Change toolkit for digital building permit

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Contents

1. Executive Summary

The wide diversity of European Municipalities in size, digital culture and regulatory requirements poses a challenge for the demonstration. The ambitious goal of CHEK to develop a digital building process (DBP) that can be applied to different cities and especially countries calls for a careful choice of representative pilot sites. Moreover, to demonstrate the feasibility, robustness and the ability to scale of the developed solutions a reliable and detailed plan for validation, measurement and verification is needed.

Deliverable *D6.1 Plan for demonstration of CHEK Digital Building Permit process on demo sites* presents the first results of actions related to CHEK pilot coordination. As a result of close collaboration between consortium partners, including municipalities, construction companies and design firms significant decisions have been made, information about the demonstration sites collected and unified and preliminary plan for demonstration has been drawn up.

This deliverable describes:

- 4 chosen pilot sites in Ascoli Piceno, Prague, Lisbon, and Vila Nova de Gaia. The essential details of the pilot sites have been presented and the information made available by the municipalities has been summarised.
- Key Performance Indicators (KPIs) and municipalities expectations for the final demonstrations. These KPIs will serve as the basis for the evolution of pilot actions.
- Preliminary plan for demonstration, including design, training, demonstration and validation phases. Additionally, to provide important context regulations chosen within WP2 for the pilots have been summarized.

The interim results of *T6.1 Pilot and demonstration planning, requirements and KPIs* will serve as a basis for further actions within WP6:

- Planning and carrying out the final demonstrations including the new building construction and building renovation scenarios (T6.2, T6.3)
- Assessment of final demonstration results and analyses of the CHEK Digital Building Permit scalability (T6.4)

2. Introduction

WP6 *Pilot actions coordination and demonstration* focuses on providing a reliable demonstration of CHEK results in operational environment. This is in line with the project objective O5 *Demonstrate Scalability.* The final demonstrations will be an important milestone of the project assessing and showcasing the final results. Thanks to pilot actions, project partners will receive first-hand feedback about CHEK tool that will lead to further enhancement and optimization ensuring scalability. The final outcome of WP6 is the assessment of the results to define best practices for the uptake of CHEK DBP process.

The wide diversity of the 4 Municipalities involved in the project and high complexity of the DBP use case poses a coordination challenge. To ensure high quality of demonstration, the pilots planning started in the first months of the project and required constant involvement of municipalities, design firms, research partners and construction companies. With the goal of developing a plan for demonstration and validation of CHEK DBP many discussions were carried out involving the use of collaboration tools such as Miro or gathering information with shared Word files. This led to the first tangible results of WP6.

The main interim results of WP6 stemming from the Task 6.1 shown in this deliverable are:

- Choice of case study areas and selection of the parcels that will be used as pilot sites, presenting the summary of information available as Open Data and data made available by municipalities for the purpose of the CHEK project
- Formulation of the list of KPIs for the demonstration cases including the preliminary highlights of work related to the definition of baselines analysing the current state of the DBP process in each Municipality
- Development of the first version of a common Plan for Demonstration showing exact steps that will be taken during the demonstration

The scope of actions carried out and scope of future actions planned within other Work Packages which have strong influence on the demonstration phase of the project have been also briefly summarised in this document. Links with tasks outside of WP6 covered in this document include:

- Collection of regulations, the approach to the selection of the rules and list of controls identified to be encoded for each Municipality (T2.1)
- Importance of determining Level of Information Need and Level of Detail for the BIM and GIS models and future actions related to BIM model parametrisation (T2.2 / T2.3 / T2.4)
- Information about the training for the demonstration participants (T5.2)

3. Pilot site description

The selection of pilot sites and the gathering of all information on regulations, guidelines and previous building permit processes connected to these plots was an important step to start defining the planned demonstration. The choice of 4 pilot sites was motivated by the need to provide a high level of diversity in regulations and variation of types of buildings. Therefore, in accordance to early project agreements 4 chosen pilots are of different occupancy type:

- Private house - Pilot in Vila Nova de Gaia
- Multi-storey (mostly residential) building - Pilot in Ascoli Piceno
- Mixed use building - Pilot in Lisbon
- Public building (such as a school) - Pilot in Prague

4 pilot sites spread out in 3 different European countries, covering 4 different application types ensure that CHEK DBP tools will be tested in diverse regulatory contexts. As a result, the scalability of CHEK DBP will be reliably tested and evaluated.

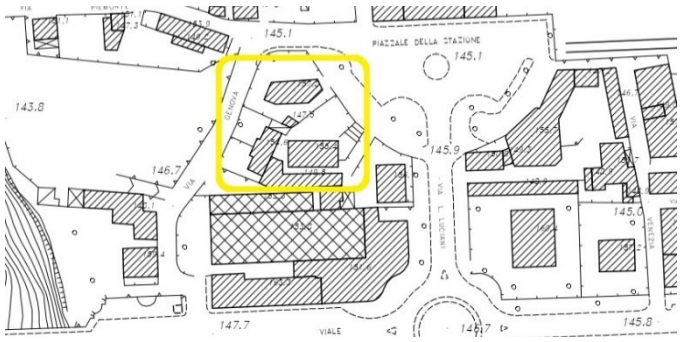
3.1 Data Collection from Municipalities

The pilot description template was prepared to gather and consolidate information from all 4 pilot sites chosen by the Municipalities. The unified information allows to quickly view and understand the context of chosen pilot sites.
The template was structured into 3 sections:

- **Site Information** providing basic information needed to locate the site,
- **Building Information** explaining type of occupancy, summarising information about preliminary assumptions about the geometry of the designed buildings, stemming from existing available information such as screening studies or previous building permits. This section is loosely inspired by the buildingSMART Data Dictionary
- **Plot Information** explains what data and in what format is available. Plot information is crucial to understand what requirements will be applicable to this plot due to among others existing zoning plans. Furthermore, it shines light on the availability of GIS data such as 3D Building Models or Digital Terrain Model. It is also highlighted whether this information was only made available to the project partners or whether it was made available to everyone. In case of Open Data links to databases are provided.

3.1.1 Pilot site in Ascoli Piceno (Italy)

Table 1 Pilot site in Ascoli Piceno

<table>
<tr><td colspan="3">Pilot: ASCOLI PICENO</td></tr>
<tr><td colspan="2"> 
View of the plot, Google Street View</td><td> 
Topographic Survey</td></tr>
<tr><td colspan="3">Site Information</td></tr>
<tr><td colspan="2">Country:</td><td>ITALY</td></tr>
<tr><td colspan="2">Municipality:</td><td>ASCOLI PICENO</td></tr>
<tr><td colspan="2">Civil parish:</td><td>Porta Maggiore</td></tr>
<tr><td colspan="2">Street:</td><td>Via Genova, 4-6</td></tr>
<tr><td rowspan="2">Coordinates:</td><td>Global:</td><td>N 42° 51' 17.4816 E 13° 35' 13.8012 (WGS 84)</td></tr>
<tr><td>Country:</td><td>Not provided</td></tr>
<tr><td colspan="3">Building Information</td></tr>
<tr><td colspan="2">Short Description:</td><td>Urban Renovation</td></tr>
<tr><td colspan="2">Construction Method:</td><td>Demolition of old buildings and new construction</td></tr>
<tr><td colspan="2">Occupancy Type:</td><td>Mixed Use: Residential and Commercial and Services (70% minimum residential)</td></tr>
<tr><td colspan="2">Gross Planed Area [m^2]:</td><td>Proposal to be carried out by the designers</td></tr>
<tr><td colspan="2">Number of Storeys:</td><td>Proposal to be carried out by the designers</td></tr>
<tr><td colspan="2">Available Information Sources:</td><td>Buildability index 3m^3/m^2 (could be developed 3m^3 each 1m^2 of buildable area);
Hmax 15m;
Distance from other building 10m;
Distance from boundary 5m;
Minimum parking area 1m^2 each 10 m^3 of building</td></tr>
<tr><td colspan="3">Plot Information</td></tr>
<tr><td colspan="2">Land and Use Zoning Plan:</td><td>The plot is placed in an urban area with high building density.

Urban zooning and information on other restriction are available at: https://sit.comune.ap.it/portal/apps/webappviewer/index.html?id=bcaf90c4fcf3477796c321b1ff58546e/

Buildability index and other parameters are defined at clause 48 of technical standards for implementation</td></tr>
</table>

	https://www.comune.ap.it/staticfiles/prg2016/RELAZIONI_PDF/PR_NTA.pdf
Cadastral Map:	All national cadastral maps are available at national land agency, upon mandatory registration, at: https://iampe.agenziaentrate.gov.it/sam/UI/Login?realm=/agenziaentrate (PDF, scale 1:2000) Alternatively, limited data are available at https://www.mappecatasto.it/c1.htm
Topographic Survey:	Available, on demand, in DWG file in scale 1:1000. (provided by Ascoli Piceno municipality)
3D Buildings and DTM:	Under development
Infrastructure Connections:	Not provided

3.1.2 Pilot site in Lisbon (Portugal)

Table 2 Pilot site in Lisbon

Pilot: LISBON

View of the plot, Google Street View

Topographic Survey

Site Information

Country:		PORTUGAL
Municipality:		LISBON
Civil parish:		Santo António
Street:		Rua de Santa Marta, nº 41-41B
Coordinates:	Global:	38°43'24.8"N 9°08'45.0"W
	Country:	PT-TM06/ETRS89 | E: - -39080.0m; N: 151925.0m (EPSG: 3763)

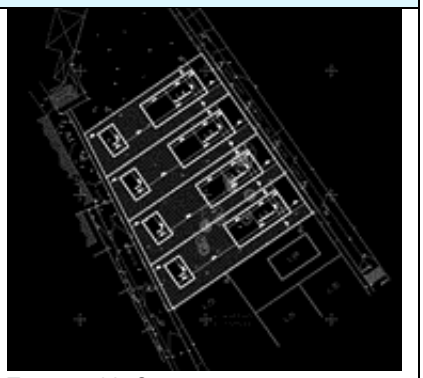
Building Information

Short Description:	Building in urban context on an empty plot
Construction Method:	New Construction
Occupancy Type:	Mixed Use: Residential and Commercial

	Gross Planed Area [m²]:	Proposal to be carried out by the designers
	Number of Storeys:	Proposal to be carried out by the designers
	Available Information Sources:	This demonstration will not be based on a previous application process nor on an existing screening study.
Plot Information		
	Land and Use Zoning Plan:	Land Use Planning Zoning (RPDML Lisbon), SHP, scale 1:10000. The plot is situated on consolidated area (A) and is subject to administrative easements and public utility restrictions as identified in the location plans. On the other hand, this plot is part of and subject to the regulations of the Urbanization Plan of Av. ª da Liberdade and surrounding area (PUALZE). This plan superimposes to Planning Zoning (RPDML Lisbon). The (RPDML Lisboa) it is only used when (PULAZE) is omitted. The location plans provided were taken from the LXI website: https://lisboaaberta.cm-lisboa.pt/index.php/pt/informacao-de-base-e-cartografia Documents shared internally for the needs of the project: • Land Use Planning Zoning (RPDML Lisbon) • PUALZE
	Cadastral Map:	Cadastral Map Plan, PDF, scale 1:500 (shared internally)
	Topographic Survey:	Available in DWG file in scale 1:1000. (provided by Lisbon municipality) The updated and certified topographical survey was delivered by the designer, in DWG file in scale 1:200
	3D Buildings and DTM:	3D Buildings: Available in CityGML format DTM: Available, but is not an Open Data
	Infrastructure Connections:	Not provided

3.1.3 Pilot site in Vila Nova de Gaia (Portugal)

Table 3 Pilot site in Vila Nova de Gaia

Pilot: VILA NOVA DE GAIA		
 View of the plot, Google Earth		 Topographic Survey
Site Information		
Country:		PORTUGAL
Municipality:		VILA NOVA DE GAIA
Civil parish:		Serzedo
Street:		Rua Boavista | Rua Nuno Augusto de Oliveira Ramos
Coordinates:	Global:	41°02'08.2"N 8°35'52.0"W | 41.035598 N, - 8.597768 E (WGS 84)
	Country:	PT-TM06/ETRS89 | E: -39080.0m; N: 151925.0m (EPSG: 3763)
Building Information		
Short Description:		Detached single house
Construction Method:		New Construction
Occupancy Type:		Residential
Gross Planed Area [m^2]:		Maximum Construction Area for the lot number 9/2021 defined in allotment plan: • Housing 225,00 sqm • Garage 121,00 sqm • Secondary construction 77,00 sqm (shed in the garden) An urban subdivision is the result of a permit that consists of creating a certain number of lots for construction following the rules of the urban area's Master Plan and the definition of supplementary rules for the construction itself.
Number of Storeys:		2 aboveground (according to allotment rules)
Available Info Sources:		Allotment permit
Plot Information		
Land and Use Zoning Plan:		Municipal Spatial Planning Plans, Open Data:

		https://sig.gaiurb.pt/geoportal?webpdm https://opendata.gaiurb.pt/
	Cadastral Map:	Cadastral Map is also available via the abovementioned link. Additionally, an allotment permit (PDF) including information on site specific requirements was shared.
	Topographic Survey:	For the Gaia Demonstration case the Topographic survey is available for the designers as a courtesy of the Municipality. In real scenario the Topographic Survey is a responsibility of the owner/promoter and it's mandatory 2 DWG files: • Planta De Síntese • Topographic
	3D Buildings and DTM:	3D Buildings: Available https://sig.gaiurb.pt/geoportal?webpdm https://opendata.gaiurb.pt/ Buildings converted from digital cartography, scale 1/5000, postgre BD – citygml) DTM: Available https://sig.gaiurb.pt/geoportal?webpdm https://opendata.gaiurb.pt/ Data accessible on Municipality's Open Data Web Portal. DTM (3D Contours and 3D points in SHP format, Raster in TIF format)
	Infrastructure Connections:	Available, accessible Open Data: https://www.aguasgaia.pt/pages/cadastro

3.1.4 Pilot site in Prague (Czechia)

Table 4 Pilot site in Prague

Pilot: PRAGUE

Southeast view

Visualization of the area

Site Information

Country:		CZECHIA
Municipality:		PRAGUE
Civil parish/ City part		PRAGUE 3
Street:		Habrová
Coordinates:	Global:	50°05'17.4"N 14°29'33.2" E| 50.088158 N, 14.492550 E (WGS 84)
	Country:	S-JTSK: Y: -737750.75, X: -1043637.12 (EPSG: 5514)

Building Information	
Short Description:	Public school planned to be built within development project called Žižkov Freight Station.
Construction Method:	New Construction
Occupancy Type:	Educational
Gross Floor Area [m^2]:	7690,59 (maximal GFA allowed by the screening study)
Number of Storeys:	4 Aboveground, 0 underground (according to the screening study)
Available Information Sources:	Screening study was conducted and a design variant was chosen. 3 files were made available for the need of the pilot. DOC1 contains description of the designed variant A of public school. Document describes urban plot and area of the school, parking solution, building description, pros and cons of this design variant. Table A1 contains also space usage areas. DOC2 is a translation of DOC1 from Czech to English. DOC3 contains visualisation of variant A design. Designs are available for the whole plot and also each floor of the building.
Plot Information	
Land and Use Zoning Plan:	No urban plan currently available in the open-access due to change of the urban plan. Local urban plan was provided as a picture in PNG format and GIS format (GDB) and also WFS service. Data are stored in project folder.
Cadastral Map:	Cadastral map in PDF format is available in project folder. Cadastral map is also available in CAD and GIS formats Online map service (WMS) is available on: http://www.geology.cz/extranet-eng/maps/online/wms
Topographic Survey:	Topographic survey for concrete building is not available. Surveying information for the whole city of Prague is available as WMS service: http://www.geology.cz/extranet-eng/maps/online/wms
3D Buildings and DTM:	3D Buildings: Available, but is not an Open Data • CityGML, EPSG 5514 LOD 2,5 • TIFF, EPSG 3857, resolution 1 m DTM: Available • TIN, EPSG 5514, TER_all https://www.geoportalpraha.cz/en/data/opendata/6F72EDDF-CAA4-4243-8776-7006CB0B2521 • TIFF, EPSG 5514, resolution = 1m https://www.geoportalpraha.cz/en/data/opendata/609AB233-4F4B-4010-A6E0-011E232E2390
Infrastructure Connections:	• SHP, 3D lines, EPSG 5514, Available, but is not an Open Data • CTMTP_KOD – classification of technical infrastructure • CTMTP_POPI – labels of classification of technical infrastructure

4. Plan for Demonstration

4.1 Design phase

The Design phase is a pivotal stage in the building and construction process, focused on translating initial concepts into tangible models. This phase needs to deliver BIM models fit for demonstration purposes.

The phase commences with a strategic definition of the goals of design models/projects in the CHEK project. Activities in this stage need to ensure that the final models will be fit for the purpose and according to the CHEK project's requirements, goals and vision.

In the preparation stage, Designers will gather all input documents and data for the four demo sites in order to obtain a thorough understanding of each project's requirements and will conduct site analyses to evaluate environmental factors, local regulations, and site constraints. With this foundation, concept design stage can start with developing preliminary sketches and conceptual drawings. Conceptual design stage will provide an initial visual representation of the project. These concepts will evolve into detailed architectural drawings and 3D models, showcasing spatial relationships.

Designers will use various software tools for their work, most notably Autodesk Revit as a world most used BIM (Building Information Modelling) application. In addition, the choice is motivated by the need of testing the CHEK IFC exporter for Revit that will be developed in CHEK. BIM models will be exported in IFC file format by using commercial but also tools developed by software companies - partners in the CHEK consortium.

However, not every BIM model inherently holds the appropriate information for Digital Building Permits. The accuracy of information embedded is essential for seamless analysis. This underscores the importance of defining the Level of Information Need (LOIN) and standardizing digital models. Since not all elements bear equal significance, over-modelling can result in bloated, intricate, and ultimately less effective models. Determining the LOIN for each element in a model, along with the precise manner of information input, is crucial for numerous reasons:

1. **Resource Optimization**: Modelling and parameterizing elements that don't bring value to the project or specific objectives can consume time and resources. By setting an appropriate LOIN, it ensures that only the essential elements are included in the model, thus avoiding redundancies.

2. **Objectivity in Selection**: Not all elements hold the same relevance in a project. Some might be critical for urban analysis, while others might be secondary. Defining the LOIN helps establish objective criteria to determine which elements should be modelled and at what level of detail.

3. **Compatibility with Analysis Tools**: In the digital age, models not only serve as visual representations but often feed analytical tools and applications. A properly defined LOIN ensures that the application's input is correct. If a model lacks necessary information or is overloaded with irrelevant data, it can result in incorrect or inefficient analyses.

4. **Clarity and Consensus**: By defining the LOIN, designers and developers can reach a consensus on what is essential to model. This ensures that all parties involved have clear and aligned expectations, and that the final model is an accurate and useful representation of the project.

In summary, the LOIN definition is not just about efficiency but also about precision and relevance. By clearly determining which elements should be modelled and at what level of detail, it guarantees that digital models are effective tools, aligned with the project's objectives, and perfectly suited for analysis and assessment in advanced digital tools.

This process emphasizes the importance of setting clear criteria for modeling and strengthens the pressing need for standardization in creating digital models. The process of digital urban permits involves a combination of technical, legal, and operational aspects. For designers, to effectively establish this process, various actions are needed. Here are some suggestions from each perspective:

1. **Continuous Training**: Stay updated with the latest BIM (Building Information Modeling) tools and technologies to ensure the models created are compatible and easily interpretable in a digital environment, and in collaboration with researchers, municipalities, and developers organize workshops and seminars for all stakeholders, including government employees and other professionals, to familiarize them with the digital process.

2. **Clear Data Definition**: Ensure all relevant design details are included in the digital models, from structural specifications to aesthetic details.

3. **Interoperability**: Use open standards and file formats that allow easy integration and review by the relevant authorities.

4. **Collaboration**: Establish constant dialogue between designers, researchers, and developers to ensure everyone is aligned in their efforts.

5. **Pilot Tests**: Prior to full implementation, conduct pilot tests to identify and address any potential issues. Establishing a process for digital urban permits is a collaborative and multifaceted effort requiring careful consideration and coordination of multiple stakeholders.

4.2 Training phase

The demonstration will start with the training led by project partner University of Minho within the Work Package 5. The aim of the training is to enable municipality technicians and designers to understand and use the CHEK solutions properly for the scope of demonstration. The training will explain the developed CHEK methodological and technological toolkit with the practice-oriented approach. This means that the training will guarantee that demonstration participants will be well informed and prepared to carry out the pilot scenarios. Therefore, the training materials should include clear instructions on how to operate during the demonstration.

Given that the preparation of training is foreseen within Task 5.2, which begins only in M18 (March/April 2024) there were no concrete action made in this respect yet. Currently in WP5 progress has been made in terms of systemising knowledge and partners' know-how, which is essential for the demonstration activates and the project as a whole.

4.3 Demonstration and Validation phase

The implementation of the uptake of Digital Building Permit process in municipalities with BIM application involves different steps and processes that should be validated to ensure the effectiveness and reliability of the system. A validation plan should be put in place to verify that the system performs as expected.

The Validation Plan (VP) will be a comprehensive document that helps project participants move forward with clear roles and expectations, for each demonstration case. Considering the complexity of the process to be validate and potential constrains it's important to be realistic about expectations for each specific Demonstration Case.

The preparation of the Validation Demonstration Case Plan shall be set out following a simple structure organized in 3 major stages – Preparation, Demonstration and Evaluation - without excluding the possibility of including other sections that are individual requirements for a specific demonstration case.

The VP is to be prepared by a Team from each project participants (municipality) responsible for the analysis of the current process and procedures to obtain building permits, and for the end user of the system. This team must ensure a good knowledge of the current process (AS-IS); know the process to be implemented (TO-BE); and have basic knowledge of BIM and urban planning languages.

For each stage of the Validation Plan, actors and roles must be defined to monitor the development and progress of each stage. Thus, each team responsible for the Validation Demonstration Case Plan should define the following personas, to provide input to the future documents.

Table 5 Responsibilities for each demonstration participant/ team of participants

Role	Thematic area	Responsibility
Validation Plan Manager	Innovation – Strategic projects and policies	Ensure the VP is prepared as per the guidelines defined Monitors Demonstration Case progress per VP
Data inspection checks	GIS + IT	Data inspection; Importing data into database itself;
System overview (description and analysis of the requirements needed to use the CHEK DBP tool)	IT (staff who will support the system)	Integration and interoperability with existent hardware and software; Computer system validation; Minimization of information duplication.
Security testing	Data protection	Retention, migration and data destruction
Test and evaluation of functional requirements and final results	Urban management (municipality staff who will use the system)	Data analysis (understanding of the parts of the CHEK DBP with the most significant utilization in the CHEK DBP adoption process in daily activities);
	Final users (municipality staff, building owners, designers and contractors)	Evaluating the effectiveness of the CHEK DBP and signalling the necessary improvements.

The process of ensuring the use or adoption of the CHEK DBP in municipalities, due to the lack of a clear understanding of the prevailing elements, will be an iterative process and places considerable demands on the technical capabilities of the organization and its people. Therefore, this core team may be changed and added to throughout the process.

Standard structure of the Validation Plan

Preparatory stage

1. Define the scope of the project: The first step is to define the scope of the project, including the goals, objectives, and deliverables. This will help in identifying the requirements for the digital building permit system.
2. Identify the stakeholders: The next step is to identify the stakeholders who will be involved in the project. This includes the municipality staff who will use the system, the building owners and contractors who will submit applications, and the IT staff who will support the system.
3. Develop use cases: Use cases are scenarios that describe how the digital building permit system will be used in different situations. Develop use cases that cover all the possible scenarios that the system is expected to handle.
4. Define the acceptance criteria: Define the acceptance criteria for each use case, which will be used to determine whether the system is performing as expected.

Demonstration stage

5. Test the system: Perform testing to verify that the system meets the acceptance criteria. This can include functional testing, performance testing, security testing, and user acceptance testing.
6. Document the results: Document the results of the testing, including any issues that were found and how they were resolved.

Evaluation stage

7. Evaluate the pilot: Evaluate the pilot implementation to determine whether the system is performing as expected. Use the feedback provided by users to identify any improvements that can be made.
8. Roll out the system: Once the pilot is complete and any necessary improvements have been made, roll out the system to all users.
9. Monitor and maintain the system: Once the system is in place, it is important to monitor and maintain it to ensure that it continues to perform as expected. This includes performing regular backups, applying software updates, and providing support to users.

Each Municipality Partner should prepare a Validation Plan for their individual Demonstration Cases according this standard operating procedure. This must be a live document that should be reviewed against each life-cycle step of the DBP process, it should be easily accessible and retained.

5. Check regulations for pilots

5.1 Collection of regulations and the approach of selections of rules

The definition of pilot check regulations is identifiable by the framework established in deliverable T2.1 (WP2). The focus of deliverable 2.1 (WP2) is to define how information requirements can be extracted for the preparation of building and city information models in the scope of digital building permit issuance. The first part has provided a CHEK list of regulations that specifies the types of checks and verifications that must be complied with in accordance with the regulations throughout the building permit process. The definition of the CHEK list was possible through constant interaction with the 4 municipalities. In this regard, emphasis was further placed for pilot cases to be developed in WP6, for which target the CHEK list has been developed in a joint effort with municipalities.

An initial typical checklist was proposed to the municipalities, which applied an iterative review process, proposing additions, cancellations and changes. In its final version, the checklist comprises 56 aspects to be examined, which can be categorized into 5 sections [Table 6]. More specifically, municipalities have been engaged to identify which of the proposed checks should be considered for prioritization. This interaction revealed that urban-level checks take precedence over checks pertaining to the building itself. For each control identified, the municipalities associated the relevant regulatory text and in specific the articles to be considered within them as well. This step proved to be complex from the start as the interaction required the municipality officers to synthesize regulatory constraints considering a municipal-level perspective and the multitude of legal references that are itself subject to jurisdictional changes. In fact, from the very beginning of CHEK, an in-depth analysis of many regulations in the countries involved was conducted in the awareness that it would be impossible to cover the entire spectrum of regulations.

5.2 Methodology of selection of rules

Given that it is not possible to analyse and codify all regulations within the framework of the CHEK project a methodology for regulation selection and interpretation was established within Task 2.1. The scheme of this methodology is described below, whereas a detailed description of the individual steps can be found in Deliverable 2.1.

1. **Identification of relevant building permit checks**
    - 1a. **Provision of a CHEK List of regulations:** Identification of necessary checks and verifications for building regulation compliance during permitting, translating selected regulations into English for partner assessment of representativeness.
    - 1b. **Categorisation of all regulations' clauses in test building permit regulation:** Each regulation clause in the test permit was classified using a new system to gauge ambiguity and digitalization potential.
2. **Rule interpretation:** Regulations were interpreted with sentence-centric and semantic markup methods, involving municipalities to resolve ambiguities, identify regulatory requirements, and highlight if-then relationships, serving as a pre-step towards defining a formal, machine-readable language for design compliance checking and specifying recommendations for clear regulations.
3. **Configuration of the conceptual models:** Results of rule interpretation identified objects, properties, relationships, and summarized geometrical and alphanumeric attributes. This supported comparing results from regulatory text analysis across four municipalities and proposed a graphical representation of information requirements.

4. **Validation:** Validation of conceptual models and information requirements has involved experts, as municipality officers and designers in addition to standard entities
5. **Comparison of results of each municipality:** Conceptual models and information requirements of municipalities have been compared

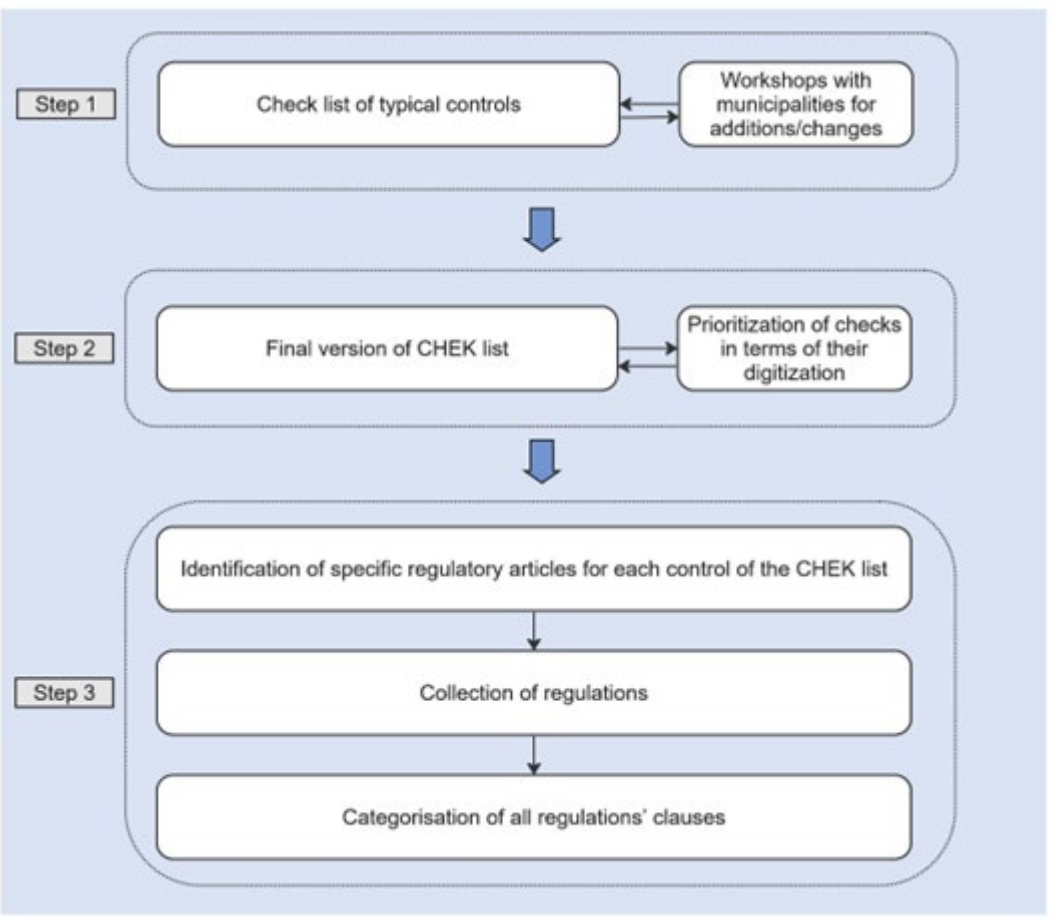


Figure 1 Methodological steps for selection of relevant regulations in Task 2.1-2.2

5.3 List of controls identified in the CHEKlist

Table 6 List of controls identified in the CHEKlist and identification of the municipality carrying out the control

Section	Check	Municipality			
		LIS	GAI	APC	IPR
URBAN INDICES	Maximum buildable urban volume	X	V	V	X
	Buildability index	V	V	V	V
	Permeable area	V	V	V	V
	Covered area	X	V	V	V
	Maximum building height	V	V	V	V
	Maximum facade height	V	V	X	X
	Maximum building length	V	V	X	X
	Number of storeys	V	V	X	V
	Facade alignment	V	V	X	V
	Roof configuration	V	X	V	X
	Fence	V	V	-	-
DISTANCES	Building-building distance	V	V	V	V
	Building-parcel boundaries distance	V	V	V	V
	Building-road distance	V	V	V	V
	Balconies-parcel boundaries distance	V	V	V	X
PARKING STANDARDS	Dimension/area to be considered when determining parking spaces	V	V	V	V
	Minimum number of parking spaces from standard	V	V	V	V
BUILDING SPACES REQUIREMENTS FOR USABILITY	Minimum dimensions [x,y,z - Uom=m] of rooms and openings	V	V	V	V
	Mezzanines	V	V	V	V
	Toilets/sanitary facilities	V	V	V	V
	Kitchens	V	V	X	X
	Ground floor, semi-basement and basement spaces	V	V	V	V
	Garages	V	V	X	V
	Stairs (indication of risers and treads, slope, railings)	V	V	V	V
	Balcony and terrace parapets	V	V	V	V
	Patio/green areas	V	V	V	V
	Minimum area [Uom=m2] and equipment of dwellings	V	V	V	V
	Relationship (circulation?) spaces and common services	V	V	X	V
	Provision of sanitary facilities in public buildings	V	V	X	V
	Spaces for waste collection	V	V	X	V
	Chimneys and ducts	V	V	V	X
	Protrusions on public streets and squares	V	V	V	V
	Protection of the arboreal heritage	V	V	V	X
	Elements/constructions attached to the building typology	V	V	X	V
	Minimum dimension per number of inhabitants	X	X	V	V
	Pergolas	X	V	V	X
	Solar greenhouses	X	V	V	X
	Loggia	X	X	X	V
	Foundations	X	X	X	V

	Allowed functions in underground spaces	V	V	X	X
ARCHITECTURAL BARRIERS	Verification of accessibility for public buildings and/or open to the public	V	V	V	V
	Presence of a lift	V	V	V	V
	Door's dimension	V	V	V	V
	Accessibility of all rooms	V	V	V	V
	Corridors dimension	V	V	V	V
	Toilets dimension	V	V	V	V
	Dimensions of the operating spaces	V	V	V	V
	Verification of visitability for new private buildings	V	V	V	X
	Accessibility of living room	V	V	V	V
	Accessibility of at least 1 toilet	V	V	V	X
	Verification of adaptability for private buildings	V	V	V	X
	Future accessibility through feasible changes	V	V	V	V
	Staircase	V	V	V	V
	Wheelchair spaces	V	V	X	V
Explanation of symbols: V – control identified to be carried out by municipality X –will not be carried out for this municipality - – control currently in discussion					

6. Objectives and Key Performance Indicators

6.1 Introduction to KPIs

Key Performance Indicators (KPIs) are measurable metrics that will be used to evaluate the performance and effectiveness of CHEK innovations during the demonstrations. They will serve as quantifiable benchmarks to help assess progress and success. KPIs will allow for identifying areas of improvement, monitoring the progress of CHEK solutions and aligning efforts with strategic objectives.

KPIs relate to project ambitions and objectives described in Description of Action and are directly correlated with criteria that were considered while building the DBP process map in the scope of Work Package 1 in the Deliverable 1.1

6.2 Internal Procedure Analysis

LIS first analysed all the phases of their current Digital Building Permit process, also as part of the CHEK T1.1, and compared it to the desired to-be process. This helped to show the planned, automatized process and to analyse the expected Internal legal assessment deadlines. Such summary additionally showed prospective timesaving arising from CHEK, which was transferred directly to one of the KPIs.

6.2.1 Ascoli Piceno

In the case of Municipality of Ascoli Piceno the national law establishes 60 days as total time of the BP procedure plus an interruption for integration of 15 days. The average current process takes between 60 to 120 days (some are very longer due to missing integration after request), there is a lot of time loss due to geometrical and law interpretation issues. In the following flowchart we describe the actual BP process:

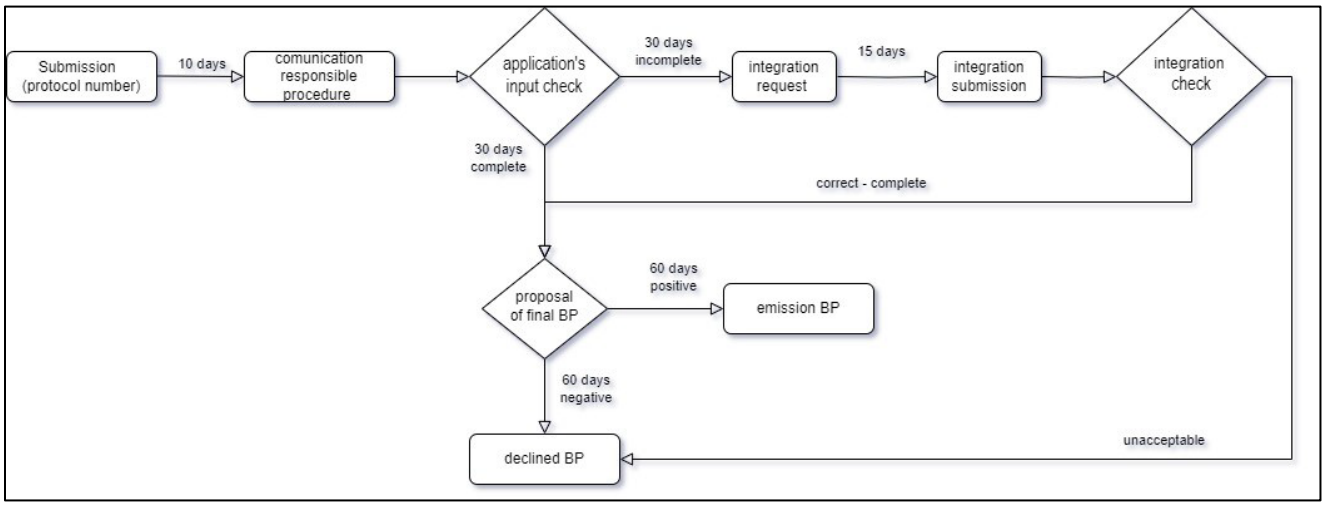


Figure 2 Flowchart of the current BP process, Ascoli Piceno

After CHEK is expected to be between 55 and 80 days, which is an average of 1,2- 2 times saving.

6.2.2 Prague

Time savings using CHEK platform with nowadays process of 2 level permitting process would amount to 10 days within formal verification and reviewing of the project. These 2 procedures currently take up to 20 days whereas after implementation of CHEK the deadline would be shortened to 10 days. The internal procedure includes asides from two above-mentioned processes also the consultations with external and internal entities that has been taken into account in determining the relative value of the KPI [Table 7]. Additionally, there could be more than 70% of time saving in preparatory phase if the architect use CHEK platform for project and documents validation before submitting.

Timeline	Architect and 3rd parties			Submiting of documents	Building authority			Planning permit	Building authority			Building (construction) permit		Notification Building (Construction) Permit
Digital Building Permit (DBP) Phases of the procedure	Collection of documentation and statements from 3rd parties				Planning permit process				Building permit process				Issue Construction Permit	
	Preparation of project documentation	*Consultation with building authority*	Issue of 1 statement		Formal Verification	(if applicable) Consultation with external and internal entities	Review of project		Formal Verification	(if applicable) Consultation with external and internal entities	Review of project		Review	
Internal legal assessment deadlines	Text below in italic is only estimation how long it takes the architect to prepare the project.				60 + 30 days				60 + 30 days				15 days	
Before CHEK	*(half year)*	*(60 days)*	30 + 30 days		15 days	40 days	5 days		15 days	40 days	5 days		15 days	
After CHEK (2 level permitting proccess)		*CHEK*			CHEK		CHEK		CHEK		CHEK			
	(half year)	*(10 days)*	30 + 30 days		8 days	40 days	2 days		8 days	40 days	2 days		15 days	

Figure 3 Municipalities of Prague process breakdown before and after CHEK (2 level permitting process)

Time saving using of only 1 level permitting process would save 50% of time.

Timeline	Architect and 3rd parties			Submiting of documents	Building authority			Building (construction) permit		Notification Building (Construction) Permit
Digital Building Permit (Dbp) Phases of the procedure	Collection of documentation and statements from 3rd parties				Planning permit proccess				Issue Construction Permit	
	Preparation of project documentation	*Consultation with building authority*	Issue of 1 statement		Formal Verification	(if applicable) Consultation with external and internal entities	Review of project		Review	
Internal legal assessment deadlines	Text below in italic is only estimation how long it takes the architect to prepare the project.				60 + 30 days				15 days	
Introduction of CHEK (IFC)		*CHEK*			CHEK		CHEK			
1 level permitting process	*(half year)*	*(10 days)*	30 + 30 days		8 days	40 days	2 days		15 days	

Figure 4 Municipalities of Prague process breakdown after CHEK (1 level permitting process)

6.2.3 Lisbon

In the case of Municipality of Lisbon the total time of the DBP procedure after CHEK is expected to be between 59 and 74 days, which is an average of 19 days saved in comparison to the current process which takes between 78 and 94 days. Municipality of Lisbon has additionally recognised that implementation of CHEK in further stages of the internal procedure related to the construction would also be beneficial.

Before CHEK

e-Urban	Municipality's digital platform > DWF and PDF								total
Internal legal assessment deadlines	8 days	(if applicable) 20 days + 20 days	30 days		30-45 days		10 days		78 -93 days

Phases

Timeline	Architecture			Notification Approval	MEP and others			Notification Granted		Notification Construction Permit	
Digital Building Permit (Dbp) Phases of the procedure	Architecture				Specialties Projects				Issue Construction Permit		
	Formal Verification	(if applicable) Consultation with external and internal entities	Review		Formal Verification	(if applicable) Consultation with external and internal entities	Review		Review		

After CHEK

e-Urban	Municipality's digital platform > DWF and PDF + (IFC)								total
Introduction of CHEK (IFC)	CHEK		CHEK						
Internal legal assessment deadlines	4 days	(if applicable) 20 days + 20 days	15 days		30-45 days		10 days		59 -74 days

Figure 5 Digital Building Permit (DBP) Municipality Internal Procedure, Municipality of Lisbon

6.2.4 Vila Nova de Gaia

In the case of Municipality of Gaia the total time of the architectural approval project nowadays is 30 days. With the implementation of CHEK DBP is expected to be 23 days.

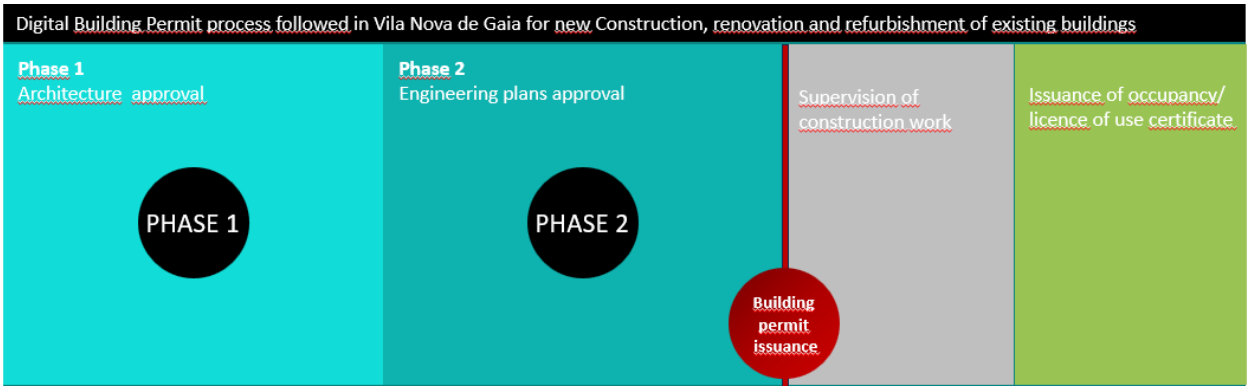


Figure 6 Phases of the current Digital Building Permit process in Vila Nova de Gaia Municipality

In the case of Vila Nova de Gaia, the average time needed to obtain a decision from the municipality on the conformity of the architectural project with the urban plan and legislation (Phase 1) is 30 days.

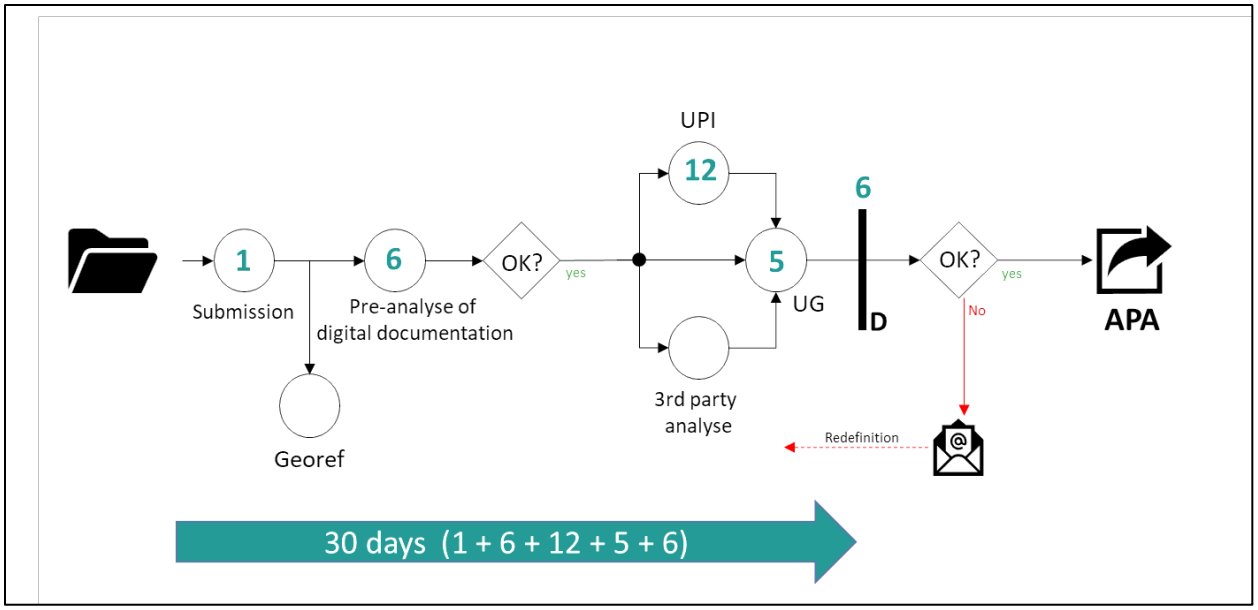


Figure 7 AS-IS process in Gaia Municipality for Phase 1 – Architecture approval

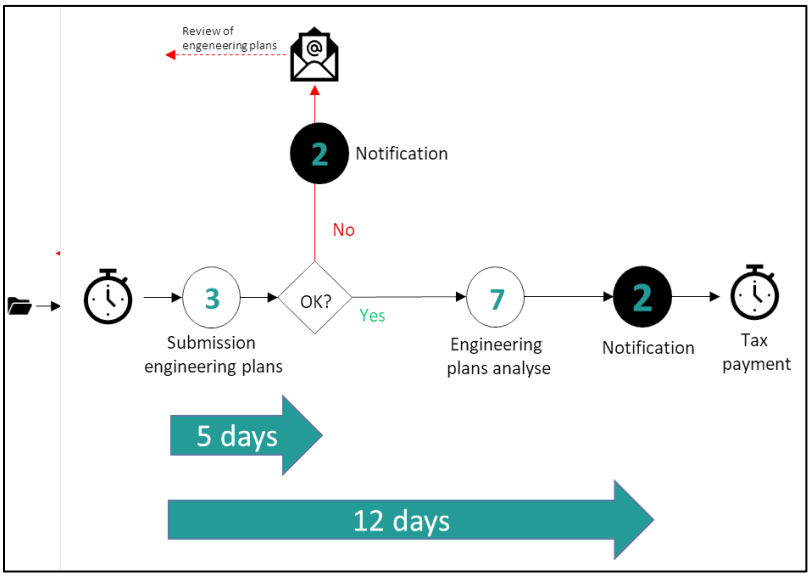


Figure 8 AS-IS process in Gaia Municipality for Phase 2 – Engineering plans approval

6.3 Approach towards KPI Creation

Formulation of KPIs began with LIS initiative which resulted in building a general framework of how KPIs were determined. Further meetings with all Municipalities and Technical partners led by WP6 partners helped produce final list of KPIs and their expected values [Table 7]. The analysis undertaken by the Municipal Urban Department of Lisbon (LIS) served as an exercise in testing a potential framework for assessing the effectiveness of the deployment of a set of digital tools, the CHEK-DBP (Digital Building Permit).

Agreed approach is that we create a universal set of KPIs for all 4 Municipalities, but each Municipality has to create their baselines for KPIs that require a baseline.

After the analysis of the phases and identification of the processes that can be either automatized or eliminated, specific **objectives** to be achieved were discussed and formalized. It was taken into account that these goals have to be measurable so that the demonstrations can evaluate their success reliably. Objectives were also connected with the corresponding **functions** and **services** to better understand how to achieve and evaluate them. Furthermore, it was recognized that for achieving a particular purpose or goal more than one of the CHEK functions can be used.

Exact **KPIs** that are valid for the process of demonstration were derived from the defined objectives and correlated with CHEK functions. Determined KPIs fall into 6 different categories:

- **Innovation** - measuring the level of maturity of the CHEK e.g., by showing the percentage of all processes that have been successfully automatized
- **Legislation, Standards and Regulations** – measuring the impact of CHEK on simplification of existing regulation
- **Process** – measuring the increase in the transparency and level of optimization of the DBP process
- **Use of Open BIM (IFC) / Data extraction**
- **User Satisfaction** – measured among Applicants and Designers, Municipal Technicians
- **Learning and Growth** – evaluating the benefits of new competences and experiences gained by the internal organizations and also benefits and capabilities on the educational level

Appropriate **units** were selected for the defined KPIs. Some KPI units are relative therefore it is crucial to define current baselines for each Municipality.

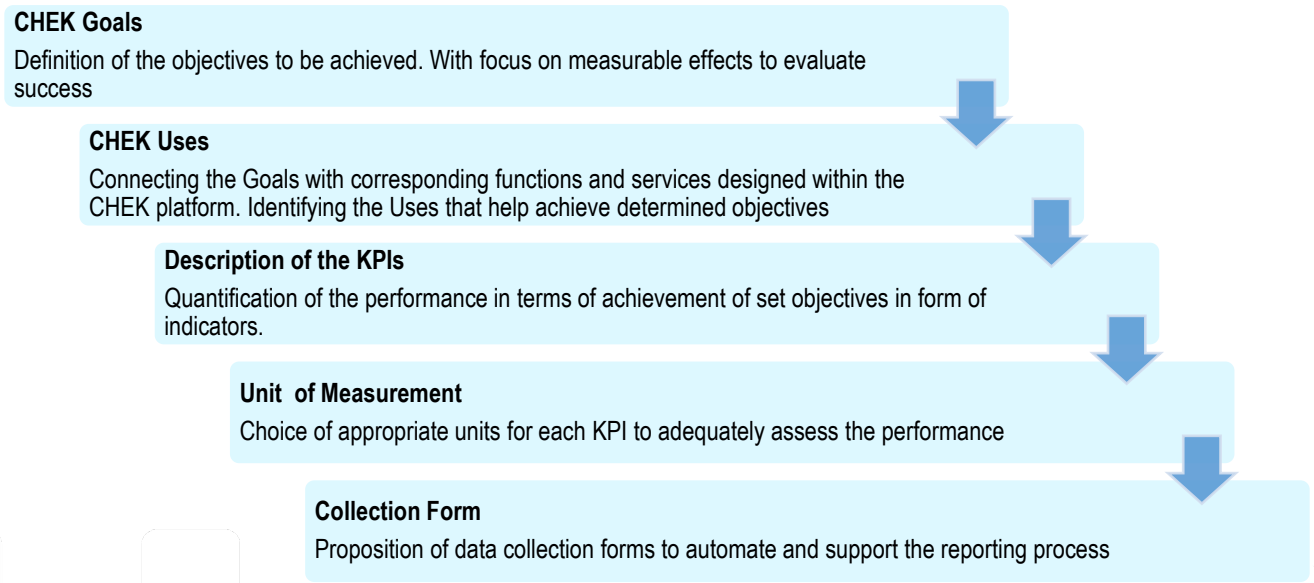


Figure 9 Workflow of the approach towards KPI Creation

Exemplary outcome of the preliminary KPI formulation exercise conducted by LIS looked as shown in Figure 10.

CHEK Goals	CHEK Uses	Description of the KPI	Unit Measurement	Collection Form
LOIN (geometric and non-geometric information)compatibility with synoptic table and INE form; Reduction of documents / Elimination of filling out forms and terms. Examples (Owner ID, Applicant, Technicians, Descriptive Memory and others)	Data extraction from the IFC model and associated documentation	**Verification and validation of Information requirements in the IFC model**	Number of processes properly instructed / Percentage	CHEK report

Figure 10 Exemplary outcome of the preliminary KPI formulation exercise

The final list of determined KPIs presented in Table 7 was simplified and shows expected KPI values.

6.4 List of Key Performance Indicators

1. Percentage of process steps using CHEK

The final TO-BE process map created within Task 1.1 divides the DBP process into 3 main phases, consisting of 13 actions in total (e.g., information collection, pre-checking, submission). The goal is to conduct all of this actions on the CHEK platform which provides an integrated environment for all actions (which is shown on the TO-BE process). This KPI assess whether all parties involved in the demonstrations (e.g., applicant, municipality) manage to carry out all the 13 actions on the CHEK platform (as foreseen in the TO-BE process map)

2. Percentage of process steps digitalised (compared to the state before CHEK)

CHEK intends to digitalise the entire building permitting process. A single platform is to be used for the digitalisation, allowing the whole process to be carried out in a single environment. This indicator will show what level of digitalisation has been achieved compared to state before CHEK (AS-IS process maps). This will emphasize how innovative and transformative CHEK is compared to the current Building Permitting process in each involved Municipality.

3. Number of digitalised regulations

Within CHEK a number of regulations were analysed and will be encoded to allow the automated rule-checking. The number and percentage of encoded rules will indicate the maturity of the platform and how much work is needed to achieve fully automated rule checking. As different regulations are analysed for each municipality, both the percentage and the number will be different for each demonstration. Only regulations that are actually tested during the final pilots will count towards this indicator.

4. Accuracy of automatically validated regulations in the use of PRE-CHEK

The correctness of automated rule checking will be verified during the demonstrations. False negative errors and false positive errors will be recognised and counted.

5. **Quality of the application that reaches the Municipality technicians**

The purpose of the PRE-CHEK is to ensure that the documentation that reaches the technicians at municipality complies with all requirements and regulations. During the demonstration, the accuracy of the PRE-CHEK algorithm will be examined and evaluated.

6. **Amount of information (number of documents) moved into the BIM model (Reduction of the number of documents)**

The advantage of a BIM model defined Level of Information Need and Level of Detail is the ability to store a large amount of geometric and non-geometric information. This helps to reduce the required number of documents, which consequently leads to a reduction of bureaucratic tasks. The demonstrations will examine how many of the documents that would have been required in the building permit application process prior to the CHEK are rendered redundant by the new process.

7. **Flexibility of the solutions, resistance to change**

Building requirements change over time, so the platform for caring out the permit process must be resilient to such changes. This resilience will be implemented in the CHEK platform thanks to changeable parameters, that should be editable by municipality technicians.

8. **Time saving within the internal assessment time**

In order to demonstrate the tangible benefits of the CHEK platform, the time required for the internal, administrative process will be compared to the time required before CHEK.

9. **Verification and validation of Information requirements in the IFC model**

All information contained in the IFC model will be verified for correctness and readability in order to assess whether the model fulfils all the intended functions.

10. **User experience. Level of satisfaction with the use of CHEK tools**

Measuring the satisfaction among the applicants in order to assess improve CHEK platforms performance.

11. **User experience and Work Performance Satisfaction level. Level of satisfaction with the use PRE-CHEK tools**

Measuring the satisfaction among the municipality technicians in order to assess improve CHEK platforms performance.

12. **Training and use satisfaction level regarding the use of CHEK**

Satisfaction regarding new competences gained.

Table 7 List of KPIs and expected values

Category	KPI number	KPI	Unit of Measurement	Targeted KPI Values			
				APC	GAI	LIS	IPR
Innovation	1	Percentage of process steps using CHEK	Percentage of process steps using CHEK (process steps using CHEK / all the TO-BE DBP process steps)	100%			
	2	Percentage of process steps digitalised (compared to the state before CHEK)	Percentage of process steps using CHEK (process steps digitalised by CHEK / all the AS-IS process steps)	75%	100%	70%	100%
Legislation, standards and Regulations	3	Number of digitalised regulations	Identification of regulations and codified articles for CHEK use Number / Percentage	65-75%	100%	65% - 70%	75%
	4	Accuracy of automatically validated regulations in the use of PRE-CHEK + CHEK	(1)No./ percentage of rules correctly validated (2)No. Of False Positives, No. Of False Negatives	95%	100% (1) 0% (2)	100%	100%
	5	Quality of the application that reaches the Municipality technicians	No./ percentage of rules correctly validated	50%	Increase in **50%** processes submitted without errors	50%	50%
Process	6	Amount of information (number of documents) moved into the BIM model (Reduction of the number of documents)	No. Documents reduced	70%	50%	70%	50%
	7	Flexibility of the solutions, resistance to change	Combined no. of changeable parameters for all rules (change possible from the Municipality's level)	100%	100%	100%	100%
	8	Time saving within the internal assessment time	Time saved for specific processes Number of days / Percentage	30-40%	23%	27%	25%
Use of Open BIM (IFC) / Data extraction	9	Verification and validation of Information requirements in the IFC model	Number of processes/ parameters properly instructed (LOD, LOIN) Number	90%	100%	70%	100%
User satisfaction	10	User experience. Level of satisfaction with the use of CHEK tools	Percentage / Questionnaire / Likert Scale	70%	80%	100%	80%

	11	**User experience and Work Performance Satisfaction level. Level of satisfaction with the use PRE-CHEK tools**	Percentage / Questionnaire / Likert Scale	100%	80%	100%	80%
Learning and Growth	**12**	**Training and use satisfaction level regarding the use of CHEK**	Number of Trainings and courses	4	At leas t 2	4	At least 2

7. Conclusion

7.1 Results evaluation

This Deliverable summarises first results related to the planned demonstration and validation activities. These interim results create an important foundation for the formulation of exact demonstration scenarios.

All the required information about the plots have been gathered and organised and all materials needed for the preparation of building permit applications have been shared by the Municipalities. The documents have been provided as individual files in different formats or as access to OpenData on Municipalities' webpages, providing the Designers and Researchers with crucial information and context for the Demonstration. As a result, designers will soon be able to start work on preliminary BIM models, already located on the target plots.

The discussion of KPIs helped to understand in more detail the various functions of the CHEK DBP platform, moreover, it was a catalyst for a conversation regarding updated expectations related to the results that partners would like to achieve during the final demonstrations. Thanks to the developed indicators, the evaluation of the demonstration will be explicit and will provide clear feedback to software developers and other project partners. Moreover, the fact that the indicators have been prepared at an early stage of the project also means that the software developers will be able to keep them in mind during the preliminary tests and enchantment of the platform.

Task 6.1 facilitated the exchange of knowledge among WP6 partners and those involved in WP2 or WP5. Work on this document not only summarises WP6's efforts but also covers other relevant information for the demonstration process contained in other WPs. Constantly updating demonstration participants on progress in other WPs is important to ensure good performance of pilot activities.

As the CHEK DBP tool will be furtherly developed and its maturity will be more advanced the Plan for Demonstration has to follow and also become more detailed. The development of the software in the later stages of the project will allow for the better understanding of the exact activates that will be carried out during the demonstration resulting in better quality of the Plan for Demonstration.

7.2 Future work

In the course of working on Task 6.1, the need to create additional information and reference points became apparent. However, it was not possible to solve all these challenges in the time foreseen for Task T6.1. These challenges will be addressed in further actions within WP6 under Tasks 6.2, 6.2 and 6.4.

1. At this early stage of the project it was challenging to prepare a detailed Plan for Demonstration. Therefore, the plan presented in this document is only a preliminary version. More precise plans suiting the individual needs of each municipality will be developed and ultimately carried out as part of the tasks *T6.2 Demonstration Scenario 1 - DBP for new building construction* and *T6.3 Demonstration Scenario 2 - DBP for building renovation*
2. Work on the formulation of KPIs has shown that further analysis of current state of building permitting process to build a better baseline for KPIs is needed. This will be done to ensure that impact of the CHEK tool is properly evaluated. Helping to precisely assess the impact and scalability of CHEK DBP, checking if objectives and expectations are met. This analysis will be described in D6.4 as it strictly relates to the Pilot's

demonstration assessment. Future actions regarding further analysis of current state of BP process starting from M14 will consist of but will not be limited to:

- In-depth analysis of level of digitalisation of the BP process, that will be carried out based on the results of WP1 and further cooperation between municipalities and research partners. This will provide a better baseline for the KPI number 2 *Percentage of process steps digitalised*
- Providing by each municipality a list of all regulations that would be normally verified during a BP resulting in determination of the exact number of regulations analysed. This would provide an insightful baseline for KPI number 3 related to the number of digitalised regulations, showing maturity of CHEK DBP platform
- The total number of currently needed documents to provide a baseline for KPI number 6 *Amount of information (number of documents) moved into the BIM model (Reduction of the number of documents)*

8. References

8.1 List of Figures

8.2 List of Tables

8.3 List of used abbreviations

WP	-	Work Package
APC	-	Municipality of Ascoli Piceno
LIS	-	Municipality of Lisbon
IPR	-	Municipality of Prague
GAI	-	Municipality of Villanova de Gaia
BIM	-	Building Information Modelling
GIS	-	Geographic Information System
KPI	-	Key Performance Indicator
DBP	-	Digital Building Permit