	Low usefulness, in general
Interviews transcript	Text file		XS <50 MB		
Workshop data	Text files, PDFs, Images, PPT Excel file IWB/CF	Support the actual status analysis and requirements definition; Feedback collection	XS<50 MB		Re-use for further related investigations; Support methodology replicability and CHEK scalability

3.3 Generated and sample datasets

These data are collected, generated and modelled to test the project developments, are compliant to the provided data requirements and standard profiles developed and used within the project, and can support further or related developments or studies (Table 3).

Table 3 – Generated and sample datasets

Data	Formats	Purpose for the project	Expected size	Origin	Data utility outside the project
3D city models generated in CHEK	GML, SQL, JSON	Support 3D city model-related developments	M 1GB–250 GB	Generated in CHEK	Inclusion in the municipality datasets; used as sample data to experiment tools

Sample data to exemplify CHEK CityGML	GML, SQL, JSON	Support CHEK CityGML and related tools developments, including GeoBIM conversions	M 1GB–250 GB		used as sample data to experiment tools
Sample data to exemplify CHEK IFC	IFC	Support CHEK IFC and related tools developments including GeoBIM conversions	S < 1GB		used as sample data to experiment tools
BIM for demonstration scenarios	IFC	Support CHEK demonstrations	S < 1GB		Possible third party reuse for further studies and developments
Drawings from demonstration scenarios Models	PDF	Support CHEK demonstrations	S < 1GB		Possible third party reuse for further studies and developments

3.4 Change supporting tools and CHEK results

These are the final data and products resulting from the CHEK research activity and often correspond to the project’s deliverables (Table 4).

Table 4 – Change supporting tools and CHEK results

Data	Formats	Purpose for the project	Expected size	Origin	Data utility outside the project
CHEK To-be process map D1.1	VISIO, PDF, BPMN	Design the CHEK process supporting platform and plan the change in municipalities	XS<50 MB	Developed in CHEK	Re-use to implement similar tools and digital permits in municipalities
CHEK Maturity model D1.2	.xls, PDF	Support digitalization of building permitting maturity assessment	XS<50 MB		Support digitalization of building permitting maturity assessment
CHEK roadmap D1.2	PDF	Support planning building permit digitalization actions	XS<50 MB		Support planning building permit digitalization actions
CHEK Change Management	Programming code (to be defined)	Support digitalization level assessment and consequent planning of	XS<50 MB		Support digitalization level assessment and consequent planning of

Virtual Assistant D1.3		building permit digitalization actions			building permit digitalization actions
CHEK Level of Information Need	Text/PDF; .xls	Specify data requirements and support standard data model profiles definition	XS<50 MB		Support methods replicability and solutions' scalability
Exchange Information Requirements	Text/PDF	Support adoption of digitalised processes	XS<50 MB		
Prototype of machine readable language for regulations	To be defined	Encode regulations parameters to support automatic checking	XS<50 MB		Support methods replicability and solutions' scalability
CHEK IFC D2.2	bSI IDS, mvdXML/JSON, EXPRESS, Gherkin	IFC data requirements definition and validation	S 50 MB–1 GB		Supports solutions' scalability
CHEK CityGML D2.3	OGC profile specs	CityGML data requirements definition and validation	S 50 MB–1 GB		Supports solutions' scalability
Demonstration scenarios results D6.2, D6.3, D6.4	Document, PDF, publication	Demonstrate and validate CHEK developments	XS<50 MB		Support methods replicability, solutions' scalability and further studies.

3.5 Other output: Software

The developed software will follow the business rules and exploitation strategies of the different involved companies and will follow the principle “As open as possible; as closed as necessary”. In case the software is developed by research institutes, an open license will be used. To ensure interoperability, software and API's documentation will be provided (Table 5).

Table 5 – Other output: Software

Data	Formats	Purpose for the project	Expected size	Origin	Data utility outside the project
CHEK Change Management Virtual Assistant D1.3	Programming code (to be defined)	Support digitalization level assessment and consequent planning of building permit digitalization actions	XS<50 MB	Developed or extended within CHEK	Support digitalization level assessment and consequent planning of building permit digitalization actions
CHEK data validity-supporting tools D2.4	Programming code (to be defined)	Implement CHEK digital building permit software components	S 50 MB–1 GB	Developed or extended within CHEK	Uptake CHEK digital building permit solutions and possibly extend them
Geo to BIM converter D3.1	Programming code (to be defined)	Provide the designers with data about the context	S 50 MB–1 GB		Use for DBP and other GeoBIM applications
IFC georeferencing tool D3.2	Programming code (to be defined)	post-processing to adjust IFC models in desired CRS	S 50 MB–1 GB		
BIM to Geo converter D3.3	Programming code (C++), Executable binaries	Extract a set of building envelopes (inc. relevant semantic data) from an IFC model to allow analysis on a city scale/ incorporation in city scale models	S 50 MB–1 GB (Currently 35 MB)		
CHEK process management platform D4.3	c, php, css, js	Support the building permitting process	M 1GB–250 GB	CYPE Software, Extended	Support the DBP process

				development within CHEK	
Open APIs D4.4	Pdf, website (github/swagger)	Document the API to be able to be used by third parties	S 50 MB–1 GB	Developed within check	Support software developers
IFC digital signature module D4.5	Programming code (to be defined)	Digitally sign submitted IFC models	S 50 MB–1 GB	Developed within check	Support DBP uptake
IFC-based checking software D4.6	Programming code (js), Executable binaries	Automation or semi-automation to check buildings geometrical rules with a building model in IFC	M 1GB–250 GB	CYPE and Xinaps extended within CHEK project	Support Architects and municipalities, scalability
CityGML-based checking software D4.8	Programming code (js), Executable binaries	Automation of checking building designs against rules that require geolocation and geospatial context information	XS<50 MB	Developed within CHEK	Uptake and extension of checking solution for digitalization of building permit process

3.6 Documentation, education and training materials

These data and materials are intended to support a shared multidisciplinary knowledge base to understand and develop suitable interdisciplinary solutions to tackle the challenge of building permit digitalization. In addition, they will support the training and education developed and provided within the CHEK WP5 (Table 6).

Table 6 – Documentation, education and training materials

Data	Formats	Purpose for the project	Expected size	Origin	Data utility outside the project
Software workshops and documentation D4.9	Videos, PDFs, webpages	Support software use	S 50 MB–1 GB	Developed in CHEK	Support software use

Wiki of DBP D5.1	platform (.html, .css, .js, .sql) + assets (.svg, .png, .markdown)	Merge the DBP knowledge, including the glossary, in an accessible wiki platform.	M 1GB–250 GB	Content (developed in CHEK) Platform (free open source)	Support multidisciplinary collaboration in the context of building permit digitalization
Glossary of DBP terms D5.1	.pdf	Support the interchange of information by providing a set of terms and definitions based on the partners integrated knowledge.	XS<50 MB	Developed in CHEK	Support multidisciplinary collaboration in the context of building permit digitalization
Training materials (documents, videos, course) + platforms such as moodle (D5.2 and D5.4)	platform (.html, .css, .js, .sql) + materials (.mp4, .pdf, .ppt, .png, .svg)	Enable stakeholders to actively take part in the building permit digitalization and use the developed systems for the goal of CHEK demonstration	M 1GB–250 GB	Material (developed in CHEK) Platform (free open source)	Enable stakeholders to actively take part in the building permit digitalization and use the developed systems in real life.

3.7 Communication and Dissemination materials

These data are produced, used and shared for communication and dissemination purposes (Table 7).

Table 7 – Communication and dissemination materials

Data	Formats	Purpose for the project	Expected size	Origin	Data utility outside the project
Papers	Pdf, online publications	Dissemination	XS<50 MB S 50 MB–1 GB	Developed in CHEK	Support research replicability and results reuse
Presentations slides	Ppt, pdf	Communication and dissemination	S 50 MB–1 GB		
Videos	Mp4, avi	Communication and dissemination	S < 1 GB		

Pictures	image formats (png, tiff, jpg)	Communication and dissemination, research and developments documentation	M < 100 GB		Communicate about Digital Building Permit
Website	Html	Communication and dissemination	M < 100 GB		
Brochures and graphics	PDFs, image formats (png, tiff, jpg)	Communication and dissemination	M < 100 GB		
Informative booklet about DBP D7.5	Pdf, online publications	Communication and dissemination	M < 100 GB		Support digital building permit and CHEK results uptake
Open science lecture D8.4	Mp4	Support and uptake open science practices	S < 1 GB		Support and uptake open science practices

4 FAIR data

4.1 Making data Findable, including provisions for metadata

All the measures will be taken to ensure Findability to the datasets produced within the CHEK project.

A condition to achieve such a goal is to assign the generated data a globally unique and persistent identifier; to attach rich and standard-compliant and indexed metadata to the datasets, including search keywords facilitating discovery.

In order to comply to such conditions, every dataset will be assigned a Digital Object Identifier (DOI), to make them citable and persistently available.

The data will be published through trusted repositories such as Zenodo³ or 4TU.ResearchData⁴ or Open Research Europe. Such repositories are based in Europe and are certified with a Data Seal of Approval certification. They can assign a globally unique and persistent identifier in form of a DOI. In addition, they allow integration with github repositories, so that open code that will be possibly further developed after the project could be published and referenced as well.

All the published datasets will be accompanied by rich standardised and community-endorsed metadata⁵ (adhering to DataCite, Dublin Core or other relevant and standard-compliant metadata schema such as DCAT, GeoDCAT, ISO19115 for spatial datasets.) to ensure that all datasets are findable. In addition, to further aid their discoverability, keywords describing the datasets will be added. 4TU.ResearchData is also using schema.org metadata, meaning that all datasets are indexed in Google Dataset Search.

In case of papers, publication venues will be chosen such that a persistent identifier can be assigned to the documents and indexing in relevant databases (e.g. Scopus, WoS) will help find the resources. The connection and advertisement of the publications to relevant repositories and research exchange platforms, such as Google Scholar, ResearchGate, and social media, such as Twitter or LinkedIn will also improve and support the resources findability.

Other media data will be published through other kinds of repositories and sharing platforms, such as YouTube for videos, through the CHEK YouTube channel, or SpeakerDeck for slides publications. Such platforms provide a URL and identifier which can be used to identify the resources uniquely. They also provide maintenance and ensure persistence of the published resources.

The CHEK website will be used to link all the generated datasets and possibly publish further resources which do not belong to the previous categories.

³ <https://zenodo.org>

⁴ <https://researchdata.4tu.nl/en/>

⁵ <https://fairsharing.org/standards/>

30/03/2023

The developed software in CHEK will be published as *Free Open Source* (31%) or commercial (69%). The free and open source software will be developed in GitHub and published through Zenodo or 4TU.Research, getting assigned a DOI. Commercial software websites will be linked to the CHEK website together with related documentation.

The standard documents (standards or best practices) developed within the project will be published through the standard development organisations repositories and a persistent identifier will be assigned by their resource management systems (e.g. OGC Rainbow⁶).

4.2 Making data accessible

The publication of data through the trusted repositories as mentioned in section 4.1 (e.g. Zenodo, 4TU.Research) will also support data accessibility, mainly through the web. They use HTTPS protocol (Hypertext Transfer Protocol Secure) which is based on TCP/IP.

All the data generated within the project will be made openly available and accessible through the publication repositories, except for part of the software code, according to the involved companies' business models and exploitation plans.

Metadata for all the data, containing the information to access the data, will be made openly available and licenced under a public domain dedication CC0, as per Grant Agreement. In 4TU.ResearchData, metadata may be freely reused under the CC0 waiver. Information about the accessibility of the dataset is also included in the metadata. Datasets in 4TU.ResearchData will be openly available and can be accessed directly from the dataset's landing page.

The data published in 4TU.ResearchData, will be archived and preserved within the repository for at least 15 years.

The accessibility of the developed software in the project will vary according to the business models of the developing companies. It will be provided as: free open source (31%) – open access; open source (23%) - access after payment; proprietary (46%) – no access to the code.

4.3 Making data interoperable

The use and development of standards will be a key part of the project and will be essential to allow interoperability and enable scalability of results. In particular, the standards developed by the Open Geospatial Consortium (OGC) and buildingSMART will be considered. A core part of the project development regards the use and development of standard data models (e.g. OGC CityGML, CityJSON, 3D-Tiles, GeoTiff, bSI Industry Foundation Classes, EXPRESS, gltf, json), best practices and interoperability supporting tools (e.g. OGC and bSI APIs, OGC Rainbow, bSI Data Dictionary, Information Delivery Specification, Information Delivery Manual, mvdXML, etc.).

⁶ <https://www.ogc.org/resources/def-server>

Other ISO standards, such as ISO TC211, ISO 19650 and INSPIRE prescriptions could also be used as an additional reference for some of the developments.

All the standards profiles and specifications will be openly made available through publication in open repositories or through the dedicated channels in the standard development organisations (e.g. OGC and buildingSMART) to allow reuse and further improvement by the community and by further future studies.

The data and related metadata will include references (as DOI or another identifier, such as URL) to other data when relevant to understand the data provenance and context.

The developed software will strain towards interoperability by reusing, whether possible, the available libraries and resources, using open data protocols, format and web interfaces. It will be developed either as Open Source software (54%), making the source code available for any extension and further improvement, or as a proprietary software modules / services. In the latter case (46%), they will connect to the central management platform through APIs published through standard OpenAPI specifications, which will contribute to making the overall architecture interoperable.

4.4 Increase data re-use

Whenever possible, all the data will be shared in their editable format, so that they can be easily re-used, modified and extended for further studies and applications and to support scalability of solutions.

Metadata about the data and any further documentation or specification useful to access, understand and re-use the data, including README files, will be published as part of the same resource in the data repository.

In addition, the methodologies and processes used to obtain the resulting (published) datasets (provenance or lineage) will be explained in either scientific publications or internal reports to be attached to the datasets themselves, allowing replicability and reuse.

All the data, possibly anonymized, in case of interview or workshop data, will be licensed using standard reuse licences allowing free and open access and re-use (e.g. CC0, CCBY) and will remain openly usable after the end of the project.

In case of software, licences will be attached according to the software companies business models. It will result approximately in: free open code license + docs (31%); Code sharing after the payment of a fee + docs (23%); no code sharing + docs (15%); no code + no docs (31%). One possible standard software license that will be used for proprietary software will be MIT licence, while open source software will mainly be provided under MIT and GPL-3.0 licenses.

To ensure data quality, the data, as well as software, will be validated using suitable methodologies according to the specific kinds of data (e.g. workshop-based human validation, data models validation through standard schema validators, iterative tests, iterative feedback collection, internal review and feedback processes and so on).

5 Other Data Management Provisions

5.1 Allocation of resources

TU Delft will be the main responsible for data management storage and quality assurance for the project. A part of the budget is reserved for the development of the data management and storage platform during the project. The chosen platforms for publishing the final data are available for free. 4TU.ResearchData repository ensures data quality and curation (manual curation at the time of deposition, and automated curation and checks for data integrity after the deposit) and is able to archive 1TB of data per researcher per year free of charge for all TU Delft researchers. We do not expect to exceed this and therefore there are no additional costs of long-term preservation. Github also allows free repository and maintenance for the hosted resources, as well as the other potential repositories chosen.

Some specific standard related data and products could be stored alternatively in the OGC or buildingSMART repositories. This would be part of current standard development organisations' business and resources, therefore no additional resources are required from the project.

5.2 Data security

The chosen repositories to store and publish the data have internal security measures which allow safe storage, ensuring the transfer of responsibility if needed and backup. They are also enabled to manage accesses. No highly confidential data needing encryption will be managed within the project.

5.3 Ethics

The data used collected and generated within the CHEK project do not have any ethics sensitive or legal issues. This part of the data management part is therefore not applicable in the CHEK case.

6 Conclusions

This document provides an insight into the planned measures to ensure that the data involved in the CHEK project as well as other output, such as the developed software will be managed according to the FAIR principles.

The expected datasets are listed and categorized, together with their expected characteristics. In addition, the main measures to increase their Findability, Accessibility, Interoperability and Reusability within and after the project are described.

The document will be updated during periodical reports and an annex will be added reporting on the actual measures used to share and publish the data, including the link to each resource.

7 References

List of Tables

Table 1 - Existing Data from Municipalities	7
Table 2 - Interviews and workshop data.....	8
Table 3 – Generated and sample datasets	8
Table 4 – Change supporting tools and CHEK results.....	9
Table 5 – Other output: Software	11
Table 6 – Documentation, education and training materials	12
Table 7 – Communication and dissemination materials.....	13