Coherent Policy Development for High-Quality and Sustainable Living Environment

Deliverable 6:
Action plan and roadmap for the further development of the e-construction services

FINAL

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Coherent Policy Development for High-Quality and Sustainable Living Environment

Deliverable 6 Report: Action plan for the further development of the e-construction services

In association with:

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CONTENT

1 Introduction

1.1 This report

This report (Deliverable 6) has been developed as part of the Coherent Policy Development for High-Quality and Sustainable Living Environment in Estonia service contract funded by the DG REFORM, with the Ministry of Economic Affairs and Communications (MEAC) – currently the Ministry of Climate - as beneficiary. Deliverable 6 consists of an **action plan and roadmap to further develop e-construction and spatial development digital services in Estonia**. This action plan builds upon the work carried out by Deliverable 4 (Proposal for the preparation of a spatial development strategy concept).

1.2 Objective

The objective of this deliverable is to provide an action plan and roadmap to further develop e-construction services in Estonia. More specifically, this action plan and roadmap will support the spatial development strategy concept in the context of improving the living environment in Estonia.

1.3 Scope

The scope of the action plan is the 'living environment' and therefore beyond 'e-construction'.
The focus of the action plan is on *public* sector IT solutions, intended for both the public and private sectors.

1.4 Methodology

This report i.e. the action plan and roadmap has resulted from:

- ✓ **Desk research** on the state of play of the e-construction platform and of existing and emerging digital services relating to the living environment;
- ✓ Two (2) **working seminars** with relevant Ministries and key stakeholders aimed at discussing the desk research findings of the project team and the draft action plan (please refer to the Annex);
- ✓ A **meeting with the steering group** to discuss the draft action plan report.

1.5 Reading guide

- ✓ Chapter 2 provides describes the e-construction platform;
- ✓ Chapter 3 presents a detailed overview and assessment of existing and emerging digital services in spatial planning;
- ✓ Chapter 4 presents the action plan and roadmap proposed to further develop e-construction services in Estonia;
- ✓ Chapter 5 provides recommendations.

2 The e-construction platform

2.1 What is it and what is its objective?

The Estonian e-construction platform is an integrated system that connects data and services relating to the built environment, enabling the use of e-services and data from various sources in one comprehensive digital environment in the life-cycle operations of built assets. In other words, the platform is an integrated environment through which existing systems are connected. Further, it is a software solution consisting of microservices that expands the functionalities of the existing Building Register (ehitisregister - EHR). Besides offering data integration for end users, the e-construction platform also facilitates processes with increased steps being automatised / digitised. The e-construction platform enables, for instance, building permits to be obtained transparently and easily from start to finish in the same environment and independent of underlying complexity of the network of databases and IT systems involved[1].

Ultimately, the aim of the e-construction platform is to improve accessibility and integrity of data as well as services flow between and for different stakeholders. The e-construction platform does this by introducing the use of digital tools to replace the analogue methods that have been in place for several decades. This simplifies the construction management-related activities of the different stakeholders. This will lead to productivity growth of the national construction sector and increase of the quality of the built environment throughout the whole life cycle, eventually contributing to a better living environment.

2.1.1 Basic principles of the e-construction platform

In short, the e-construction platform has been developed under the premise that availability of information makes the construction sector and the management of built environment more transparent and user-friendly, and that, thanks to the data-based decision-making process, the quality of the decisions made improves. To improve productivity of the construction sector that tends to lose and re-create information in every handover between stakeholders[2], the e-construction platform aims to improve the flow of standardised and reliable information between all stakeholders in the construction sector. Against this backdrop, the following basic principles have been followed when developing the e-construction platform:[3]

1. The relevant built environment stakeholders have constant access to the data generated during the life cycle of the building, while the data can be continuously and automatically updated. The information system is structured in such a way that related and authorised parties can update various object-related data so that the available data is state of the art, relevant and reliable.
    - This allows stakeholders involved in the life-cycle of buildings and infrastructures to become involved as early as possible during each phase i.e., development, design, construction and use of the building. This leads to cost optimisation over the whole life

[1] This consists of smaller processes such as obtaining consent from neighbours and utility companies, and approval from Fire Department.
[2] This is due to combination of low digitisation and high number of companies involved in the process.
[3] Vision of e-construction platform. (in Estonian) 2018. Available at: https://eehitus.ee/wp-content/uploads/2019/04/e-ehitus_visioonidokument_21.11.2018.pdf

cycle of the buildings due to a reduced number of mistakes made when developing such and increased quality of the construction works.

- During the planning, construction and use phases of buildings, collection and sharing of information and data takes place automatically, without unnecessary manual involvement. When using building information model (BIM) based information exchange, the e-construction platform will provide a smoother and more automated flow of information and close cooperation between all participants in the sector.

2. The platform is implemented as a growing organism, with the possibility to add new functionality and data. For example, the iteratively developed **digital 3D twin of Estonia's built environment**, which gives easy and convenient access to all data related to plots, buildings and infrastructures will introduce several new features in the next release. These include, among others, a simple modelling tool to support involvement of citizens in the spatial planning process and the addition of new layers of data, e.g. greenery.
    - By creating a digital twin of the built environment, spatial planning is brought to a new level, which will contribute towards ensuring the best possible quality of life for people living in Estonia. New buildings can be adapted to the surrounding environment from the initial design phases (see here), and their possible impact (e.g. shadows) can be assessed and analysed.
    - The more data is available in the public databases, the richer the information will be in the digital twin and the better it can support decision making. The automation of the creation and exchange of data throughout the life cycle of buildings, from design to demolition, and the ease of access to these data will also help to reduce human errors. This also helps to f**acilitate communication between individuals, and the state and local governments** by making interactions much quicker and more efficient. Parties of the public sector can assess the performance of any structure with the help of information models, while part of routine inspection takes place automatically without any intervention of an official. As a result, the burden on officials will be reduced and it is possible to focus on making discretionary decisions in a transparent and thoughtful manner.
    - 3D twin is only one of the ways information is made available for the users (like 3D picture is only one way BIM models represent the underlaying data). The overall principle is to ensure that users can access data in a format that is 1) intrinsic to the specific data, e.g. spatial data is mostly available in 2D or 3D maps and 2) suitable for the user, e.g. the user may need some specific aspects of the spatial data as total roof area of the houses in a specific area or the buildings by construction year in a municipality (available in the Information Portal).

2.2 Why is the e-construction platform needed?

The greatest bottleneck of the construction sector in Estonia is the absence of joint principles when organising information flows. There is lack of information exchange and effective cooperation between the stakeholders in the sector[4] stemming from the characteristics of the sector which typically involves several very different stakeholders. This is a problem of the construction sector worldwide. Although academic papers for several years have proposed different IT solutions to improve cooperation, these

[4] Long-Term View on Construction 2035. (in Estonian) 2022. Available at: https://eehitus.ee/wp-content/uploads/2019/04/2022-05-EPV-lopparuanne-v2.pdf

theoretical proposals have provided only limited answers to the existing problems and are mostly not implemented in practice.[5] This has resulted in the fact that today most of the data related to the built environment and the life-cycle of buildings is available in different information systems and databases, which are managed by different service providers and agencies. This makes collecting necessary information and filling in different formal documents very time-consuming.[6] Due to such fragmentation in information when collecting it from different databases, contradictory information is common. Mistakes are made especially during the planning and design stages, whose later correction tends to be expensive for all the stakeholders. As such, reliability and consistency checks on existing data and information are absolutely necessary, especially when collecting data about the existing buildings and facilities. There is also loss of information due to the several private initiatives by companies (e.g. service providing) and associations (e.g. local housing management) where information about living conditions and environment is collected and analysed. The national e-construction platform improves the scope and quality of analyses through introducing **integration of services and databases**. As such, information in the databases becomes clearer, more reliable and more understandable for the Estonian housing sector, which is mostly privately owned and managed. This also facilitates a more **effective and professional** communication between owners / users of the properties and the state and the local authorities.

Against this backdrop, to ensure productivity growth in the construction sector, one of the most important activities is to make the sector's work processes and information flows more efficient between all the stakeholders; this also increases the sector's added value per employee and reduces mistakes and contradictions on the construction sites.[7]

The challenges of building the e-construction platform are described in Section 3.4, *the barriers to the development of digital services in Estonia*.

[5] L. C. Tagliabue, D. M. Hall, A. Chassiakos, and D. Nikolic, R. Soman (2022). Proceedings of the 2022 European Conference on Computing in Construction, July 24-26, 2022, Ixia, Rhodes, Greece. doi: 10.35490/EC3.2022
[6] Vision of e-construction platform. (in Estonian) 2018. Available at: https://eehitus.ee/wp-content/uploads/2019/04/e-ehitus_visioonidokument_21.11.2018.pdf
[7] Idem

3 Assessment of digital services for the living environment in Estonia

This chapter first provides an overview of the main public digital solutions in the built environment in Estonia. Second, it provides an overview of emerging digital solutions. The chapter ends with an assessment of the current and emerging digital solutions and a discussion about the challenges faced.

3.1 Existing digital services

This section is dedicated to the description of existing public digital services in Estonia including: the construction classification system (CCI-EE), the Building Register, the Land Cadastre, Property Registration Portal, National Digital Land Register, Planning Database PLANK and Register of Roads. First, an overview of the state of policy related to digital services is provided. Then a short description of each of the services is given.

3.1.1 Policy background on digital services

The Long-Term View on Construction 2035,[8] approved by the Cabinet meeting of the Government of the Republic of Estonia, is the document that forms the basis for public agreement, cooperation and change in the legal environment between public and private sectors. This document can be considered as an input for designing a strategic development document on the living environment. The need for the different types of digital services in the construction sector is mentioned in the Long-Term View on Construction 2035 – Objective 6: The construction industry promotes innovative solutions to increase productivity and quality, under Activity 6.2 which describes the following strategic package of activities to develop an *e-construction platform, including digitisation of construction data, standardisation and making data available (realisation of the e-construction vision), provision of digital sandboxes; open e-databases with virtual prototypes; bringing e-government processes into the sector in order to increase user-friendliness, speed of procedures and efficient operation of the sector; creation of an inclusion platform and BIM model platforms; to make use of BIM in the design of new buildings mandatory in the public sector, incl. to create a capacity in building registry to process building and use permits on the basis of a BIM model."*

Today, several publicly accessible e-services are provided both on national governance level, but also particularly for the construction sector. This fact has been highlighted in several documents and review papers.[9] The results received from the survey carried out earlier in this project (in Deliverable 2) also show that respondents show quite high level of usage of digital services. In several of these papers, the Estonian e-construction platform – its scope and functioning qualities – is thoroughly described and highly assessed as an attractive example on innovative approach for the construction sector.

[8] Long Term View on Construction 2035. Available at: https://eehitus.ee/timeline-post/long-term-view-on-construction/

[9] E-Government Survey 2022. The Future of Digital Government. United Nations Survey 2022. Available at: https://desapublications.un.org/sites/default/files/publications/2022-11/Report%20without%20annexes.pdf; Handbook for the Introduction of Building Information Modelling by the European Public Sector. Strategic action for construction sector performance: driving value, innovation and growth. EU-BIM task group. Available at: http://www.eubim.eu/downloads/EU_BIM_Task_Group_Handbook_FINAL.PDF; Susan Divald. E-formalization case study. e-Estonia: A digital society for the transition to formality. Available at: https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_policy/documents/publication/wcms_781500.pdf

3.1.2 Existing digital databases related to the built environment

Currently, data about built and living environments are available on different databases/systems of information and from the user manuals, mainly from:

- **Ehitisregister (Building Register) i.e. EHR:** The Building Register is a national database of construction entities established and authorised by the Ministry of Climate (formerly Ministry of Economic Affairs and Communications). Building Register is a dynamic web-map-based interface that allows e.g. applications for building permits, construction notices or energy declarations.
- **The Maa-ameti geoportaal (Land Cadastre):** The Land Cadastre is a national register with the objective of recording and preserving information reflecting the value of land, the natural status of land and the use of land, and to make such information available to the public. The Land Cadastre consists of the cadastral register and maps.
- **Kinnistuportaal (Property Registration Portal):** The property registration portal serves as a gateway to the proceedings of property registration, which in turn grants access to property information in National Digital Land Register.
- **E-kinnistusraamat (National Digital Land Register):** The National Digital Land Register is a database governed by law, which ensures that the transactions related to real estate are secure and obey relevant regulations.
- **Planeeringute andmekogu – PLANK (Planning Database):** The planning database PLANK is the unified system by the Ministry of Finance for all planning decisions to be collected and provided for the users.
- **Teeregister (Road Register):** The Road Register gives an overview of all the roads in Estonia. All users can view the map application, carry out simple searches and read the ready-made reports.
- **Construction classification system of Estonia (CCI-EE)**, which is part of the Construction Classification International (CCI).

Most of these databases listed above have already been integrated to Estonian e-construction platform which is an open public digital service. In order to use the broader range of services available on this platform, the user has to undergo an identity verification process. According to established practice in Estonia, the main identification method is the national e-identity which can be verified using the national ID card or mobile identification (Mobile ID or SmartID).[10] This "hard identification" provides "certainty beyond reasonable doubt" that the person using the system is who he/she claims to be. This is important when logging events that do have legal meaning for timing (e.g. time for appealing certain decision) so that a) alternative expensive analogue tools for proving it, e.g. registered mail service, can be avoided, and b) legal certainty is increased. Any not-identified person can still use the system but will only be able to obtain access information that is available for public use. Identified individuals have access to all buildings and facilities they are legally related to (i.e. as owner). Legal entity representatives have access to the relevant information according to their authorised activities.

There are several construction and real estate sector related databases available in Estonia which sometimes carry identical data. Collecting and depicting data from and in these databases implies double work, i.e. inefficiency. The e-construction platform is not a new database but a services

[10] Note that bank identification systems can no longer be used to access government systems. Only options linked to the national e-identity are accepted.

platform for integrating existing databases relevant to the field of construction in the widest sense. The e-construction platform will address the existing data in the databases while not changing the structure of existing databases.[11] The e-construction platform foresees requirements for information exchange and hopes to achieve higher efficiency and transparency of all the subsystems that are related to the platform. Moreover, such a public initiative for developing a sector-based e-platform gives the possibility for the private sector to analyse the currently available processes and to develop new services that will provide higher added value for society and for the stakeholders.

Ehitisregister (building register, EHR)

The purpose of the building register is to store, provide and disclose official information about planned construction, buildings under construction, existing construction entities and related administrative procedures. The building register is free for everyone to use. This register is particularly important and handy for local governments and for owners of immovable properties when having to process documents related to construction entities and the legal procedures related to them. Recently, the term *digital building logbook* has been used in Europe to describe systems like the Estonian Building Register.

It should be mentioned that in Estonia, the English term "building" (ehitis) is used commonly as an umbrella term for all types of built structures, which includes not only buildings, but also encompassing roads, bridges and other specific infrastructures.

Users of the building register can be either natural or legal entities. For each legal entity, an institutional type is assigned, which is related to the main characteristics and field of activities of this institution/company. Different roles are assigned to institution/company users depending on their institutional type. Types of institutions include the Ministry of Climate (Superuser), the local government (hereafter KOV), Consumer Protection and Technical Supervision Agency (hereafter TTJA), Notaries, Bailiffs; the issuer of the energy label and all other institutions/companies. KOV and TTJA are procedural type of institutions which have to carry out activities that are legally foreseen.[12]

In May 2022, most of the EHR-system was fully renewed and transitioned to the micro-service based IT-architecture used by the e-construction platform. The main reasons for this change were the need to update the software, to eliminate the security gaps, and more importantly, to give the possibility to introduce new features and updates to individual services iteratively without significant disruptions to end-users. The currently renewed version of EHR has the following characteristics:

- The ability to search in the database about construction entities and in the relevant documents;
- The possibility to compile necessary construction process-related documents using the data on the construction entities found from the databases connected to the e-construction platform;
- Users may submit necessary applications and share information notes with the stakeholders connected to the system, for example to apply for a building permit;

[11] Vision of e-construction platform. (in Estonian) 2018. Available at: https://eehitus.ee/wp-content/uploads/2019/04/e-ehitus_visioonidokument_21.11.2018.pdf
[12] User manual of Building Register (in Estonian). Available at: https://www.ehr.ee/public/help/EHR_kasutajajuhend.pdf

- It contains information about heating and cooling systems used in the buildings and about the history of any construction entity; accordingly, this information can be used for analytical purposes;
- Any active user can have a customised dashboard. For example, the person who has submitted a document (an application) to authorities can now follow the workflow of how this document is handled by different public offices and agencies. The Building Registry is also a processing environment for permits and notifications applications mainly granted by municipalities; it also documents the involvement of neighbours and affected infrastructure owners, and for obtaining the decisions and opinions of relevant authorities like the Fire Department. Information about the decisions of different stakeholders can also be traced.

Traditionally, relatively static technical data about the construction entities is entered into the building register: basic parametric data about the entity, the major structures and the technical systems, location data of the site, data about the construction process, auditing data, maintenance manual of the entity, data about construction-related applications and design conditions, notices, permits and prescriptions, state supervision data and energy certificates data.[13] Current developments are among others[14] going to create and introduce suitable software solution for BIM-based building permit processes in the Building Register. The solution will enable the analysis of BIM models in Industry Foundation Class (IFC) format based on today's best BIM practices and be able to carry out automated regulatory and building code checks.

Technical inspection of the construction design documentation (compliance with zoning plans, laws and regulations) is one of the most time-consuming and error-prone activities during the processing of building permits. There are many technical requirements and a lot of reviewers, including local authorities, Rescue Board, Health Board, Heritage Protection Board, etc. Currently the EHR supports uploading of digital project documentation in simple 2D formats (e.g. pdf) which are much less structured and data-rich compared to BIM-models. If any part of the project needs to be updated, the reviewers will have to go through the full documentation for several times. This can be considerably resource-consuming, as more than 12 000 building permits and more than 8 600 permits for usage are processed in Estonia each year, and not a single project has supposedly passed the procedure without any revisions.

BIM has become an integral part of the design process, especially in large public buildings and real estate developments. BIM helps companies in the Architecture Engineering Construction (AEC) industry to significantly save time and improve the quality of projects by reducing the number of errors related with information exchange. BIM is already widely used in the design and construction of buildings in Estonia. The result of this software development project will simplify the permitting process by making it possible to submit BIM projects for building permits directly, without first converting them to pdfs. The BIM-based permit procedure makes it possible to shorten the building permit processing time by automating the technical inspection of construction designs. A more efficient building permit process will also increase the productivity of the AEC industry which is one of the key objectives of the Ministry of Climate (formerly MEAC). Preparation for introducing the BIM based construction permission already

[13] User manuals. (in Estonian). Available at: https://livekluster.ehr.ee/ui/ehr/v1/help/instructions
[14] Other ongoing developments are: the preparation for dynamic energy labels that allow assessment of energy use of buildings based on real-time information collected from utilities; map input/output for information portal + integrated predictive analytics; GHG assessment tools together with simulation tools allowing home owners to predict impact of e.g. addition solar roof on energy consumption, etc.

started in 2019 with the analysis and prototype of the BIM-based building permit procedure and it is forecasted that the development will be in the implementation phase by the end of 2023 (currently in a pilot phase with Tallinn City).[15]

Another goal of the Ministry of Climate is to provide visual output of the built and living environment. For this, the 3D digital twin[16] has been developed using data from different partner databases and services. The first version of the 3D digital twin has been live since 2021. The Ministry of Climate (formerly MEAC) has iteratively updated the environment with new features and functionality with the latest major update released on 2 June 2023. The broader goal of the e-construction platform and the 3D twin is to simplify usage of the data required for activities related to the life cycle of the buildings, improve the quality of data and direct the parties in the construction sector to use innovative solutions, e.g. digital modelling of building information (BIM), which is the most innovative solution when improving the productivity growth of the construction sector. 3D twin is a built environment 3D model visualisation application that allows the user to view buildings and building data in relation to the surrounding environment, also in the temporal dimension, i.e. the state fixed and recorded at different times (history). In addition to visualising and linking different data layers from various sources (e.g. cadastre information, restrictions, planning database, register of roads etc.) together in one comprehensive view, the 3D twin also allows anybody to download and upload 3D data. 3D buildings and terrain in various formats (CityGML, Collada, IFC) that can easily be used by architects and engineers in their design software can also be downloaded. At the same time, detailed BIM-models in IFC format can also be uploaded in the 3D twin for viewing and sharing. This is especially important for real estate developers and architects who want to better communicate changes they are planning to make in the environment. The national 3D twin has been developed as a re-usable component and service in the e-construction platform, which also allows for integration with various other information systems.

Maa-ameti geoportaal (Land Cadastre)[17]

The Land Cadastre is a national register managed by the Land Board. Its objective is to record and preserve information reflecting the value of land, the natural status of land and the use of land, and to make such information available for the public. The Land Board is in charge for managing the cadastre and the objective of this register. As such, the function of the Land Board is to register cadastral parcels, register encumbrances and rights of use of land, and collect and process data necessary for the valuation of land. The Land Cadastre is run according to the procedures foreseen in the Land Cadastre Act that provides the bases for maintenance of the land cadastre (hereinafter cadastre), the objective of maintenance of the cadastre, the procedure for registration of cadastral units, the composition of cadastral data and the procedure for the processing thereof, and the procedure for the financing of the cadastre. The objective of the maintenance of the cadastre is to register information in the cadastre reflecting the boundaries and spatial extent of the immovable value of land, the natural status of land and the use of land, and to ensure the quality of such information and that it is preserved and made available to the public. Buildings are visualised on Land Cadastre maps as 3D images. The Land Cadastre consists of the cadastral register and maps. The cadastral register contains the following data pertaining to a cadastral parcel: cadastral register number, address, area, intended use, restrictions/encumbrances, data pertaining to boundary points, etc. All data can be visualised on different maps (cadastral map, restrictions map, land quality and valuation map, etc.). Cadastral

[15] https://eehitus.ee/timeline-post/bim-based-building-permit-process/
[16] https://livekluster.ehr.ee/ui/ehr/v1/3d
[17] http://geoportaal.maaamet.ee

documents are stored in the cadastral archive. There are also several specific data carrying maps: topographic database, orthophotos, elevation data, soil map, geological map etc. The e-Cadastre software also enables the maintenance of a digital archive.

Kinnistuportaal (Property Registration Portal)[18]

The Property Registration Portal is a digital environment which allows preparing and submitting property registration applications and monitoring real-time information about the status of proceedings of the submitted applications. In addition to property registration applications, the users of the portal can also prepare and submit challenges to record entry orders made, grant consents necessary for entering records into the Land Register, and authorise other persons to submit property registration applications. The portal is intended for:

- Citizens;
- Companies, banks, advocates;
- Employees of state agencies;
- Employees of local governments;
- Bailiffs, bankruptcy trustees, etc.

The option of electronic communication with the Land Register can be used by everyone who needs to submit a property registration application and is not required to enclose a notarised disposal order to the property registration application. In the latter case, the notary has to prepare the property registration application and to submit it to the Land Register department.

The activities filed in this portal are:

- Submitting property registration applications;
- Amending and withdrawing applications and submitting additional documents;
- Granting required consents for making records;
- Authorising others to submit property registration applications;
- Monitoring real-time information about the status of proceedings of the submitted applications;
- Filing challenges;
- Paying state fees;
- Reviewing notices pertaining to the immovable property, all in one place.

An application, consent, authorisation or challenge filed via the Property Registration Portal must be digitally signed. One can submit additional documents to the Land Register department as digitally signed documents via the Immovables Portal or as documents on paper.

E-kinnistusraamat (National Digital Land Register)[19]

The Digital Land Register facilitates compiling and filing registration petitions, paying the state fee for petitioning an entry concerning a registered immovable, and following the processing of the petition in real time. This database is powered according to the Land Register Act that provides the procedure for maintenance of Land Register. The Land Register is a database aimed at collecting, storing and disclosing information on the creation, transfer and encumbrance of immovable property with real

[18] http://www.rik.ee/et/kinnistuportaal
[19] http://www.rik.ee/et/e-kinnistusraamat

rights, as well as on the transfer, encumbrance, alteration or termination of a real right encumbering an immovable.

The Digital Land Register also enables compiling and filing a petition for changing or revoking the registration petition filed through the portal or for filing additional documents until the entry regulation has been confirmed. Through the Digital Land Register, consent can be granted for making an entry into the land registry or provide authorisations for making registration petitions. It is also possible to use the Digital Land Register for compiling and filing an appeal against rulings. If data of immovable properties is needed only infrequently, then one can make individual queries in the portal without entering into an agreement. In order to receive or verify large amounts of data on a daily basis, one can register as a customer of the Digital Land Register.

Citizen login allows free-of-charge viewing of land registry documents, the ability to authorise another person to view documents, order the digitisation service, and paid viewing of land property data. Contractual customers of the e-Land Registry are companies and agencies which need larger amounts of reliable data about immovable properties on a daily basis. All data issued by the e-Land Registry have legal force.

A registration petition filed through the Digital Land Register will automatically be registered in the land registry diary and the seal that is created for the registration will immediately become visible to all in the detailed view of the registry part. Real-time registration of the petitions is very important due to the fact that the order of registration petition arrivals is taken into account when making the entries.

Plaaneeringute andmekogu- PLANK (Planning Database)[20]

The Ministry of Finance completed a nationwide unified planning database (PLANK), which brings together all established planning decisions. The database simplifies and speeds up access to planning data, which is of interest to various authorities, businesses and residents. The central database ensures the correctness of the data and allows various interested parties to be sure that the available plan is the most up-to-date and based on it, for example, they can start preparing a construction project. Starting from 1 November 2022, it is mandatory to submit all established plans to the new environment.

The database provides a big leap forward in the field of digitalisation of planning data. In order to better process the data, improve accessibility and allow for its use in other information systems, the submitted data must be formatted in a more machine-readable form. It is accompanied by standardised formatting requirements that ensure more efficient, effective data acquisition and use, and in summary, it extends the lifecycle of planning data.

PLANK is a powerful tool especially for local authorities who handle most of the planning solutions. Working with PLANK is important also for the developers, entrepreneurs and for different property owners.

PLANK is one of the activities carried out by the Ministry of Finance for the digitisation of the field of planning. The information presented in the plans must be easily accessible, understandable and usable.

[20] www.planeeringud.ee

Planning area and 3D spatial limits are also visualised in the 3D twin. Through the digital processing of plans, changes must be implemented to simplify the planning processes, allowing the preparation of plans to focus on the most important thing - finding the most suitable spatial solution for the area. As of August 2023, preparations are underway to develop the planning information system PLANIS. PLANIS is an information system for municipalities to manage spatial plans based on the requests of the citizens (similar to what EHR does with building permits). PLANIS is part of the e-construction platform and will be directly linked to PLANK.

Teeregister (Register of Roads) [21]

The Register of Roads includes data on publicly used roads. These data are primarily intended for use by employees of the Ministry of Climate, the Transport Board and local government specialists to solve questions and make decisions regarding the country's road network. All users of Road Registry can use the map application, perform a simple search to view data of interest and view/read ready-made reports. Roads are represented in their spatial form as line objects.

In addition, authorised users can, according to the procedural role, submit proposals for adding, changing or deleting data in the road register, perform an expert search to view data of interest, transmit and receive in-app notifications, prepare and save reports based on the road register data and create graphs based on them, change the settings of their road register user account.

At the same time, everyone can use the road register to obtain road-related information e.g. road surfaces, traffic frequency on roads, bus stops, winter/summer maintenance, etc. The address system of the road register is the basis for determining the location of the register data in the landscape and in the database.

Construction classification system of Estonia (CCI-EE)

The construction classification system is an important instrument of cooperation in the era of digitalisation; it is the common language to handle all the digital information based databases and platforms.

Availability of successful digital services starts with agreeing on the common language to be used. In the analogue world, when preparing different contracting documents, the language to be used is first agreed upon. If any issues arise, consultancy, arbitration and conflict resolution are common. As such, agreeing on final language usage is a time- and resources- consuming process. In the digital world, all the prepared data and documents contained in databases should be fully machine-readable. To use this advantage of machine-readability, digital language should be clear so that it is understandable for different IT equipment to be used during the different phases of the life-cycle (development, management, maintenance) of the built environment. Therefore, as a precondition for introducing digital services, "language courses" and relevant "ABC books" are required. In professional language we keep in mind the availability of a reliable classification system that is best suited for the new circumstances.[22]

[21] https://teeregister.mnt.ee/reet/home
[22] CCI-EE Classification System: Essence And Use. (2021). Available at: https://ehituskeskus.ee/wp-content/uploads/2022/03/CCI-EE-guidance-material_14.02.2022_70-p_En.pdf

In 2018, Tallinn University of Technology won the tender "Construction classification system in Estonia" launched by the Ministry of Economic Affairs and Communications (MEAC). By the end of 2020, the concept of the classification system was proposed and in 2021 during the follow-up project, activities were targeted to implement the system.

CCIC (Construction Classification International Collaboration) is an international organisation that owns and manages a faceted system that has been worked out using the efforts of different countries to assure the system has international dimension. Based on the common unified international frame, each country participating in the project introduced its own national classification system. In Estonia it is called the CCI-EE system accordingly.

The following principles have been followed when designing the CCIC and the national CCI-s:

- ✓ Fully digital and unified – the system of coding used is designed in such a way that the data should be fully machine readable such that all the actors/stakeholders involved who participate during the lifetime of any construction entity and fulfilling whatever role (client, consultancy, contractor, user, etc.) may access and utilise the data effectively;
- ✓ Usable for the whole built environment, for all types of construction entities (not only for buildings as quite many classification systems are designed for); this gives the possibility to use this classification system for living environment which consists of not only of houses/buildings, but also of roads, engineering networks and different specific facilities (for example, playgrounds for children and different sporting facilities for elderly);
- ✓ Usable for all the stages of lifecycle of any building or infrastructural facility and allowing unchanging codes to be used for any structural elements – the classification system provides stability of codes in longer run;
- ✓ Internationally understandable and usable as the main classification concepts are based on ISO standards (e.g. EVS-EN ISO 12006-2; ISO 81346 series; EVS-EN ISO 23387 and others); in everyday practice, the whole built environment is developed using international knowhow and resources from workforce to material resources;
- ✓ Open to innovation; the system is not limited to today's knowledge but it is constantly open to the possibility of adding new aspects (materials, quality criteria, requirements, etc.) appearing in the market place when developing the built environment.

The total implementation of the CCI-EE system will still take time and the relevant works are continuing. It is important to underline that there are several different agencies who run the databases related to built environment and construction entities. More relevant teaching materials and courses are needed, but first of all, the actors involved should understand the necessity of implementing the new classification system for the sector.

3.2 Emerging digital services

The digitalisation of the construction sector is increasingly recognised as a potential game changer for the sector, which could contribute significantly to sustainable development. Just about five to ten years ago, building information modelling (BIM) was declared the centrepiece in the digital transformation of the built environment and construction industry. Today the scene is much wider and there are new digital tools developed that can be used to improve the efficiency of the sector.

Against this backdrop, this chapter elaborates on the following tools: Digital twins, Internet of Things (IoT) and PropTech, data rich design processes, information flows and automation, generative and parametric design, Artificial Intelligence (AI) in planning and construction, Virtual Reality (VR) and Augmented (AR) or Mixed reality (MR). Some of these innovative tools and working methods have already been taken up by companies who use them in development processes of buildings and infrastructure. Their use is, however, not yet widespread. Implementing the e-construction platform is expected to open up the possibilities for much broader usage of different new digital instruments.

Digital twins

Digital twin as a concept does not have a single definition. In this report we use the definition of a digital twin as "a digital model with relevant attributional data connected to it". The vision of the digital twin is to make a digital replica of an object in the real world. The digital twin is meant to be of use when planning, designing and operating an entity or aggregation of entities of interest. On a small scale the digital twin can be a 3D-model of a building used to visualise, simulate, and test different design ideas before building. Once the building is physically established, digital twin can be perceived and utilised in practice as a database to store relevant information about building's engineering systems or its administrative states. The goal is to establish a two-way architecture of data flow between a physical building and its digital counterpart. A classic example of such system would include a strict attributional data scheme introduced into a BIM model as well as information inserted during design and building phases which in later operational phase would serve as a query object for relevant quantification or analysis. At the same time, sensors integrated into engineering systems such as HVAC or electrical collecting and feeding data back to its digital twin model via IoT protocols would optimise facilitation and operation of respective systems.

On a larger scale, a digital twin can include an infrastructure of a city, or even a whole country. A digital twin of a country's railway infrastructure can for instance provide useful information for planning and operations. With the right data connected to the digital twin, operations can transit from reactive to predictive e.g. with the use of existing railway signalling systems in combination with new technology such as artificial intelligence (AI), the digital services can find patterns and give warnings before an incident happens. This technology has successfully been tried and used on railway networks, water and sewage infrastructure, traffic situations and building maintenance etc.

Through the e-construction platform, Estonia has formed a base for a national digital twin. At the same time, there are several ongoing EU initiatives to align data and digital twins are now emerging from different member countries so that they can be part of a European digital twin. There are also ongoing projects in laying the foundations for a global digital twin – not the least in projects like Destination Earth[23], although the models and data produced on this scale are not as detailed as the models and data in the cities and the buildings digital twins. The benefits of keeping abreast with the development of this project is that data made available can be scaled down and used in every country and city and give comparable analyses with other countries and cities. Climate data and information about climate change are some of the data collected on a global level that are of interest and important when planning for a high quality living environment.

[23] Destination Earth | Shaping Europe's digital future (europa.eu). Available at: https://digital-strategy.ec.europa.eu/en/policies/destination-earth

IoT and PropTech

Digital models as mentioned above (3D models and digital twins) can be used to visualise data collected from sensors. There is a huge development in the Internet of Things (IoT) sector which allows for data collection in almost any area. The development has moved from a situation where an analysis always started with considering the data available, to a situation where almost all data can be collected. Today, the challenge lies in understanding which data creates value for planning and operations, i.e. it is important to find the right data that creates value when collected in large quantities, as well as to work out a strategy for data storage and for dealing with redundancy. With new technology such as Artificial Intelligence (AI) there is a need for data to train the algorithms. There is also the question regarding how much data can be stored; storing large amounts of data has both functional and an environmental impacts that needs to be evaluated.

For both buildings and other infrastructure in the cities, IoT and sensors are an emerging technology where we have only seen the beginning. For buildings the collecting term is "PropTech". The past years there has been a large development in this field, not the least within collecting data for sustainability actions. The now available PropTech solutions are often built on software that locks data in, although there are exceptions.

There are a number of initiatives to create reference architectures that help us collect data in a standardised way. OASC (Open and Agile Smart cities)[24] and the reference architectures for Internet of Things (IoT) platforms for cities are examples of such initiatives. OASC is a European initiative driven by seamless sharing and working to avoid locked-in data and drive towards smart sustainable communities is. They make use of MIMs[25] (Minimal Interoperability Mechanisms), with features based on open technical specifications that makes it possible to scale solutions globally. The development of digital twins and the collection of data via IoT (Internet of Things) is constantly increasing and by making sure that both the 3D models and the data collected follow the specifications and guidelines set up by i.e. EU, it will be easier to use future datasets for example on climate data and other large scale data that can be used in planning.

Data rich design processes

Technology is one part of the emerging landscape of digital services. The underlying processes and information flows are other aspects that needs to be considered to truly benefit from emerging technologies and data availability. The importance of data richness and quality cannot be overstated in the modern design of the built environment. With increasing complexity of construction projects and the growing emphasis on sustainability, there is a need for reliable, accurate, and comprehensive data to inform strategic decisions as well as to ensure favourable conditions for process automation. In achieving these objectives, it is of utmost importance to implement established industry standards as well as best practices that emphasise the synergy between early planning in GIS environment and routines in BIM, associated data structures, file formats and overall interoperability across planning, design and operational phases of buildings and infrastructure. Data flows from early stages of GIS data to planning, design and operation where BIM data comes in is a challenge that must be managed.

The core strength of a robust system architecture is based on a central execution plan where design requirements are uniformly applied across projects. Such process enables stakeholders to generate

[24] Open & Agile Smart Cities (oascities.org)
[25] MIMs - Open & Agile Smart Cities (oascities.org)

consistent data and information flows, and in turn to execute strategic decisions based on data-driven insights and predictive analytics. By systematically integrating GIS and BIM, stakeholders can identify and address potential design issues at an early stage, optimise performance of a building or an infrastructure unit, and improve resource efficiency. High quality data also ensures better communication between associated stakeholders, leading to more effective decision-making and in turn cheaper and faster outcomes. To achieve a functional flow of such process, a top-down approach to implementing such design synergy is necessary to ensure that specific roles and responsibilities are in place, and to ensure that data is collected, stored, versioned, visualised and shared according to ratified requirements.

Connecting data from environmental databases can also provide tools for planning and construction which allows for data driven design that makes it easier to see the environmental impact of different choices of design and materials used in construction. There are several different SaaS (Software as a Service) for tracking and reporting CO_2 emissions that are available on the market. The tool allows for cities and businesses to gather and monitor of all their climate plans in one place for a comprehensive follow-up on their carbon management. This facilitates strategic decision making for boosting the impact. It also allows for cities and companies to share publicly, and compare their progress with peers, encouraging accountability and progress. It also provides a reporting function that can be used to fulfil official reporting requirements.

Information flows and automation

In the field of spatial planning and construction design, uninterrupted information flow and task automation are critical mechanisms to ensure efficiency, accuracy, and transparency. Well-structured and continuous information flow enables strategists, designers, planners, and engineers to make informed decisions, resulting in better-designed buildings, infrastructure, and cities. Automation, on the other hand, helps to streamline the design and construction process by eliminating repetitive manual tasks and reducing the risk of errors.

One key aspect of information flows in spatial planning and construction design is the availability of open data. Open data refers to the idea and practices that certain types of data should be publicly available for everyone to access, use, and share. This is relevant in all stages of planning and design routines, but mostly in the early stages of establishment. By making data open, governments, companies, and organisations can facilitate effective collaboration and innovation, leading to better outcomes in the planning and construction process. As an example, open data can include information such as land-use maps, environmental impact studies, building codes, building information and more.

Robotic Process Automation (RPA) and **ETL (Extract, Transform, Load)** techniques are methods that can help streamline the spatial planning and construction design processes. RPA involves using software robots to automate repetitive manual tasks, which replicate human interaction with a machine such as data entry, document management, and reporting. By automating these tasks, RPA can help reduce non-systematic errors, improve accuracy, and save time and money. Similarly, ETL tools aid data transformation between different systems by performing data cleansing and conversion operations as well as ensuring rigorous data audit along the way. As a result, interoperability plays the key role in information flow between different actors and systems in spatial planning and construction design domains. Interoperability refers to the ability of different systems, applications, and software to communicate and exchange data with one another seamlessly. The task of interoperable systems can be

achieved through the use of earlier mentioned open data and standards, on systems level such as GIS and BIM or respectively open formats such as OGC Geopackage or Industry Foundation Class (IFC) which allow data to be shared between different software applications.

Blockchain technology can provide a secure and transparent system for data traceability and transparency in spatial planning and construction design. Blockchain is a distributed ledger technology that allows transaction records to be logged in a secure and transparent manner. The technology is widely utilised within fintech and supply chain industries, however it progressively finds applications in many other fields which require tamper-proofed data logs. In the context of the built environment, blockchain can be used to record information related to building permits, contracts, inspections, and other aspects of legal property status on a large scale of applications. At the same time examples of blockchain integrations within more delineated operations such as logging critical data from IoT platforms might ensure that data is authentic and easily accessible. However blockchain technology is usually unreasonably expensive.

In summary, a flawless and seamless information flow is a critical component of spatial planning and construction design. As explained above, a combination of effort to integrate open data and automation as well as ensure that systems' parts are interoperable sets minimum criteria for a sustainable system. Moreover, it is suggested that blockchain, as an event-logging system, plays an important role in facilitating the efficient and secure exchange of information between stakeholders, leading to better outcomes in the planning and construction of buildings, infrastructure, and cities.

Generative and Parametric design

Parametric and generative design are advanced data-driven design tools that are becoming increasingly pivotal in spatial planning and construction. These design techniques fall directly under the umbrella of automation ambitions mentioned in the previous section yet may be also explicitly used in design phases. Parametric design, as its name implies, has to do with a creation of models that are driven by a set of parameters or rules, which can be adjusted to explore different design alternatives. Generative design, on the other hand, employs algorithms to generate a range of design options based on a set of constraints and objectives.

These tools have great potential for improving and positively affecting aspects of sustainability in spatial planning and construction. By using parametric and generative designs in GIS, BIM or other spatial design applications, designers can explore a range of design options instantly and efficiently, allowing them to find solutions that are more sustainable in terms of e.g. energy and material waste efficiency.

Parametric and generative design can also be used to meet regulatory requirements that are in concern. For example, these tools can be used to create designs that meet accessibility requirements, avoid clashes between set criteria or comply with building codes. This balances design efforts and financial strains, while also ensuring that designs meet the necessary standards. As these tools continue to evolve and become more accessible not only to designers but also other relevant stakeholders, we can expect to see them used more widely in the construction industry, leading to a more sustainable and efficient built environment.

AI in planning and construction

Artificial intelligence (AI) means that a computer system in the same way as us humans can recognize its surroundings, perceive, or act on those processes that take place. One technology in AI is **machine learning**, which means that it is possible to teach an AI to make decisions on historical and new data to recognize patterns. AI is predicted to be one of the pieces of the puzzle that will make a significant difference to the sustainable society.

In the spring of 2023, the AI Act is planned to adopt an EU regulation[26] that regulates the use of AI. At the time of its adoption, it applies to all EU countries and the application of the regulation will apply 2025 onwards. The regulation aims to ensure that the use of AI and data respects human rights and facilitates innovation and technology development.

Advanced chatbots is a fast-developing branch of AI. Examples of such application is large language models (LLM) like Open AI's GPT series or Google Bard AI which have become increasingly common in generating content from text-based queries or prompts. This type of application is set to be relevant in various digital services in the public sector and will most likely only increase. It is anticipated that a number of the processes in spatial planning and construction where information needs to be collected, shared or compiled ChatBots and other AI applications will play a more important role in the future by coordinating data and information management between stakeholders.

A prerequisite for being able to apply AI in any procedural phase in the digital routines of the built environment is that a critical amount of structured data is available, and its standardisation becomes an important step in reaching the applications. To fully be able to use AI in our processes we need to secure that data are available, updated and with adequate quality. We also need to make sure that the interpretations by AI systems are made correctly, and traceable in order to keep the public processes within planning and construction transparent and trustworthy.

Virtual reality (VR) and Augmented (AR) or Mixed reality (MR)

Virtual reality, or VR, is the technology of creating a virtual 3D-model of the reality which allows you to look at and move around in a digital version of reality, or more common in spatial planning and construction what is planned to be built. The technique allows all the different stakeholders in a complex process such as spatial planning to see what is planned before it is built, and make simulations and alterations if needed, saving both time and money rather than making changes in the already built environment.

VR can be used successfully in a virtual meeting with the stakeholders involved and also in communication with citizens (e.g., communicating what is going to be built, collecting citizen thoughts on the area being developed).

Many companies and some cities have looked into the possibilities of using computer games such as Minecraft in communication[27] with preferably the younger generation to create more involvement and participation in the cities' planning processes.

[26] The Artificial Intelligence Act. Available at: https://artificialintelligenceact.eu/
[27] UN-Habitat. Using Minecraft for Community Participation, see https://artificialintelligenceact.eu/

Whereas VR creates a whole digital version of a place, AR is a growing technique that reinforces reality. You start from the real value and add digital parts that together give a higher value. Augmented reality is closely related to MR, the difference being that while AR lays a digital filter over the reality, while MR wants to create interactions between the two (for instance, laying a virtual layer of the pipes underground over the ground so that the excavator knows where to dig the hole).

AR could help in getting a better understanding to better plan coming construction work and use of resources. For instance AR can be used in a mobile phone application, allowing a person to walk around an area and see in their phone the building regulations for that site overlayed in the site.[28] AR phone apps are probably going to develop towards showing the "invisible" (e.g., pipes and wires located underground or in the structures). It is expected that in the near future (1-2 years) these practical solutions will be introduced also for AR.[29] The same technique can also be used in a construction site where one can walk around and through your phone (or tablet) see the different phases in the buildings construction.

3.3 Assessment of existing and emerging digital services

This chapter assesses the built environment digital services identified and provides an overview of the key opportunities, barriers and risks identified. It should be noted that since the emerging tools and methods are currently just theoretical conceptions and are not in use as real systems, no practical assessment of these can be provided.

The assessment in this chapter is based on the review of various academic studies and research papers by different groups of professionals have been working with these national e-services such as housing sector managers and maintenance professionals, and engineering master students. The main findings of the current chapter were highlighted and discussed and validated on the first workshop with the local professionals dedicated to digital services in living environment. The assessment also includes the answers to the questionnaire performed for Deliverable 2 (with responses of mainly administrative officers of public institutions) of the TSI project this Deliverable is part of. Active feedback has been given by the planners during the discussion meetings organised for compiling Deliverable 4 of the current project.

Firstly, the role of digital services for society is shortly discussed based on the general expectations. Digital tools are the new reality we face in all the sectors of human activities. Then the general proposals and wishes from the practitioners who are already using the e-services are provided to improve the working environment they are tackling with. Finally, in this chapter the assessments reflect these proposals that are directly related to construction entities and how they are and should be depicted in the e-construction platform.

All the discussion and proposals done in the subchapter are not directly related to any of the currently existing services, rather these proposals hopefully support the general picture the e-construction platform should provide.

[28] Movies NGP, The National Geodata Platform (Sweden). See video (part 3), available at: https://www.lantmateriet.se/sv/nationella-geodataplattformen/om-plattformen/filmer-ngp/
[29] Taavi Jakobson (Ministry of Climate)

Role of digital services in the society

Generally, society and individuals can benefit of the availability of digital services in the construction sector and the built environment. At the same time, the users of these services are critical about the different properties these services have as the needs are changing and different professionals have different expectations. Therefore, the services that are available are to be updated continuously.

It is reasonable to encourage the adoption of digital solutions at the national level. At the same time, digitisation is not a goal in itself, but a means for improving efficiency of professionals and for providing reliable service for individuals. Digitisation without understanding of different buildings and facilities, construction technology and the construction process will not generate benefits. Digitisation of the construction sector must be based on expediency, and digitisation must benefit both for the public and private sector organisations and individuals. The private sector as a producer of data would like to see benefits “here and now” whether these involve reductions in business costs, the time spent in submitting data, the shortening of procedural times and the increase of transparency of the procedure, the development of new services, the promotion of new entrepreneurship (e.g., “start ups”), the mitigation of risks, the reduction of corruption/”grey market”, etc.

Further, in order for the use of digital solutions to become a new reality or practice, the sector must develop existing and new technologies and services, the regulations should be supporting or even encouraging digital transformation – hand in hand with governmental (IT) systems that “nudge” the industry towards digitisation, raise public awareness and educate the parties in the field to use digital technologies. What makes it complicated is that all of this should be done more or less in parallel and in cooperation with state offices, educational institutions, industrial associations and private sector companies. This means that the construction sector, or the system, must be treated holistically and only by systematically developing it is possible to reach a new stage of development in the construction field, which would be based on science and knowledge.

Further, as discussed by the experts at Workshop #1 as part of Deliverable 6, digital services have helped increase the efficiency of work and processes have become easier. There is also a common understanding that the development of digital services can significantly increase meaningful involvement of citizens in local spatial development.

General bottlenecks of digital databases

The greatest risk identified for the e-construction platform is when the proposed new digital solutions will not meet the needs of the intended users. As emphasised during Workshop #1, current databases have been designed with municipality officials in mind and has turned out to be difficult for industry experts to navigate and make sense of all the data in there. If that were the case, the long-term input by different organisations will lose its value. The most detrimental to the future of digital service, however, would be if a negative feeling around digitalisation arises as result of this.

The e-construction platform includes several innovative functional tools for the users. In spite of this, the respondents to the survey carried out under the framework of Deliverable 2 have still listed several **bottlenecks** that the conception of the current e-construction platform has.

- The building register (EHR) is not user-friendly, it is ineffective, and should be improved, for instance by allowing users to create and modify project directly in the register;

- Poor data quality and reliability are a general bottleneck affecting the e-construction platform; a concrete example mentioned was the portal of the Land Board, which currently does not show data on land restriction zones/encumbrances, utility networks.

It should be noted that these comments probably reflect the experiences with the prior version the EHR (replaced in June 2022). The EHR is developing fast and improvements are visible; by now the processes of acquiring building permits and residency permits are 23% and 27% faster respectively compared to the old version.

Some respondents to the survey, carried out in Deliverable 2 of this project, also provided feedback on digital services that are currently unavailable, but which could be useful to facilitate the cohesive development of the living environment. These include:

- A central depository of information where the different layers of information can be stored and easily be retrieved, facilitated with common agreements, classification system etc.;
- A nationwide planning environment;
- Improved integration between different services, improvement of the flow of processes, further automation etc.;
- Tools to improve collaboration, such as viewing of calendars across organisations, and to improve efficiency of communication amongst stakeholders.

Analysis of the answers carried out presents an overview of the reasons why digital service(s) are currently not being used more widely. The main reason is that there has simply been no need for it in the daily functions of respondents. There were also other respondents who indicated that they are in fact unaware of the digital service(s) that are available and/or that these services are too complex. Better information on these services and the guideline manuals explaining how to use the digital services was agreed would be helpful. As most of the respondents to this survey have been the people whose everyday job obligations are related to using digital services, these findings are alarming. The in-progress development of the e-construction platform should ensure to eliminate these bottlenecks in the (nearest) future and all the improvements done in the system need also better communication for the users.

More critical to digital services are the practitioners in the area of planning activities who participated in the workshops organised for Deliverable 4 of this project. During the workshops they have provided quite a long list of bottlenecks related to their everyday jobs:

- Detailed technical, as well as important spatial data for residents and other target groups, is fragmented, including between different government areas;
- There is no analytical tool to support spatial decisions;
- Support for appropriate anonymisation and aggregation of personally identifiable data collected in bulk to enable broader use of the data;
- Assessment of the significance and application areas of different spatial data;
- Better involvement of the public in spatial decision-making;
- There are no functionalities for collecting input related to the desired spatial development from residents and other parties actively in use;
- Information technology support for energy consumption and GHG emission reduction planning of the built environment;

- Regular monitoring of the type and condition of the natural environment and evaluation and visualisation of the condition and dynamics in an easily accessible way for the public;
- Regular monitoring of the condition and price level of residential areas and evaluation and visualisation of their dynamics easily accessible to the public and/or decision-makers;
- Use of modern digital solutions in construction from planning to disposal, robot solutions, factory construction.

In addition the D4 workshops also mentioned that the e-construction platform is currently only under development and different subsystems of the platform have originally been very differently developed and structured so far, and the whole system requires harmonising and reasonable balancing.

One general and rather critical problem to be solved is the ownership issue of data related especially to privately owned built environment as not all the private information currently collected is of public value (e.g., laundry facilities in a house, purpose of different rooms). Next to that, there is also the issue of anonymisation of social data related to built environment.[30]

As most of the buildings (especially the housing stock) are in private ownership, the owners of these buildings may be not willing to share some user related technical data for public databases. Also the end-users of the premises (households) may be not ready to share in particularly some of the resources consumption related (e.g., heating, electricity, water, etc.) for public analyses. Quite often, private individuals being the owners or the users of the buildings may have no proper and reliable records available about the running costs and activities related to these buildings. This tradition of data management is missing in Estonia while official databases and platforms would require such data to be provided in a correct and objective manner.

Many of these problematic topics highlighted above can be solved when using relevant e-solutions and the conception of e-construction platform already includes the ideas and proposals that can improve the problems of managing the national living environment.

The key issue highlighted which relates to several problematic issues is the chaotic distribution of data into different currently existing databases and registers managed by different government authorities.[31] Massive amounts of data have been collected in such databases, sometimes contradictory or even faulty. A reasonable amount of taxpayers' money has been spent to do this. Generally, bottlenecks have been identified by the Deliverable 4 workshop participants and are related to lack of tools to support spatial decisions.

When using data about the built environment for assessing the living environment, social data has to be collected and analysed. All data related to residents (e.g., their habits, consumption patterns, mobile positioning etc.) are collected only on a project-basis and are not related to these e-databases addressed in this study. It is specified which buildings are for shopping, where schools are and what other buildings people/households need in their everyday life. Different organisations collect very diverse spatial data but it is difficult to assess the practical value of these surveys and how applicable

[30] Private databases & Registers. Human Rights Guide. Available at: https://www.inimoigustegiid.ee/en/themes/data-privacy/databases-registers/private-databases-registers
[31] E-ehituse platvormi andmete ja teenuste analüüs (Analysis of e-construction platform data and services), in Estonian only. Available at: https://pdfslide.tips/download/link/e-ehituse-platvormi-andmete-ja-teenuste-anals-jwc-java-web-component-jwt-json.html

these results actually are. These aspects become sensible and there is legal restriction when handling and publishing data related to individuals. More analysis about suitability of the living environment for the users is needed, although legal restrictions are to be defined more clearly concerning the use of personal data.

In line with the messages above, during Workshop #1 discussions, participants highlighted that reliability of data about the built environment seems to be currently the key issue. In addition, experts highlighted that data management across digital services tends to be quite poor generally and that there should be better justification for data collected.

Information about construction entities

The "building register" carefully collects and maintains data about buildings. The main problem is related to the historical name choice namely *hooneregister* (building register, or register of houses) which implies the building register concerns solely buildings. As previously mentioned, the building register *ehitisregister* or EHR should not only include buildings but all types of "construction entities". This leads to important data lacking in the register. The data collected so far has been targeted mainly for administrative purposes, and it is not known how much the collected data is being used (and by which users). These issues were also raised by experts at Workshop #1.

It is mentioned by the participants of different D4 related workshops that data about roads and different networks (pipelines, cables) is mostly missing. When thinking in terms of the living environment and residents, there is no clear information about public transport facilities, about playgrounds and sporting facilities. Another example to showcase missing data is, for example, in smaller cities and suburbs of larger ones, the single family housing plots are traditionally surrounded by fences. Though local authorities have some local requirements relating to height and material and sometimes even colour, the register does not include neither numerical nor visual data about the fences. Although fences are construction entities and an important element of living environment (showing the role of the owners when creating his own living environment and neighbourhood), there is no relevant information about these elements of environment in the register. Until now, trees and vegetation can hardly be found in the 3D twin (on the maps and 3D twin, there are only green flat areas surrounding the buildings); however these elements will be added in the next iteration which will be implemented in approximately 12 months[32]. When thinking about maintenance manuals and log-books of the buildings, then trees are of crucial importance for developers and for reconstruction of the existing structures of the buildings, but also when assessing comfortability of the environment. The grey 3D "boxes" representing the buildings lack individuality – normally the facades have the windows - and finally, in practice, the colours used for the facades create the actual living environment.

Data about construction entities collected to EHR is mostly "static" one – number of storeys, size of the building, number of rooms there etc. This data is relatively stable during the lifetime of any building. It is only during major reconstruction and/or the maintenance and management of the entity that considerable changes/amendments may be done. As some of these works can be carried out without construction permission, there is no major procedure and incentives for the owners of the construction entities to make relevant corrections in public databases. Often, *only* facility managers complain about EHR data not being reliable, as they are in a position which allows them to see the differences between

[32] Jaan Saar (Ministry of Climate)

the databases and real life most. As such, it important to understand what ‘good quality’ or ‘accurate’ (or ‘correct’) data means.

Data regarding the share of heating systems used in houses and the efficiency of these systems are also lacking. Traditionally, single family houses have been heated with wood- or coal-burning stoves. This has changed over the years, with the installations of oil and gas-based heating systems, and electricity-based heating systems. In more recent times, solar and geothermal technologies are also being installed. There is currently no reliable information available, even though energy efficiency certificates are being issued.

Therefore, as an IT system, the e-platform may function perfectly in the future, but the data used may be not correct for decision making. This may not be a problem for public owners (e.g. local authorities and road administration where the relevant procedure to update and correct the data can be introduced); however, in Estonia’s situation where the vast majority of buildings are owned and governed by private individuals, it may be rather complicated to get the private sector to provide updated data.

According to legal requirements, maintenance manuals are to be provided when applications for construction permissions are prepared. However, as a building is a complex of structures and facilities, it is, in fact, difficult or impossible to prepare a single manual for the whole building. Different utility systems require very specific manuals to be used for carrying out proper maintenance (e.g. ventilation, heating, elevators, façade systems, etc.) and all these guideline documents should be prepared by different actors and at different times. Currently, these manuals that are submitted to the EHR are of varying quality, prepared by different organisations from different countries, and these documents are mostly not machine-readable. Therefore, this data cannot be used automatically.

The next issue is related to logbook data. Logbooks are to provide enough detailed information to allow building services systems to be run and maintained energy efficiently, in line with the design intent, and to control and minimise energy consumption. If certain maintenance activities are required to be done, the e-construction platform should start giving alarm signals to authorised persons (e.g. to carry out a chimney sweep, or to a plumber for changing the water meters, or to check on the smoke detectors), and to the owners and users of these buildings. When having the state of the art information available, the authorised persons (e.g. insurance, rescue service) can have a quick overview of the whole neighbourhood regarding the performance of buildings and the risk levels. Quite many professionals working in private maintenance companies have this critical information about the buildings available and it is used when planning everyday activities. The challenge will be to merge public databases with these privately owned information in the future.

The e-construction platform can become a tool for scheduling specific audits about the construction entities only if the initial data is reliable and correct. Although this topic generally raises the question about data ownership and the management and accessibility to different databases, it is already working in quite a number of areas, with highly reliable information (e.g., Consumer Protection and Technical Authority (TTJA) uses e-construction platform information for lifts' audit).

Finance related data is sensitive and giving everybody full access is not reasonable. At the same time, this data is of key importance to make decisions that are reliable and clear for the bodies related to the buildings and important for the stakeholders related to the neighbourhood.

On the e-construction portal, there is no data related to finance/costs/expenditures of the built environment. While financial data is usually considered extremely sensitive, such data about the built environment is often of public interest. In fact, most comparative analyses are connected to expenditures and income related data. When developers initiate a project, they are making long-term decisions based on financial calculations of feasibility studies. Also later in the process, they will need similar sorts of financial data to assess the efficiency of the project in general. Only then can developers be sure that the strategic goals related to the development of the building can be reached.

Financial parameters are important also for all users of the premises, either in housing sector or in business. Financial parameters are always used when potential users negotiate about the conditions of accommodation. These data critical benchmarks used to evaluate the feasibility of any proposed activities to improve the quality of the built environment.

Technical data is surely of primary importance, but when carrying out complex comparative studies, such generic decisions are made based on past of anticipated future expenditures. Clearly, when consumption based data (electricity, heating, gas, etc.) is used, physical units are perfectly good for analyses, but information about maintenance services and their related costs is fully missing.

Understandably, buildings are serviced by different companies using different methods and technologies. These buildings have different users with different traditions of user-behaviour, which results in different prices and costs for the provided services. When following the general principles of classification of services in the sector, this data provided has the generic value of describing certain aspects regarding the quality of the building, but also to highlight to the owners and users the possible maintenance needs. This data is important to understand the price of ownership in the long run.

3.4 Overview of the main barriers to the development of digital services in Estonia

In order to successfully develop digital services in Estonia, identifying the current barriers and opportunities is a crucial step in order to ensure that necessary actions are taken to tackle these barriers.

Based on the assessment of the existing and emerging digital services in Estonia, a compilation of the main barriers for developing digital services is assembled in this section, relating to:

Technical barriers, relating to the availability and accessibility of relevant technological infrastructure;

- *Lack of harmony in data formats*: a main obstacle, particularly for building the e-construction platform is creating information flows between different stakeholders and in different phases of planning and construction because data is stored in different formats. Because of this, there is not one format or software that can handle the entire information flow. For instance, at the early stages in spatial planning, many of the data sources concern geographical data, so called

GIS-data. Later in the processes, when the detailed infrastructures and buildings in an area are planned, the software used are mainly based on BIM-data. There is a fundamental difference in the structure of GIS and BIM data that make them hard to combine without creating distortions in the data. Quite a fair amount of research has been put into this field during the last years looking for ways to create data flows between GIS and BIM, creating solutions that will make the gap between the sectors smaller.

- *Closed data systems*: Most of the construction sector works in closed IT systems, where the data (from PropTech and similar solutions) is locked in systems in formats which are hard to extract, exchange and combine with other data.
- Administrative burden relating to using the building register: The building register is not user friendly – it is ineffective and needs to be improved. The process of applying for a building permit is time consuming (although this has improved notably as compared to its earlier version).[33] This is partially because if there are any revisions to the project, then the reviewer must go through the full documentation (several times).

Regulatory/legal barriers, relating to legal frameworks and regulatory environment which governs digital services;

- *Current legal framework does not reflect the needs of digital solutions*[34]: National legal acts (e.g. Building Code, Planning Act), which govern construction and planning, do not provide sufficient support for the development of digital services. More consistency is required in terms of defining minimum requirements on data (e.g. which classification system should be used on preparing BIM), what data should be publicly available and what information has limited access, requirements on data formats (definition of machine readable data formats), as well as the principle of information creation to be more data-driven.
- Lack of appropriate anonymisation and aggregation of personally identifiable data: Concerns about the security and privacy of data can prevent the sharing of data. As most of the buildings are in private ownership the owners of these buildings may be not willing to share some user related technical data for public databases. Also the end-users of the premises (households) may be not ready to share some of the resources consumption related (e.g. heating, electricity, water) for public analyses. Quite often private individuals being the owners or the users of buildings implies there is no proper and reliable records available about the running costs and activities related to these buildings.

Social/organisational barriers, relating to the awareness and willingness of relevant stakeholders to transition to the use of digital services.

- *Lack of data sharing:* The construction sector involves various stakeholders, where there is a lack of effective cooperation. This leads to inefficiencies (e.g. too much time spent on checking inconsistencies) as well as higher risk of human error, especially in the planning and design phase. Ultimately, this can lead to increased costs when later corrections are needed. Therefore, the introduction of the e-construction platform will require a change in thinking to make the move to systems where data can be shared with others.
- *Fragmentation of data and services*: As consequence of the above, today, most of the data related to the built environment and the life-cycle of buildings is available in different several

[33] The median average processing time for a building permit has fallen over 20% as compared to the prior version of the system and is currently 22 days in 2023.
[34] CIVITTA and MEAC. (2018). Vision of e-construction platform. Available at: https://eehitus.ee/wp-content/uploads/2019/07/e-construction-platform-vision-ENG.pdf

different information systems and databases managed by different service providers and agencies. Due to such fragmentation, information gathering is a time-consuming effort. In addition, contradictions in data are common and fragmentation may also lead to data loss. In the context of the e-construction platform, making a transparent and efficient data flow throughout all phases will require a considerable cultural change and new working methods.

- *Lack of awareness/training for universal digital language (e.g., CCI)*: currently, the digital language of construction services is not harmonised, which can deter the adoption of new digital services.
- *Lack of awareness/involvement of digital services*: based on the DLV2 survey, respondents who do not use digital services explained that they were unaware of the digital services and that they think that the services are too complex.
- *Fragmentation of spatial decisions*: spatial decisions and spatial knowledge are fragmented between different agencies and institutions.
- *Meeting the needs of users:* The greatest risk is when the developed e-construction platform services does not meet the needs of the intended users.

4 Action plan

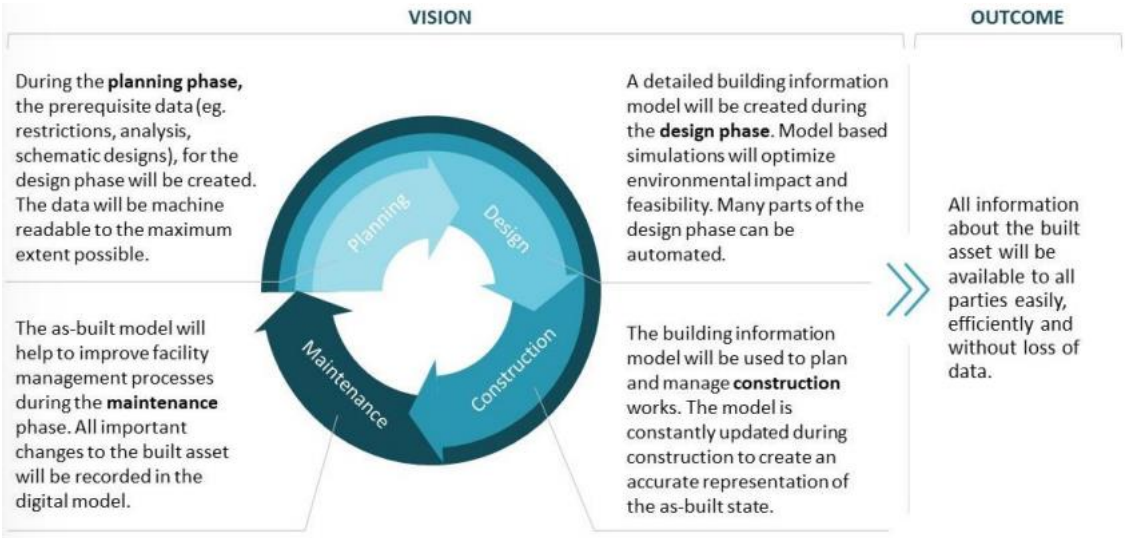
The objective of this chapter is to draft an action plan and roadmap to further develop the e-construction platform and spatial development digital services to support spatial development in Estonia.

The chapter begins with explaining the vision and mission of the development of digital services in Estonia. This is followed by a chapter spelling out the recommended actions based on the various objectives identified.

4.1 Vision and mission of the development of digital services in Estonia

Estonia's long-term vision for the construction sector is built upon the ultimate goal of *raising productivity* of the sector by at least threefold and establishing principles for the development of a high quality living environment.[35] To achieve this growth, Estonia's construction sector must substantially improve its efficiency, where digital services will play a major role. In 2018, the Ministry of Economic Affairs and Communications published the vision of the e-construction platform report, which identifies the long-term vision for e-construction in Estonia (Figure 4-1). Ultimately, the main goal for the development of these digital services in Estonia is to ensure that all information about the built environment is easily accessible to all parties, efficiently and without loss of data.

Figure 4-1 Long-term vision of e-construction (2018)



Source: Estonian Ministry of Economic Affairs and Communication (2018). Vision of e-construction platform.

In this context, the successful development of the e-construction platform will be critical, where we understand the **vision** of the e-construction platform to be:

'The e-construction platform is to enable lossless exchange of standardized and trustworthy data between all stakeholders throughout the building lifecycle.'

[35] Estonian Ministry of Economic Affairs and Communications (2018). Vision of e-construction platform.; Estonian Ministry of Economic Affairs and Communications (2021). Long-term view on construction 2035.

The e-construction platform's objective is to develop '*standardised and reliable information that concerns the building's life-cycle, which moves between the parties of the complete building's life-cycle without losses'*. To achieve this objective, the platform has three goals:

1. Building information model is the standard across the building's life-cycle;
2. Proceedings of the public sector are transparent and fast; and
3. Utilization, provision and development of new services are easy for various parties.

4.2 Objectives

Based on the vision and mission as well as the identified barriers to developing digital services in Estonia, the main objectives of this action plan can be defined as:

A. **Improving the usefulness and quality of data:** data is the foundation of having good quality services and ultimately engaging stakeholders. Currently, the data used for digital services is considered not trustworthy and incoherent. Actions are required to ensure that the data used for digital services is of high quality and useful based on current and future needs.

B. **Improving the usefulness and quality of digital services:** while high quality data provides a good foundation for digital services, the digital services themselves need to be designed in such a way that they are useful and accessible to the various end-users. Therefore, it is crucial that digital services provide a user-friendly experience.

C. **Strengthening cooperation and engagement of stakeholders with digital services:** the value of digital services greatly depends on how stakeholders interact with the services in practise. However, not all relevant stakeholders are aware of the benefits of using digital services or consider services too complex, which make it difficult for these stakeholders to adopt new and existing digital services. Further, the multi-phase nature of construction creates fragmentation in the construction process, deterring effective cooperation amongst stakeholders across the building lifecycle, which ultimately impacts the availability of relevant data. Therefore, actions are required to strengthen cooperation across the building lifecycle as well as raising awareness of the benefits of digital services.

4.3 Actions per objective

This section provides a list of actions per objective, which are aimed to directly address the barriers and opportunities for developing digital services in the construction sector in Estonia. Details are provided for each action, including identification of roles and responsibilities, expected impact and bottlenecks/challenges.

4.3.1 Objective A: Improving the usefulness and quality of data

A major theme of the barriers for existing digital services in Estonia is a lack of high quality data, in terms of lack of harmony across different data, lack of data sharing, which ultimately leads to lack of trust in data as well as time-consuming procedures to verify and harmonise data. To improve quality of data, several actions are suggested to build upon the existing relevant efforts, including:

- A.1: Review of data needs of existing digital services
- A.2: Develop national model of built environment common data environment
- A.3: Strengthen regulation on construction and planning to clarify data ownership and responsibility and legal means of ensuring data quality
- A.4: Enforcing regulation and standards for data formatting and exchange

- A.5: Introduce nation-wide BIM-based permit procedure

These actions to improve the quality/usefulness of data used for the construction and planning sector are intended to improve the efficiency and reliability of data processes (i.e. data generation, collection, storage and transfer). The processes will ultimately improve the trustworthiness of this data as well as make processes in the construction and planning sector more efficient (not only in terms of improving technical efficiency, but also encouraging adoption of digital solutions).

Existing policies/actions on Objective A

There are already several policies/actions that the Estonian government is pursuing to improve the quality and value of data used for construction and spatial planning, namely:

- The **X-Road** is a secure and decentralised open-source data exchange platform that allows different public and private organisations to share data. It can write to multiple information systems, transmit large data sets and search across several information systems at the same time. Thereby outgoing and incoming data is secured. Regarding the construction sector, this means that relevant information from various departments (e.g., land registry, building permits, environmental data) and regions can be seamlessly integrated and accessed by stakeholders. This integration ensures that construction companies, architects and other professionals have access to accurate and up-to-date information, leading to better decision-making and planning processes.
- **Building Information Modelling** (BIM) is a data-rich 3D modelling process that enables collaboration and coordination among various parties involved in a construction project. BIM captures detailed information about the building's components, materials, and systems. This data-driven approach improves data quality by reducing errors and inconsistencies between different construction documents. It also enhances data usefulness by allowing stakeholders to visualise the construction process, leading to improved cost estimation, clash detection and overall project management. For BIM-based information exchange, **openBIM** is the preferred format/method, as it supports interoperability and adheres to international data exchange standards. The Estonian government has made efforts to develop software solutions for **BIM-based building permit processes** in the Building Registry, which is funded by EU European Structural and Investment Funds. Currently, technical inspections of building design is a lengthy and mistake-prone process in the building permit assessment procedure. However, a BIM-based process would automate this evaluation.
- Another initiative is the EU project **TOOP (Only Once Principle)**. TOOP was coordinated by the Tallinn University of Technology (TalTech), with the aim that when in contact with authorities, information should only need to be entered once, and then share with the software and organisations those parts needed for the activity intended. When this inserted data is correct and fully machine readable, this data will be shared with all the relevant subsystems related to the e-platform. The platform is not used for collecting the data, rather for sharing it with relevant registers and databases. Always the latest inserted data is used over the whole platform. Presumably, there is already reasonable reduction of time for administrative activities by the officials.
- Estonia has been actively promoting the ease of doing business via the concept of **open data**, making government data and information freely available to the public and businesses. E-solutions offered, like digital signatures, electronic tax claims, the availability of public records online and the e-Business Register, increase transparency and efficiency. Especially the e-Business Register can provide construction companies and developers with valuable data

for analysis and decision-making and simplify bureaucratic demands. This could lead to more innovative construction practices and businesses.

- The Estonian **Geoportal** is the platform through which spatial data under the administration of the Estonian state and local governments and other legal persons governed by public law are made public and accessible. The portal is part of the Infrastructure for Spatial Information in Estonia, which in turn is part of the Infrastructure for Spatial Information in the European Community (INSPIRE). It makes spatial data managed by different owners easily useable for the general public, and provides data mostly translated into maps.
- Estonia is part of Digital Nations and thus actively collaborating with nine other countries around the globe to share best practices on aspects like open data and AI. While this is not focused on the construction sector, it can result in improving practices regarding data sharing and its quality.
- **Open data policies** in Estonia are covered by the Public Information Act (PIA), which was updated in 2019 to comply with the EU's Open Data Directive. Before the elections, the Ministry of Economic Affairs and Communications was responsible for the topic. The Estonian government also seeks to provide open data via its Open Data Portal. The portal enables the general public to consume and visualise key data, including a collection of use cases generated from key data. This can be used for commercial and non-profit purposes and increases the data availability, and thus usefulness, also for construction sector companies.

Action A.1 – Review of data needs of existing digital services

Data needs are constantly changing as the needs of users develop. As Estonia moves towards a high quality living environment and zero-carbon economy, the data used by digital services will also need to change. The first step in this process is creating an inventory of the data required to meet the current and future needs of all parties involved in the building lifecycle and living environment.

	Action A.1
Concrete actions to be taken	• Conduct a **high-level analysis of existing data** used in digital services. The aim of this analysis is to have an overview of what kind of data is currently being used, particularly focusing on what data is already used relating to high quality living environment and zero-carbon economy. • **Identifying relevant stakeholders and engaging stakeholders** involved throughout the spatial planning and construction process to create an inventory of the data requirements in each specific stage of the building lifecycle. The aim of stakeholder engagement is to assess how current data fulfils their needs. Stakeholders to consider are representatives from the construction sector, households, property/infrastructure management, etc. • **Identify current trends and possible future (short-term) data needs.** In addition to current digital services, a review of developing or existing prototype services should be reviewed to ensure larger basis to ensure new emerging data needs are satisfied along with existing needs. • Based on the data mapping and stakeholder engagement, **identify the gaps** in data coverage • Develop an **action plan for EHR to transition from document based repository to a central database and logbook** for the built environment. The next steps required depend on the gaps identified, but can include, mapping of spatial and built environment state level master data,

Action A.1	
	modifying regulation to include new data requirements, collaboration with relevant institutions to improve access to required data, and/or piloting new mechanisms to collect the data necessary.
Roles and responsibilities and necessary institutional arrangements	• **Ministry of Climate** (formally MEAC's responsibility) to be responsible for the assessment of data, though it will require strong collaboration with other departments such as the Land and Spatial Board. The responsibility of the next steps may depend on what changes are needed. • Various stakeholders will be engaged to provide inputs on data needs
Source of financing	Public funding
Implementation period	Short term (2024-2025)
Monitoring indicators	• Share of existing data coverage of data needs • Milestones in terms of setting up an action plan, updating policy, creating data-sharing agreements between institutions, implementing pilot projects, etc. • Use and added value of available data
Expected impact	• Improve the quality and usefulness of data used by digital services to ultimately better inform decision-making and planning in the construction sector
Priority of implementation	High
Bottlenecks/challenges	• Lack of stakeholder engagement – stakeholders may not be aware of what their actual data needs are and how this information can benefit them, which may deter participation and therefore the survey of data needs can have gaps. • Managing the volume of needs – built environment data requirements are diverse from stakeholder to stakeholder. Without finding a common set of relevant master data, there is a risk of not setting priorities and loosing focus.

Action A.2 – Develop national model of built environment in a common data environment

In order to improve the quality of data used by digital services, there needs to be a common ground in terms of standards and formats of data. One way to do this is by creating a national model of building environment in a common data environment (CDE), where there is an agreement of data ontology, terminology, classification systems (CCI) technological interoperability, with attention to international standards.

Action A.2	
Concrete actions to be taken	• **Establish a working group** with representatives from relevant government authorities, local municipalities, urban planners, architects, engineers and IT experts to oversee the development of the model • Assess the current data models, evaluate available international standards, models and practices of other states and identify gaps. Further, investigate how a CDE can be based on the e-construction platform and new/existing services. • Based on the current and future needs of relevant stakeholders (derived from Action A.1), **develop a common data environment** which can allow stakeholders to collaborate, share and access data in various formats (3D models, BIM, GIS, etc.) throughout the built environment lifecycle. • **Pilot the CDE** in various cities/regions before **scaling to national level**.

Action A.2	
	• Continue **regularly updating and evaluating** the model based on user feedback. • **Assess feasibility** of integrating databases with similar data components and user base, for example Road Registry into Building Registry to reduce maintenance and data cleaning costs. During the analysis probably more databases come up.
Roles and responsibilities and necessary institutional arrangements	• The **Land and Spatial Board** would be responsible for the development of a CDE as this needs strong coordination support coming preferably from a rather holistic organisation; • Relevant stakeholders (local municipalities, urban planners, architects, engineers and IT experts) will be involved to provide guidance in the development of the CDE; • Specific municipal/regional authorities will be involved in the piloting phase.
Source of financing	Public funding. Potentially can use EU funds, such as Horizon Europe, Digital Europe Programme (DIGITAL), European Regional Development Fund (ERDF) and Connecting Europe Facilities (CEF).
Implementation period	Short-medium term (2024-2026)
Monitoring indicators	• Report on the current status of data models and gaps • Milestones in terms of the development of the model and the no. of pilots • No. of stakeholders adhering to set standards.
Expected impact	• Improve the usefulness of data, ease of cooperation and efficiency of service development and operation for digital services by creating a common environment
Priority of implementation	High
Bottlenecks/challenges	• Ensuring interoperability across data from different sources can be challenging • Maintaining and establishing a common data environment can be resource-intensive • Lack of stakeholder adoption of the common data environment should be prevented by maintaining strong stakeholder engagement from the commencement of the model.

Action A.3 – Strengthen regulation on construction and planning to clarify data ownership and responsibility and legal means of ensuring data quality

In conjunction with Action A.2, there needs to be clarification in Estonian regulation of who is legally responsible and claims ownership of data in order to maintain data quality.

Action A.3	
Concrete actions to be taken	• **Comprehensive review of existing Estonian and EU legislation on data ownership and responsibilities** related to construction and spatial planning (data gathering, storage, data anonymisation, aggregation of data etc.) and identify gaps in the legal framework, including consultation with stakeholders to collect views of data ownership. This should build upon the analysis done by the University of Tartu in 2020.[36]

[36] Sorainen AS (2020). Ehitise elukaare õigusruumi digitaliseerimiseks kohandamine ("Adaptation for digitalisation of the building life-cycle legislation"). Available only in Estonian at: https://eehitus.ee/timeline-post/ehitise-elukaare-oigusruumi-digitaliseerimiseks-kohandamine-uuring/

Action A.3	
	• Based on the review, **amend legislation** to clearly define data ownership and responsibilities, also setting some requirements for the use of open data exchange standards (CCI, openBIM). • Establish a **periodic review of regulation** to adjust to the changing needs of stakeholders and changes in digital services
Roles and responsibilities and necessary institutional arrangements	Ministry of Climate (formally MEAC's responsibility) will be responsible for conducting the review of regulation and amending legislation
Source of financing	Public funding
Implementation period	Medium term (2025-2026)
Monitoring indicators	• Report on existing legislation and gaps • Milestones in terms of amendments in legislation
Expected impact	• Improve the quality of data by defining ownership of data and stipulating which stakeholders are responsible for the management of data
Priority of implementation	Medium
Bottlenecks/challenges	• Stakeholder resistance to regulation changes should be moderated by including relevant stakeholders in the legislation review process • Defining data ownership can be complex given the number of stakeholders involved throughout the construction and planning process • Regular monitoring should be done to reduce non-compliance with new regulation • Overregulation may lead to unforeseen hindrances for open data exchange and reduce willingness for individual participation (eg. sharing data) • The review must take into account how amendments must align with current Estonian and EU legislation

Action A.4 - Enforcing regulation and standards for data formatting and exchange

Enforcing data standards and data exchange protocols are important elements to improve the trustworthiness of data used in the construction and planning sector. The previous Actions A.2 and A.3 set up regulation and protocol for data formatting and data exchange, however, these changes can only have an impact as long as they are followed. Therefore, additional action is required to integrate these standards into the industry.

Action A.4	
Concrete actions to be taken	• Develop a **Construction Data Dictionary** which provides compliance guidelines that outline how stakeholders should adhere to new and existing regulation for data formatting and exchange. This should build on the already existing data dictionaries and data governance guidelines. • **Adopt international open data standards and data exchange protocol**, taking into account international standards and best practices. This may include developing **digital data templates** to ensure consistency and simplify data entry as well as encourage the elimination of paper-based processes • **Test data standards and protocol** on pilot construction projects to refine the data standards and protocol • **Integrate standards into public and private procurement** (this process will depend on the expertise of the committee to decide

Action A.4	
	to what extent standards will be enforced, which may entail: integrating standards in public procurement process, launching awareness campaigns, amend legislation to enforce standards and data exchange protocol, developing data conversion tools to facilitate the transition)
Roles and responsibilities and necessary institutional arrangements	Ministry of Climate (formally MEAC's responsibility) is responsible for setting data standards and data exchange protocol
Source of financing	Public funding
Implementation period	Short to medium term (2024-2027)
Monitoring indicators	• Milestones such as set up of committee, development of the construction data dictionary, development of digital data templates
Expected impact	Enforcing standardised data formats and data exchange protocol will help facilitate better data management and ultimately greater trust in the data underlying digital services
Priority of implementation	High
Bottlenecks/challenges	• This action relies on having a common data environment (Action A.2) where stakeholders can access data from different formats and new regulation clarifying data ownership and responsibility (Action A.3). • Best practice for disseminating a standard would be for the state to adopt it. This would mean that EHR would have to have the capacity and resources to become fully compliant to agreed-upon standards within a reasonable timeframe.

Action A.5 – Introduce nation-wide BIM-based permit procedure and use of the CCI (the Construction Classification International system).

As mentioned, a BIM-based permit procedure would shorten the building permit processing time by automating the technical inspection of construction designs (already being prepared). While BIM-based permits are already being developed, this system will need to be mainstreamed in an effective way that leads to quicker permit application processes and fewer mistakes. Further, implementing a BIM-based permit system can potentially help promote wider adoption of BIM technologies throughout the construction and planning processes.

Action A.5	
Concrete actions to be taken	• **Planning and preparation** (defining to what extent BIM will be used in the permit procedure; allocating resources) • **Implementation of BIM-based permit procedure and automated checks** (setting guidelines, training staff, set up secure platform for submission etc.) • **Continuous development and updating of the CCI system** to ensure the operation of the permit procedure**. Piloting phase** (test new procedure with a sample group and revising the procedure accordingly) • **Launching phase** (implement new permit procedure nation-wide
Roles and responsibilities and necessary institutional arrangements	Ministry of Climate (formally MEAC's responsibility) will be responsible for the implementation of the BIM-based permit procedure

Action A.5	
Source of financing	Public funding and EU structural funds/private funds (which are already being used for the development of BIM-based permit procedures)[37]
Implementation period	Medium-long term (2024-2027)
Monitoring indicators	• No. of staff trained • No. of applications submitted • Average duration of permit procedure (from submission to approval)
Expected impact	• Increased efficiency of permit procedure (less resources required due to less time required and reduction in human errors) • Improved accuracy and quality of designs • Improved transparency on the permitting procedure
Priority of implementation	High
Bottlenecks/challenges	• Lack of awareness/expertise – successful implementation will require training staff and improving relevant stakeholders who are involved in the permit procedure • Lack of harmony in data formats – standardisation will be required to promote more effective information sharing • Data security/privacy of sensitive/personal information • Slow uptake and resistance to change by local authorities

4.3.2 *Objective B: Improve the usefulness/quality of digital services*

To improve usefulness of construction digital services, several actions are suggested to build upon the existing relevant efforts, including:

- B.1: Draft a built environment digital services strategy (including state and municipality actor levels),
- B.2: Support innovative initiatives to motivate emerging innovations in digital solutions,
- B.3: Develop digital services quality standards (setting up feedback/monitoring mechanisms, UX/UI design, user guides) based on international standards,
- B.4: Develop centralised service for government notifications/messaging to contact stakeholders/citizens.

By taking these actions, the intention is to ensure that digital services meet the current and future needs of stakeholders in the construction and planning sector.

Existing policies/actions on Objective B

To improve existing digital services, the Estonian government has already taken several actions, including:

- The **Estonian Digital Construction Cluster** (EDCC) is a collaborative platform that brings together export-oriented stakeholders from the construction industry and universities offering innovative construction solutions to cut both production costs and the carbon footprint. By promoting cooperation between the private and public sectors, the EDCC works towards improving the usefulness and effectiveness of innovative digital services in construction. It also collaborates with public authorities, like Enterprise Estonia (EAS), the Ministry of Finance or Ministry of Climate.

[37] BIM_based building permit procedure prototype. See: https://eehitus.ee/timeline-post/bim-pohise-ehitusloa-menetluse-prototuup/

- The **e-construction platform** aims to create a holistic picture of Estonia's built environment, i.e. by creating its 3D Digital Twin and combining several services (of which some are described below). See Section 2 for a detailed description of the e-construction platform.
- Developing the platform is linked to several smaller projects and dedicated funding schemes, like **e-leap** (*EE: ehituse e-hüpe*). E-leap is a support measure of €4.5 million for the digitalisation of the construction sector and was launched 2022. Founding rounds will be opened twice a year from 2022-2025 to accelerate innovative digital solutions. It is financed by the European Recovery and Resilience Fund (RRF) Next Generation EU and demands at least 50% self-financing by the beneficiaries.
- In 2022, a new **e-construction procedural environment** for the Building Register was launched which updates the entry and processing of the use and construction permits and the construction notification. It also wants to improve the tool's transparency.
- Estonia's **e-Residency** system (launched in 2014) is part of the electronic identity system called e-ID. E-Residency allows individuals to become an digital resident of Estonia and access Estonia's diverse digital services. This is regardless of the individual's citizenship or location. People globally can apply for an e-Residency to start and run a location-independent EU-company completely online. This also simplifies and increases the efficiency of construction businesses.
- There are several **existing digital services** which are described in Section 3.1.2, including the Building Register, Land Cadastre, e-Land register.

Action B.1 - Draft a built environment digital services strategy (including state and municipality actor levels)

Building on the vision of e-construction platform published in 2018, a built environment digital services strategy should be drafted, which provides a roadmap for state and municipality actors on how digital services are planned to develop in the long-term.

	Action B.1
Concrete actions to be taken	• Building on the existing analysis in this study of the current digital services, a comprehensive analysis of existing services should be done, including municipal level services. The analysis of data needs from Action A.1 should also be taken into account. • **Draft the built environment digital services strategy**, with clear objectives and vision as well as identification of the key focus areas for services. The strategy should take into account the objectives and actions of this study into account (e.g. adoption of nation-wide BIM permitting, digital services quality standards, etc.). • The strategy should include **clear outcomes and monitoring indicators**, which can be regularly evaluated • The strategy should also include **sufficient budget allocated** to support the implementation of the actions outlines in the strategy
Roles and responsibilities and necessary institutional arrangements	Ministry of Climate (formally MEAC's responsibility) would be responsible for developing the strategy
Source of financing	Public funding
Implementation period	Short term (2024-2025)
Monitoring indicators	• Milestones such as drafting of the strategy

	Action B.1
Expected impact	The strategy should provide clarity on the direction of digital services in the construction and planning sector, focussing on tackling the most important issues, such as improving the quality of data, breaking down silos between agencies and promoting greater awareness of digital services.
Priority of implementation	High
Bottlenecks/challenges	• Taking into account all of the different needs by state and regional actors can be a challenge • Depending on the financing constraints, ensuring that all actions outlined in the strategy can be sufficiently funded is an issue • If the objectives are not clear for stakeholders, then some stakeholders may have difficulty adopting the strategy

Action B.2 - Support innovative initiatives to motivate emerging innovations in digital solutions

To encourage innovations in digital services, such as AI solutions, should supported to motivate emerging digital solutions.

	Action B.2
Concrete actions to be taken	There are several ways to support innovative initiatives, including: • Establishing a **fund to support the development of innovative digital solutions**, potentially targeting specific issues identified in the strategy developed in Action B.1. This should be developed as a continuation of existing initiatives, such as e-leap. • Setting up collaborations between government agencies and local or international private companies to develop and implement innovative digital solutions
Roles and responsibilities and necessary institutional arrangements	Ministry of Climate (formally MEAC's responsibility) to be responsible for setting up support mechanisms for innovative initiatives
Source of financing	Public funding, with financial support from private companies (through collaborations). Potentially can use EU funds, such as Horizon Europe, Digital Europe Programme (DIGITAL), European Regional Development Fund (ERDF) and Connecting Europe Facilities (CEF).
Implementation period	Medium-long term (2025-2030)
Monitoring indicators	• Amount of funding allocated and used for developing innovative digital solutions • No. of innovative projects funded • No. of private-public partnerships set up
Expected impact	Encourage innovative solutions in digital services to drive advancement of the construction sector and make current/emerging digital services more effective/efficient.
Priority of implementation	Low/medium
Bottlenecks/challenges	• In order to set up a fund, there needs to be enough financial resources to maintain support for initiatives. Depending on the project, this may require long-term financing in terms of maintaining digital solutions/services • Uncertainty about intellectual property rights can deter private partners from joining public initiatives

Action B.3 - Develop digital services quality standards based on international standards

Setting up quality standards for digital services can create guide to improve the user experience and encourage greater use of services, which will ultimately ensure that digital services are able to support activities and decision-making in the construction and planning sector.

Action B.3	
Concrete actions to be taken	• **Assessment of digital services** specifically focusing on the user-experience with digital services (this assessment can be combined with that in Action B.1) • **Adopt digital services quality standards**, taking into account international standards and best practices. This should consider standards for feedback mechanisms, UX/UI design, user guides, customised user experience based on stakeholder type, etc.. • **Test standards** on a digital service (such as the e-construction platform or Building register) to refine the standards • Integrate standards into all digital services • Maintain **regular reviews of the standards** to update the standards based on feedback and current needs
Roles and responsibilities and necessary institutional arrangements	Ministry of Climate (formally MEAC's responsibility) to be responsible for the development of quality standards
Source of financing	Public funding
Implementation period	Short-medium term (2025-2027)
Monitoring indicators	• Milestones such as assessment of digital services, adoption of standards, testing of standards • No. of digital services which are compliant with standards
Expected impact	Creating quality standards will improve the user-friendliness and efficacy of digital services, which will ultimately improve their use in supporting construction and planning activities and decision-making.
Priority of implementation	High
Bottlenecks/challenges	• Ensuring that quality standards are applicable to all digital services can be a challenge as each digital service has it's own unique characteristics. The standards should take this into account. • Making sure that the quality standards meet current and future needs can be a challenge, which makes it important to incorporate flexibility in the standards and have regular reviews of the standards. • Adopting quality standards on state level, on e-construction platform in particular, can prove difficult.

Action B.4 - Develop centralised service for government notifications/messaging to contact stakeholders/citizens

Relevant stakeholders and citizens are not always aware of recent actions in the (digital) construction and planning sector. Creating a centralised system for the government and local authorities to communicate updates can help keep stakeholders informed in an efficient way.

Action B.4	
Concrete actions to be taken	• **Conduct assessment of needs and preferences** from government stakeholders and private stakeholders (construction/planning sector, citizens) for communication. Identify what specific communication services are needed and in which context (e.g. project alerts/updates, consultation notifications, etc. in the form of SMS, emails, mobile apps, websites, etc.)

Action B.4	
	• Develop **templates/guidelines** for various messages to ensure consistency and clarity in communication for government agencies/local authorities to use • Pilot communication services to test messaging format and content • Integrate construction/planning communication services into the State portal (eesti.ee) • Continue **monitoring and updating** the communication services based on stakeholder feedback
Roles and responsibilities and necessary institutional arrangements	Estonian Information System Authority (RIA), which manages and operates the State Portal
Source of financing	Public funding
Implementation period	Medium term (2025-2028)
Monitoring indicators	• Milestones such as the report on assessment of communication needs/preferences, development of templates, launch of service • No. of messages sent through communication service
Expected impact	Relevant stakeholders and citizens will be better informed of activities relating to construction and planning at a state/regional/local level.
Priority of implementation	Medium
Bottlenecks/challenges	• With all communication services, there is the issue of data privacy and security concerns, in terms of protection of citizen data. • Integration with the State Portal may require significant resources and time • Encouraging citizens/stakeholders to opt-in to messaging services may be a challenge. Attention should be made that services are available for all citizens, including those will limited access to technology. • Misuse of messaging system can be an issue if clear guidelines are not made in how government/local authorities should use it. Having templates/guidelines should help prevent miscommunications

4.3.3 Objective C: Strengthening cooperation and engagement of stakeholders with digital services

The value of digital services not only depends on the technical qualities, but also on the use of the services by relevant stakeholders. To make digital services more easily accessible, several actions are suggested to build upon the existing relevant efforts, including:

- C.1: Reduce fragmentation of spatial decisions between different agencies and institutions
- C.2: Create digital environment for involvement of the public and all parties involved in the building environment to be involved in spatial planning decisions
- C.3: Awareness raising of the usefulness/benefits of digital services and of sharing data/knowledge, particularly for the e-construction platform.

These actions are intended to increase trust among and between stakeholders by creating better communication channels and increase awareness of relevant information and available digital services relating to construction and spatial planning.

Existing policies/actions on Objective C

The Estonian government has already taken several measures to improve cooperation and engagement of stakeholders with digital services, including:

- The Estonian government has developed **National Spatial Planning Concept**, Estonia 2030+, which provides a strategic framework for guiding spatial development across the whole country and governmental levels. This concept aims to create a cohesive and coordinated approach to spatial planning until 2050, considering factors such as transportation, environmental protection, land use and urban development.
- To enable a better understanding of spatial planning and support planning processes a public **spatial planning portal** was launched. The website provides guiding and explanatory documents on spatial planning as well as information on training possibilities.
- The Ministry of Finance established a **National Planning Database** (PLANK), which allows stakeholders to access all kinds of planning documents. Currently, a planning information system (PLANIS) is being developed, which will be a part of the e-construction platform and directly linked to PLANK.
- Additional to the aspects mentioned earlier, **X-Road** is a key initiative to bring together different stakeholders. As such it enables data exchange among several stakeholder groups, i.e. governmental departments, citizens and private sector stakeholders.
- Tartu was the first city to introduce the concept of **participative budgeting** to include citizens actively in the budget designing process. This allows the citizens to decide on how the government should spend 1%, or €200.000, of its year's investment budget. This budget is supposed to be invested on objects like buildings.
- The Ministry of Economic Affairs and Communications launched a webpage on **digital construction**. Besides e-leap, as introduced earlier – it also fosters the collaboration among various stakeholders. For example, it introduced the possibility of displaying network facilities. This asks, among other, network owners to implement their facilities for 5G access points to eventually reduce underground facility demolitions and construction delays due to finding unknown infrastructure.

Action C.1 - Reduce fragmentation of spatial decisions between different agencies and institutions

Fragmentation of spatial decisions creates inefficiencies in terms of redundant efforts across agencies, lack of coherence and consistency which causes conflicts across spatial decisions and limited knowledge/information sharing. To prevent these issues, more efforts need to be made to create communication channels and opportunities for collaboration across agencies and institutions.

	Action C.1
Concrete actions to be taken	• Establish an **inter-agency committee**, which represents the key government agencies and institutions involved in spatial decision-making. This committee will act as a communication channel for sharing information and coordinating collaborations across different departments • Conduct **cross-agency trainings** to increase spatial decision-making skills across departments as well as encourage knowledge sharing.
Roles and responsibilities and necessary institutional arrangements	Agencies to be involved, but not limited to: Ministry of Finance (as the authority for policies and funding relating to spatial planning); Ministry of Regional Affairs (as the authority responsible for sustainable spatial planning); Ministry of Climate (as the authority responsible for economic and infrastructure impact of spatial planning); Land (and Spatial) Board

Action C.1	
	(as the authority responsible for land surveying and maintaining the land cadastre)
Source of financing	Public funding
Implementation period	Medium-long term (2026-2030)
Monitoring indicators	• No. of inter-agency committee meetings • No. of cross-agency trainings
Expected impact	Improve communication between agencies concerning spatial planning issues to improve consistency and efficiency in planning processes
Priority of implementation	High
Bottlenecks/challenges	• Competing interests between agencies and resistance to change may lead to disagreements in how spatial planning decisions are made. However, this makes having inter-agency discussions more important to create more consensus across agencies

Action C.2 - Create digital environment for involvement of the public and all parties involved in the building environment to be involved in spatial decision making

A simple and user-friendly digital environment can encourage more involvement of relevant stakeholders, particularly citizens, to be informed and more involved in the spatial decision making process. Through such an environment, stakeholders can not only provide feedback on new developments, but also participate in the data collection process of the current environment. This potentially can be integrated into the e-construction platform.

Action C.2	
Concrete actions to be taken	• Set up a **working group with relevant stakeholders** (citizen-led organisations, architects, engineers, local authorities) to provide input in what is needed for a digital environment for spatial decision making • Develop online platform (integrated into the e-construction platform) to access and update information on ongoing spatial planning projects as well as provide input/feedback and add relevant information about the current environment. Features of the platform will be contingent on the results of the working group. The PLANK database, managed by the Ministry of Regional Affairs, which allows stakeholders to access plans, but not interact with them, should be the basis of the platform • Pilot the platform with a representative sample of intended users, potentially for specific municipalities/regions • Launch the platform nationally, potentially launching separate platforms for each region/municipality. Coordinate with RIA to integrate platform updates into the centralised communication services of Action B.4. • Maintain and update platform based on user feedback
Roles and responsibilities and necessary institutional arrangements	• Ministry of Regional Affairs and Agriculture as the main responsible actor in developing the platform as the developers of PLANK and PLANIS (together with Ministry of Climate). • Specific municipalities/regions to support piloting of platform • Involve RIA in integrating platform updates into the centralised communication service
Source of financing	Public funding, potentially using EU funds, such as, ERDF, DIGITAL or Horizon Europe, as an investment in digital infrastructure
Implementation period	Medium term (2025-2027)
Monitoring indicators	• No. of workgroup meetings • No. of monthly users of the online platform(s)

Action C.2	
	• Milestones in terms of launch of (piloted) online platform(s)
Expected impact	Increase in involvement of stakeholders, particularly citizens, in spatial planning decisions
Priority of implementation	Medium
Bottlenecks/challenges	• Ensuring that all views of relevant stakeholders are represented can be a challenge, as some groups may have better access to participate than others, leading to a bias in decision-making • More public involvement can lead to more diverse and conflicting views, which can make finding a consensus on spatial planning decisions difficult and cause delays in projects • If relevant information is not communicated clearly or involvement is perceived as an extensive time/effort commitment, stakeholders may feel discouraged to participate

Action C.3 - Awareness raising of the usefulness/benefits of digital services and of sharing data/knowledge, including information campaigns for e-construction platform

In order to ensure that the intended users of digital services are aware of the value of these services, there needs to be more outreach to relevant stakeholders to showcase the usefulness of existing/new digital services. This outreach should be both constant, in terms of dedicated resources online which promote digital services and private-public collaborations, as well as intermittent, in terms of events such as trainings and workshops.

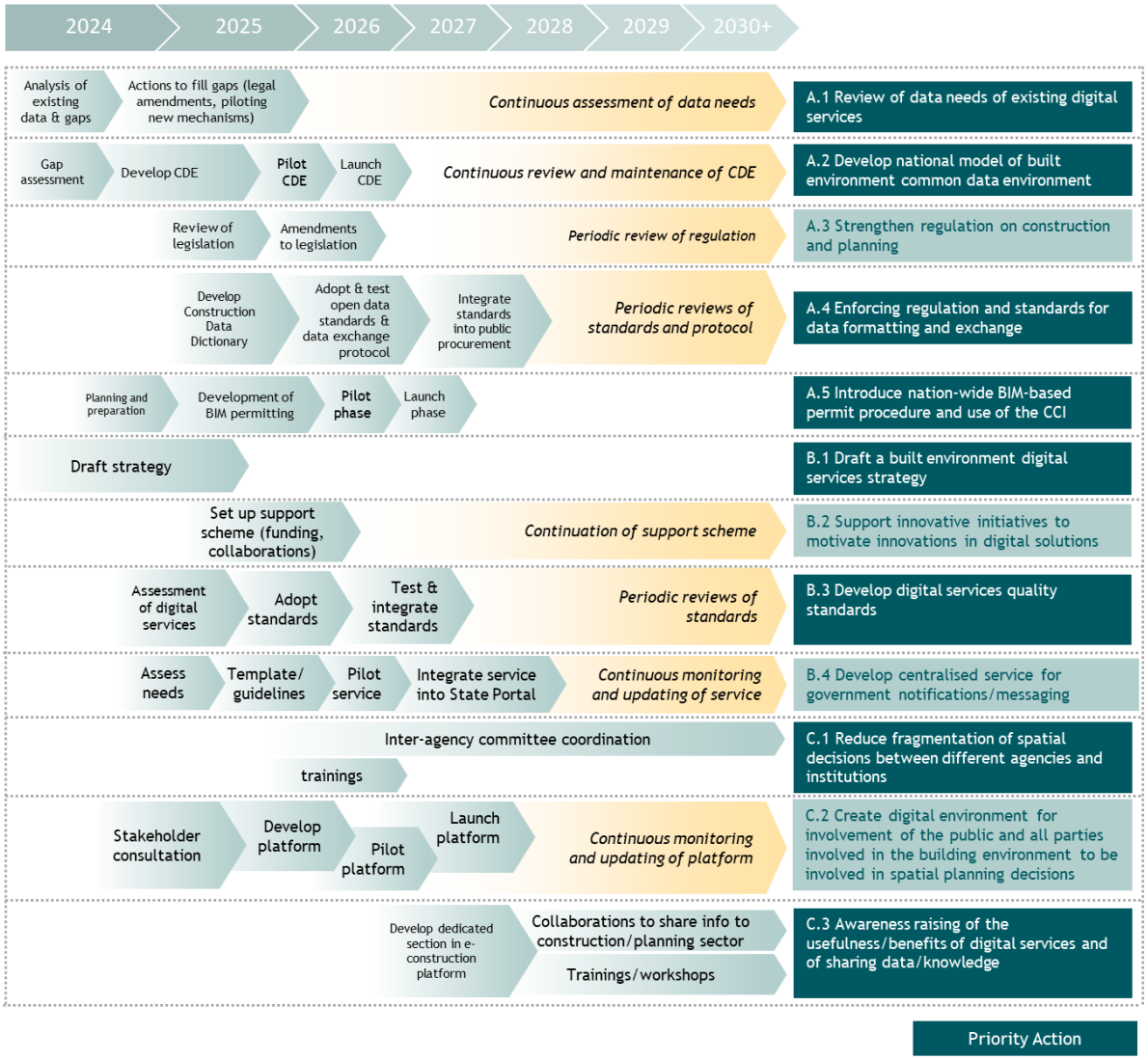
Action C.3	
Concrete actions to be taken	• **Develop dedicated section in the e-construction platform** (similar to the MEAC website) to provide information about the general construction digital services available and the user stories / features of the e-construction platform • **Collaborate with associations in the construction industry (architects, engineers, etc.) as well as local municipalities** to share information and promote the adoption of digital services and the e-construction platform. Particularly emphasizing the use of digital solutions to tackle everyday issues relating to construction and spatial planning • **Organise trainings/workshops** with government/ municipal employees, engineers, architects, etc. to showcase digital services and the e-construction platform. For municipal employees it is critical for the government (Ministry of Climate) to a) arrange workshops and b) provide safe environment (forum) for discussion/distribution of business practices so that the private sector would get harmonized and high quality service across Estonia from them (significant quality differences exist currently between even neighbouring municipalities)
Roles and responsibilities and necessary institutional arrangements	• Ministry of Climate (formally MEAC's responsibility) to manage awareness raising efforts • Construction industry associations and local municipalities to facilitate sharing of information and promote digital services to relevant stakeholders
Source of financing	Public funding
Implementation period	Medium-long term (2027-2030)
Monitoring indicators	• No. of gov. website pages developed to promote digital services/e-construction platform

Action C.3	
	• No. of associations in collaboration to promote digital services/ e-construction platform • No. of workshops/trainings held
Expected impact	Increase the number of users for digital services, particularly the e-construction platform
Priority of implementation	High
Bottlenecks/challenges	There can be some resistance from stakeholders to change the status quo, which requires learning how to operate new digital services such as the e-construction platform. Workshops/trainings should help user become acclimated with the platform.

4.4 Roadmap for action plan

The figure below provides a timeline for all of the actions for the three objectives, identifying which actions are considered a priority. Most legal actions and required assessments are to occur in the short term (2024-2025), whereas the developing and piloting of various digital services and data processes are to occur in the medium term. Once these actions have raised the quality of data and digital services, then awareness raising can follow, which occurs after 2027. Many of these actions require continuous efforts after the initial actions in terms of continuous assessment and monitoring of the processes set up.

Figure 4-2 Overview of the timeline and priority of actions



5 Conclusions and general recommendations

5.1 Conclusions

In order to further develop e-construction services in Estonia, an action plan has been devised to address the following objectives:

A. Improving the usefulness and quality of data;
B. Improving the usefulness and quality of digital services; and
C. Strengthening cooperation and engagement with digital services.

Several actions have been suggested, which target each objective, where the most important actions are in **bold**:

- **A.1: Reviewing data needs of existing digital services**
- **A.2: Developing national model of built environment common data environment**
- A.3: Strengthen regulation on construction and planning to clarify data ownership and responsibility and legal means of ensuring data quality;
- **A.4: Enforcing regulation and standards for data formatting and exchange**
- **A.5: Introducing nation-wide BIM-based permit procedure and the use of the CCI (Construction Classification International system).**
- **B.1: Drafting a built environment digital services strategy (including state and municipality actor levels);**
- B.2: Supporting innovative initiatives to motivate emerging innovations in digital solutions;
- **B.3: Developing digital services quality standards (setting up feedback/monitoring mechanisms, UX/UI design, user guides) based on international standards;**
- B.4: Developing centralised service for government notifications/messaging to contact stakeholders/citizens;
- **C.1: Reducing fragmentation of spatial decisions between different agencies and institutions;**
- C.2: Creating digital environment for involvement of the public and all parties involved in the building environment to be involved in spatial planning decisions; and
- **C.3: Awareness raising of the usefulness/benefits of digital services and of sharing data/knowledge, particularly for the e-construction platform**.

Where ultimately, these actions are intended to enhance the ability of e-construction services to aid and encourage the use of digital services in the construction and spatial planning decision-making process

5.2 Recommendations

Based on the recommended actions, a roadmap has been developed which details the timeline and priority of the actions (Chapter 4.4). Below, a few overall recommendations have been made, which summarise the overall intention of the action plan.

5.2.1 Recommendation 1 – Ensure high quality of data by standardising data processes and increasing stakeholder involvement

A major barrier for digital services is the lack of trust that stakeholders have for the underlying data. Key steps for Objective A involve regulating data processes in such a way which creates greater consistency in data generation, collection and storage (via developing a national model in a CDE (Action A.2); stronger data management regulation (Action A.3); enforcing standards (Action A.4); BIM-based permitting together with developing CCI (Action A.5)) as well as improves more efficient transfer of data (via data exchange protocols (Action A.4). By setting up these structural guidelines and regulations on data, there is more transparency on data processes which ultimately make this data more reliable for stakeholders to use in construction and spatial planning decision-making.

Additionally, there needs to be greater stakeholder involvement in terms of deciding what data is needed (via *Review of data needs* (Action A.1) and how data formats and data exchange should be standardised. Their involvement is crucial not only to ensure that the data used is of value for their decision-making, but also that there will be greater compliance of the protocols and regulations set up.

5.2.2 *Recommendation 2 – Develop a long-term vision for digital services for construction and planning*

In order to improve the quality of digital services used for construction and spatial planning (Objective B), a long-term vision needs to be created in terms of developing a built environment digital services strategy (Action B.1), setting up quality standards for services based on international standards (Action B.3) and exploring new innovations in digital solutions (Action B.2). These actions are intended to create a clear signal to stakeholders how digital services will evolve to ultimately support decision-making for construction and spatial planning more efficiently and effectively. In this sense, there should be a move towards knowledge-based thinking, where there is a shift from *information*-centric approach towards an *insights*-centric approach which focuses on using data and digital solutions to facilitate decision-making and foster collaboration throughout the entire lifecycle of buildings and spatial planning projects.

5.2.3 *Recommendation 3 – Strengthen stakeholder involvement and cooperation in the entire lifecycle of buildings/spatial planning*

Once digital services and the underlying data are of high quality, stakeholders need to be sufficiently and continuously engaged to be able to effectively use digital services in their decision-making. This not only entails awareness raising campaigns (Action C.3), but also setting up complementary digital services/environments for stakeholders to not only be informed (Action B.4), but also have a say in decision-making (Action C.2). However, a prerequisite is a coherent and consistent strategy for spatial decision making amongst those already involved in decision-making (government agencies and institutions), which requires greater communication and knowledge-sharing across these agencies (action C.1).

5.3 Further analysis required

For several actions, further analysis is required to have a comprehensive understanding what how the quality of data and digital services needs to be improved to support the development of construction sector and high quality spatial planning. This additional analysis includes:

- Analysis of existing databases used in digital services and the remaining gaps in data coverage (A.1 – *Review of data needs of existing digital services*)

- Assessment of current data models and gap analysis (A.2 – *Development of national model of build environment, common data environment*)
- Review of existing Estonian and EU legislation relating to data ownership and responsibilities relating to construction and spatial planning (A.3 – *Strengthen regulation on construction and planning*)
- Analysis of current data formats and dataflows (A.4 - *standardisation of data formats and synchronisation of dataflows*)
- Comprehensive analysis of existing digital services (including regional level), also looking at the current user-experience and international standards for digital services (B.1 – *Drafting of a built environment digital services strategy* and B.3 – *Development of digital services quality standards*)
- Assessment of needs and preferences for a government communication service to contact stakeholders/citizens (B.4 – *Development of centralised digital services quality standards*)

Annex - Workshop minutes

Workshop 1

Agenda

Time	Agenda point	Presenter
9:00-9:30	Registration and coffee	
9:30-9:40	Welcome and introduction to the workshop objective and sessions	Jüri Rass (Ministry of Climate)
9:40-10:00	Presentation of the EC-funded TSI project[38] with focus on Deliverable 6	Irati Artola (Trinomics)
10:00-11:00	Break-out session 1 – Assessment of current digital e-construction services and spatial development digital services	Jüri Rass (Ministry of Climate) Roode Liias (TalTech) Moderated by: Jaan Saar, Taavi Jakobson and Emlyn Witt
11:00-11:15	Plenary – Debrief of Break-out session 1	Jüri Rass (Ministry of Climate) Rapporteurs / table moderators
11:15-11:30	Coffee break	
11:30-12:30	Break-out session 2 – Assessment of emerging digital e-construction services and spatial development digital services	Jüri Rass (Ministry of Climate) Roode Liias (TalTech) Moderated by: Jaan Saar, Taavi Jakobson and Emlyn Witt
12:30-12:45	Plenary – Debrief of Break-out session 2	Jüri Rass (Ministry of Climate) Rapporteurs / table moderators
12:45	Closing remarks	Jüri Rass (Ministry of Climate)

Participants

Besides the project team, presenters, and moderators of the break-out sessions, attendees were the following:

- Kristi Grišakov (RAM, RUPO)
- Kalle Toomet (Eesti Linnade ja Valdade Liit - ELVL (The Association of Estonian Cities and Municipalities))
- Kea Siidirätsep (ET Infokeskus AS)
- Maili Hirlak (Maa-ameti geoportaal (Land Cadastre))
- Kermo Mägi (RAM)
- Rasmus Kask (Ministry of Climate)
- Hele-Mai Metsal (Tallinna Sadam (Port of Tallin))
- Alex Roost (Silikaat Grupp)
- Tiit Hion (Digitaalehituse klister (Digital Construction Cluster))Kristel Uibo (Digitaalehituse klister (Digital Construction Cluster))
- Regina Viljasaar-Frenzel (Ministry of Climate)
- Siim Puskar (Ministry of Climate)

[38] Coherent policy development for high-quality and sustainable living environment in Estonia

Main take-aways

BREAK OUT SESSION 1	
What is the users' experience in using the existing services?	• There are serious quality issues for building data including inconsistencies between data relating to the same objects. • There are issues relating to where the data have come from – whether these are from aerial photos (as in the case of the Land Board), documents, etc. • The problem of how to integrate data from different sources. • Different organisations seem to be speaking different languages and have different priorities. These priorities also change in time and the data requirements change with them. • The UI/UX of services is different and often cumbersome. The Building Registry has been designed with the municipality officials in mind. It's difficult for industry experts to navigate and make sense of all the data/documents. UI/UX should be constantly monitored by service owners. • You have to open many windows/tabs and you quickly lose track if you for example want to get an overview of several buildings on one property. • Some documents are just for administrative purposes but they don't add much value to owners and general public. Search functionality is very weak. • The 3D twin is a good example of how different data sources are combined to give a better overall picture. But some of the services are new and lack some data. You can view spatial plans from the planning registry (PLANIS) but only a fraction of the zoning plans are in the database. Utility network zones and restrictions are visible but not the owners of those utilities (who should I contact?). The utility network database (VRA) provides a solution but the system is not operational yet and it will take time to collect all the necessary data in the database. • In general Estonian common services (e.g. SmartID) support the overall user experience, Landboard maps good, Building Registry's UI complicated (experience from 2 years ago and the user was not aware of the recent complete makeover of the system). • One of the common problems is: where to find the information, e.g. noise measurements? • The Building Registry is merged with municipalities in the mind of users (e.g. they speak about Building Registry's comments not realizing that these comments and requirements are entered by local municipalities' officials, Fireboard and other officials). Is it a problem or opportunity? Or rather - how it could be utilized as an opportunity?
How reliable are the provided services? What are your ideas for improvement?	• A good example is the national statistics database, where in recent years, data definitions and collection have been standardised. • Some basic "must have" data should be of guaranteed reliability. What are the "must have" data – these need to be agreed • A common database is needed and this should be developed together, at least for the basic use-cases. • Consideration should be given to the whole ecosystem of users and use-cases. For example, in urban environments, consideration of individual trees makes sense, in forested areas, it doesn't. • Reliability and quality measurement must be appropriate for what the data describe and how they are used. It can be linked to users' satisfaction. • Quality and reliability standards need to be agreed and there are clear limitation differences between public and private buildings data, for example. • Reusing and co-using data.

BREAK OUT SESSION 1	
	• The biggest issue is the underlying data. You can't trust the data from the Building Registry. Who is the owner of the data? It should be the municipality and property owners but neither of them really feel ownership/responsibility for data accuracy in the Building Registry. • It seems that the Land Board cadaster is one of the databases that is perceived by the industry as more trustworthy and accurate. • Geodesists must constantly re-check information downloaded from Land Cadastre due to errors. • Full checking of all the data against real life would be extremely costly for taxpayers and would slow the processes. • It is also to understand what "correct data" means in each system. E.g. in the Building Registry information is correct if there is a document signed off by a competent institution proving the correctness. This creates differences between data in the registry and real life (timing differences, illegal or undocumented construction, …). However, the users tend to judge correctness based on how the data matches the real world. • What would help: 1. Adding information about estimated preciseness/source of the data (e.g. Building Registry's Infrastructure Registry will have all the underground data objects rated from A = "measured onsite with precision tools", i.e. data is correct to a few millimetres to D = "information from old maps", i.e. the cable or other object is in the range of 10m from where it is marked); 2. To get information fixed: o Errors in data must be easily noticeable, e.g. it is easy to see on 3D map if there is no height information added to a building; o Fixing information must be easy, i.e. information that exists in databases should not be entered again (only if it needs updating); what can be entered in discreet categories should be done so; amount of information to be entered should be limited; UI should be simple; o Errors should be avoided by sanity checking and cross-checking of data (e.g. the new Building Registry has 300+ automatic checks that either stop wrong data to be added, e.g. for 1000m hight for a building or warns the user to review entry e.g. for 50m hight) o Users must be motivated to update the data. Here the market plays its own role: banks, insurances, public notaries when the building is sold, etc require correct information but it can be further amplified by transparency + crowdsourcing information for discrepancies etc. 3. Information in different databases should be brought together by services – for construction and spatial planning this place should be e-construction platform. 4. As seen from the feedback collected from the field communication is needed to let public know about the developments that have taken place in the public systems.
How have digital services influenced everyday activities?	• Digital services have influence daily life a lot, everybody relies on digital services but the multiplicity of different systems is making life complicated • Government e-services have made a huge positive change for everyone. • Many business services have been greatly simplified. • Data can also be simply and conveniently downloaded as needed. • The Land Board database has made all aspects of spatial planning much easier.

BREAK OUT SESSION 1	
	• Checks on details in many aspects of work can be made from one's desk, one usually doesn't have to drive somewhere to check physically. • Increase of efficiency but we should not stop here or go only for efficiency. The tools can really democratize the data and significantly increase true and meaningful involvement of citizens into the questions of local development.
What are the challenges faced by the E-construction platform?	• Definitional issues around buildings, construction entities, etc. and their importance for the living environment. • Competitiveness between different public agencies / different "owners" of data. • Challenges with measurement / data collection • Breaking down the different data / organisational / professional "silos" • Different platforms, different users, different use cases, different sources, different scales. • Data collection and curation – measurement issues, validation issues, scale issues, quality issues and who pays for all these? • Data protection • Data requirements change in time. • The danger that e-platforms might be thought of as solutions to societal problems in their own right, while they are really just tools for enabling solutions. • Trust – can you trust the data provided by services on the e-construction platform? We need to have good data collection and management principles implemented so that we could improve data quality (up to date, accurate, trustworthy…) • Communication. Getting the word out about new services and possibilities is also a challenge • When consolidating data from different sources it is important to "speak the same language" – to adhere to same standards/classifications. • It is also mandatory to move away from documents-based thinking (thinking that pdf is "digital enough") and processes to data-based thinking. Only when data is machine readable and standardized, we can utilize machine aided processes (e.g. automatically checking if the planned building fits into the area designated in the spatial plan – already by architect before sending the application to municipality) and showing the information to the recipients in the format suitable for them to review it (e.g. spatial data can be represented in coordinates, surface calculations, vectors, …, or as a 2D or 3D picture – all necessary for different purposes). • The next step is to move from data-based thinking to knowledge based thinking.

BREAK OUT SESSION 2	
Which gaps in data management need to be covered to assure high quality living environment?	• Maintenance of the living environment requires much more and different data than is currently available. • For the zero carbon / circular economy future, not enough / not up-to-date / not the needed data relating to (building) materials and their future reuse exists (the concepts pf materials passports and buildings as material banks). • The differences between the intentions and decisions (which are reflected in the data collected) and what is actually done (the data required

BREAK OUT SESSION 2	
	• We need to define and prioritize the data objects related to the built environment. Which data is important for what kind of buildings? This data needs to be accurate and as up-to-date as possible. • We need to have a holistic view on all the data we collect related with the built environment, ie. a built environment data space. This should ideally be managed by one organization – hopefully the land and spatial agency (MaRu) in the future. • We need to better communicate and acknowledge the importance and value of data. Currently government agencies don't understand the importance and don't make the necessary investments for proper data management. • It is important to adhere to the "once only" principle not only in the information systems but in the wider context. E.g. when the information that is entered to the Building Registry is also duplicated in the explanatory letter and again duplicated on the drawing, it does not only mean waste of time but also a source for errors. So in some cases the process should be turned around. Following the same example – assuming that the explanatory letter is still required the process could be: the architect enters information into the Building Registry, utilizing as much as possible the information already there and the explanatory letter is automatically generated by the system. A lot of information in creative processes is not quantifiable but it is not a problem. The architect can enter e.g. their concept or idea behind a building on one unstructured data field. This can he then added to explanatory letter, saved to Building Registry's database, can be distributed to the construction company (so that the bricklayer knows that they are building a cathedral) visualized in 3D twin for everybody to see as the architect's message. It would make sense to consider crowdsourcing for obtaining "sanity check" information to focus data correction activities.
Which tools need to be introduced to improve the quality of information management in the sector?	• Data quality always requires people and people cost money. There is also the issue of what is quality and for whom? What are the objectives of the potential data use cases (living quality / aesthetics / energy efficiency / environmental considerations) and what is important for different users / managers. • The main objective of the Building Registry is to support the processing of various applications and supervision activities. It also supports policy making but this does not have any legal justification for data collection, at least not in current legislation. We need to better define what kind of data and why the government is collecting. • Automatically collected data can be quality checked to some extent through crowd-sourcing – this is a question about who is interested in using the data and how / for what. • Feedback panels in the user interface (which are well-advertised) enable problems to be flagged / improvements to be made. • Data collection from satellite images and from aerial photographs were compared and these could be more sensibly used if single solutions were sort for the whole government rather than individual agencies arranging their own procurements of services. • The use of AI (image recognition) in conjunction with satellite / orthographic images is currently used for identifying solar panels, buildings, roads, etc. but this can be developed further. • Mobile data collection.

BREAK OUT SESSION 2	
	• More use of pictures in data collection. • We also need to understand the business value of collected data. • The tools for citizens' involvement need special attention because in addition to helping to create better quality space these also motivate people to participate in "simpler" tasks like correcting their data – when they see that this really makes a difference. These tools start from simple notifications when something happens in the neighbourhood to visual (3D) tools that help people to understand what is changing and how this might affect them to tools that enable feedback in as easy way as possible (including simple drawings or 3D models) to transparency that shows how their feedback impacts the decisions. To take the next step in the spatial data revolution we must move from data to knowledge. This transition must be supported by systems, both technical (IT) and organizational. • Regarding tools, the building logbook should be further developed so that it becomes a practical tool for maintenance activities. Predictive maintenance and pro-active recommendations for asset owners. A well-maintained building has more value. • Current business models don't support proper data handover for facility management. Developers are not interested is managing, they just want the project handed over.
Who should be the target of the new services?	• Authorities (local and national) are the most obvious and simplest user groups. • Apartment associations' needs are also relatively easily understandable but it depends on the individuals that they are representing (the apartment owners). • Many different kinds of interest groups (e.g. dog owners) • General public, everybody as everybody is impacted by our built environment.

Workshop 2

Agenda

Time	Agenda point	Presenter
9:00-9:30	Registration and coffee	
9:30-9:40	Welcome and introduction to the workshop objective and sessions	Jüri Rass (Ministry of Climate)
9:40-10:00	Presentation of the EC-funded TSI project[39] with focus on Deliverable 6 *AND* Presentation of the overall action plan (overview of the barriers - objectives)	Nora Cheikh (Trinomics)
10:00-11:00	Break-out session 1 – Technical objectives - Improving the efficiency and usefulness of digital services	Roode Liias (TalTech) Nora Cheikh (Trinomics) Moderated by: Jaan Saar, Rasmus Kask and TBD
11:00-11:15	Plenary – Debrief of Break-out session 1	Roode Liias (TalTech) Rapporteurs (Jaan Saar, Rasmus Kask and TBD)
11:15-11:30	Coffee break	
11:30-12:30	Break-out session 2 – Social objectives: Making digital services more easily accessible and strengthening cooperation between stakeholders	Roode Liias (TalTech) Nora Cheikh (Trinomics) Moderated by: Jaan Saar, Rasmus Kask and TBD
12:30-12:45	Plenary – Debrief of Break-out session 2	Roode Liias (TalTech) Rapporteurs (Jaan Saar, Rasmus Kask and TBD)
12:45	Closing remarks	Jüri Rass (Ministry of Climate)

Participants

Besides the project team, presenters, and moderators of the break-out sessions, attendees were the following:

- Christopher-Robin Raitviir (Ministry of Climate / Tallinn Municipality)
- Regina Viljasaar-Frenzel (Ministry of Climate)
- Alex Roost (Remicon OÜ)
- Tambet Tiits (Maa-ameti geoportaal (Land Cadastre) – only first session)
- Kaie Kirss (Reminet OÜ)
- Ivo Jaanisoo (Ministry of Climate – only second session)
- Hele-Mai Metsal (Tallina Sadam (Port of Tallinn))
- Tiit Hion (Digitaalehituse klister (Digital Construction Cluster))
- Siim Puskar (Ministry of Climate)
- Sulev Õitspuu (Maa-ameti geoportaal (Land Cadastre))

[39] Coherent policy development for high-quality and sustainable living environment in Estonia

Main take-aways

BREAK OUT SESSION 1		
	Objective A: Improve efficiency of digital services	***Objective B: Improve usefulness/quality of digital services***
How well do the objectives presented align with the overall visions and goals in terms of improving technical aspects of digital service?	There should be a clearer distinction between Objective A and B. s many actions within both objectives are linked thematically to either data or services, a better categorization would follow suite. We suggest that Objective A should be named "Improved quality and usefulness of data". All the participants agreed that data quality is the foundation of good quality services and reinforces cooperation between parties. Current problems in the digital domain arise from untrustworthy and incoherent data. Also, in terms of the overall vision, quality of data was the nr. 1 focus theme in e-construction vision document.	While good quality of available data provides the grounds for digital services, usefulness, accessibility, customized experiences and strive for constant improvement ensure, that maximum value is provided to the end-users. Since the digital services are offered by a multitude of service providers, it is less clear on how to achieve meaningful improvements across the field of built environment. The general consensus is that for private sector, using feedback and constantly improving service quality is a matter of survival and profit, so the focus of improvement should be on the public sector practices. We recommend adding the quality "accessibility" as part of objective B name, as it is tightly linked to usefulness and quality.
Do you consider the proposed set of actions adequate in achieving the objectives? If not, what measures are missing?	BIM-permit procedure has too much reference to construction permits. We should be talking about automating processes in more general terms. We should start with planning and it should cover the whole building lifecycle. This should also include environmental impact assessments and other relevant reports/analysis/assessments. BIM and GIS data transfer issues are mostly related to software. Data flows between different systems (not just BIM/GIS) are insufficient and there is little integration between the systems. We should avoid using the GIS and BIM acronyms altogether as this is too detailed. "Pilot data precision rating system" is an unclear term. The problem is not the precision of data but the correctness and trustworthiness. What is missing: The importance to standardize data exchange formats and methods – implementing a common language across when we are talking about developing our living/built environment. Following the renaming of the objective, a mixed set of actions from	The headline for the objective should be "Improve usefulness/quality of digital services and data" A good service starts from good data. It's good that the importance of common standards is mentioned. We recommend adding "common international standards" as we should not be developing EE specific standards. Monitoring & feedback is important as well. Services should adapt to the needs of the users – the most relevant parts should be at the forefront so the users understand the value more easily and quicker. Additional recommendation for gov developments: There should be a centralized service for government notification/messaging to contact people. This is not an problem only for our field but a general problem for the whole e-government. Suggested to shift some actions from objective A and C, and to combine some actions under a more general action (B.3. and B.4.):

BREAK OUT SESSION 1		
	the original A and B objectives were agreed upon by the participants: 1) Survey of data needs – there is a clear need for a comprehensive broader view of data needs within the field of built environment through-out the life cycles on the level of state, local municipalities, and private sector parties. Currently various individual bodies govern their own data sets and there is a lack of cooperation, lack of shared concepts of data governance and quality. Importantly, there must be priorities put forth, as not all needs can be met simultaneously. It will be a difficult task, as there are many involved parties and conflicting needs, but emphasis should be placed on finding common ground. 2) A national model of built environment common data environment (CDE) – coming to an agreement of a shared ontology, classification systems (CCI), technological interoperability and common ground with international standards. This action reflects on the original O A.4. "Pilot data precision rating system" as it should also entail standards and guidelines of ensuring data quality for data governing organisations and O A.2. principle. 3) Strengthen regulation to clarify data ownership, responsibilities, and legal means of ensuring data quality – the legal aspects of data gathering, storage and dissemination must be reviewed and if need be, adjusted to accommodate fulfilling data needs and functionalities of the CDE model. This action also includes solving questions of anonymizing data and use of aggregated data for research. 4) Synchronization of dataflows – it was agreed that dataflow synchronization is of key importance, but not only between GIS and BIM models, but all types of data throughout the lifecycle of built environment.	1) Drafting a built environment digital services strategy (including state and municipality actor levels) – a minimal set of current and future digital services in the field of built environment must be mapped out. This avoids duplication, ad hoc development of services, addresses yet unfulfilled needs and sets clear long-term priorities. 2) Support for innovative initiatives (open data, service platforms, public-private cooperation) – all participants agreed that all the digital services, that can be offered by the private sector shouldn't be made by public sector. Main role of the public sector is to make good quality data and platforms available, nurturing a standardized playing field, focus on digital public services and support cooperation with private sector parties (e.g., offering platforms to and in return getting data from private sector). 3) Digital services quality standards – public sector digital services are currently considered cumbersome to use. To improve their quality, standards should be put into place and best practices shared including (but not limited to) UX/UI design, monitoring feedback, agile development, more easily comprehensible user guides (where needed) etc. 4) Customized user experience based on stakeholder type – though this action could be seen as subtopic of digital services quality, it is important to emphasise the particular needs of end users, to understand their use cases and design services accordingly.

BREAK OUT SESSION 1		
	5) Improvement of data governance practices – as standardized methods of ensuring data quality are worked out within action 2, there has to be a consistent effort of data quality improvement and oversight for meeting set goals.	
Which actions do you consider a priority?	Group 1: Actions 1 & 3 ("Nation-wide BIM-permit procedure" and "Support data flows between GIS and BIM"). Actually it would be better to combine these actions. Action 2, the once-only principle – if this is what is meant? Action 4, improving the correctness and trustworthiness of data -- Group 2: The action list in Q2 is presented in the order of priority	Group 1: Action 2, standardization and accessibility Action 1, why we need this or that type of data? Actions 3 & 4, which should also be combined maybe. -- Group 2: The action list in Q2 is presented in the order of priority
Can you tell the timeframe when you think each of these actions are required (short/medium/long term?)	Action 1 and 2 are research projects setting the base for following actions, they should be taken in the short term. 3, 4 and 5 actions are implementations of 1 and 2, 3 should be undertaken in medium timeframe, 4 and 5 are continuous actions.	Action 1 and 2 are research projects setting the base for following actions, they should be taken in the short term. 3, 4 and 5 actions are implementations of 1 and 2, 3 should be undertaken in medium timeframe, 4 and 5 are continuous actions.
Do you consider these actions feasible? Are there any concerning challenges/risks related to these actions and if so, are there any suggestions for mitigating these risks?	Main risks we discussed were loosely linked to other actions: - If there is low awareness and understanding of the benefits of data quality management, these projects will not be funded and cooperation with stakeholders will be difficult. - Creating a CDE needs cooperation of and time-investment from many parties from state, municipality, and private sector level. Actions of objective D are paramount in achieving the goals of objective A. - There is no single institution or body supervising and enforcing the creation of built environment CDE. Achieving improved data quality is a joint effort, but someone has to take the central, leading role.	The main risk in improving usefulness, quality, and accessibility is that the public sector institutions responsible for various digital services, do not or only partly adapt strategies and standards. Providing and improving digital services is the responsibility of the service providers and it might prove difficult to improve systematically and centrally said qualities.

BREAK OUT SESSION 1		
	Motivating third parties (private sector, individuals) to hand over good quality data might prove difficult. A mixed methodology of enforcement and nudging techniques should be explored.	

BREAK OUT SESSION 2		
	Objective C: Make digital services more easily accessible	***Objective D: Strengthen cooperation amongst stakeholders***
How well do the objectives presented align with the overall visions and goals in terms of improving technical aspects of digital service?	These objectives (C and D) should be combined, we don't see a reason to differentiate them. Therefore the comments are in just one column. As two of the three actions start with "awareness" rising in turn related to communication and "accessibility" is more akin to a quality of services, we recommend changing the objective name to "Improve the awareness of digital services and their benefits". In terms of overall goals, many participants voiced the idea that good data is a precondition for good services and when an adequate quality level has been reached, the bottleneck of adopting digital services shifts to awareness and communication.	Cooperation between stakeholders throughout the lifecycle of built environment is considered an integral part of overall goals.
Do you consider the proposed set of actions adequate in achieving the objectives? If not, what measures are missing?	Regarding communication it is important to emphasize the benefits that the services provide. Communication should be targeted for specific stakeholder groups and use-cases. "Strengthen intellectual property protection" – this is misleading and should be taken out. There is plenty of legislation. This is not a topic. We need to build **trust** between stakeholders and understand that we are all in the same boat. We need to look at the bigger picture and better communicate how different stakeholders influence each other.	Nr 1. Action ("Strengthen intellectual…") was considered irrelevant to the objective by participants. Some proposed that the current regulations are too stringent already and present a challenge for open access to and ease of use of data. Action nr. 5. is related to data and should be part of objective A, action 6. respectively Objective C. It was unclear what was meant with the last point, so it was omitted.

BREAK OUT SESSION 2		
	Involvement in spatial-decision making – we need to develop a simple and easy to use digital environment for managing spatial decision processes. Not just for getting better feedback regarding new developments but also for collecting data about the current environment. Proposed that the quality of digital services must be of high level before starting communication projects.	
Which actions do you consider a priority?	Group 1: D4 – reduce fragmentation of spatial decisions at government level. D3 – spatial-decision making environment. C3 – awareness of raising of the usefulness of digital services. -- Group 2: Priority of actions should be as follows: 1) Awareness raising of the usefulness of digital services and of sharing data/knowledge 2) Awareness/training resources for universal digital language (with an emphasis on specialists rather than end users) 3) Information campaigns for e-construction platform and other digital services	Priority of actions should be as follows: 1) Reduce fragmentation of spatial decisions within and between different agencies and institutions. 2) Increase participation of all built environment lifecycle parties (from planning to maintenance) for improved 3) Increase involvement of public in spatial decision-making 4) Incorporate real-time collaboration and develop technology tools for collaboration
Can you tell the timeframe when you think each of these actions are required (short/medium/long term?)	Awareness raising is a medium to long term goal that must be done systematically. Information campaigns are means to an end, short term endeavours.	All the actions are of medium to long term timeframe.
Do you consider these actions feasible? Are there any concerning challenges/risks related to these actions and if so, are there any suggestions for mitigating these risks?	Some stakeholders have their own agenda and don't want to be involved in making any changes – they are against all kind of changes and only want to argue. It is very difficult to involve them in developments because they just want to fight against any development. The spatial decision making environment should be a good communication tool for mitigating this.	Continuing fragmentation of decision-making processes within planning system was seen as the main risk to strengthening collaboration. Institutional silos with their individual interests and goals in mind leads to the planning system becoming a battlefield rather than a collaboration.

BREAK OUT SESSION 2		
	End users and their expectations are not at the focus of developing digital services, but the data needs of state or municipalities. This risk is mitigated by B.4. Ease-of-use of various current digital services provided by the state emerged as the main stumbling block for awareness rising. If a website or a platform needs a user manual, it should be improved before communication campaigns can be undertaken.	