INCREASING THE EFFICIENCY OF THE LITHUANIAN CONSTRUCTION SUPERVISION SYSTEM

Output 2: Summary report on data analysis findings presenting the methods used and the main findings in terms of risk and non-compliance predictors.

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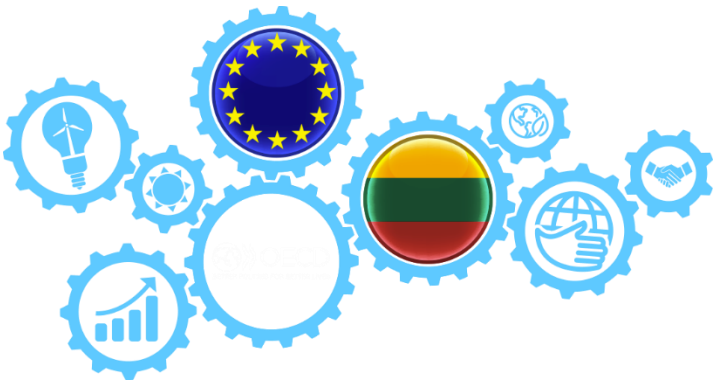

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- Reduce manual input of data in all linkages of regulatory work from permitting, through construction inspection, to construction completion, and in-use inspections. Digitalisation of the whole process using emerging technologies would improve accuracy, standardize data input, enhance efficiency of staff allocation, reduce costs, and improve data analytics.
- Provide digital capability to authorities and other stakeholders of the construction sector. By providing training and apprenticeship programs on digital technologies, it would be possible to improve their efficiency and productivity, while preparing integration in an increasingly digitised regulatory system.

2. Integrate existing and new technologies to support digitalisation

- Reorganise a centralised digital platform for all building permits in a way that transparency and efficiency are enhanced. This would reduce waiting times, avoid duplicated work from different governmental agencies, reduce lack of information, and facilitate the follow-up of requests.
- Improve integration among regulatory services. A comprehensive data sharing framework should be developed to enable seamless sharing of data among different authorities and stakeholders in the construction sector.
- Introduction of new technologies: regulatory bodies could introduce digital technologies, such as Internet of Things (IoT) sensors, drones, or artificial intelligence (AI) to collect and share data about construction projects. However, regardless of the specific technology used, it is important to establish a standardised framework for data sharing and develop policies and procedures to ensure the privacy and security of shared data

3. Continue improving the quality, relevance, and consistency of data streams

- Revisit the risk assessment model to include and clearly distinguish measures of impact and probability. Among the eleven existing risk assessment models, some are only based on probability, this may result in inefficient allocation of resources by leading to either underestimation of the potential impact of risks, neglect of high-impact but low-probability risks, or over-focus on low-impact but high-probability risks.

- Update the inspection check lists to include information about sources of construction issues and of actual risks. Current data collection focuses on legal compliance of permitting requirements. A more impact-oriented data collection would provide historical information of reasons for construction issues.
- Revisit risk categories and how they figure in risk assessment algorithms: Greater level of granularity on risk assessment can render it more precise while simplifying the algorithm foundation.
- Rethink mechanisms of extraction and storage of data: Online storage platform and direct differentiate extraction by stakeholder would increase the number of beneficiaries of data collection, improve efficiency and cooperation, and reduce resistance to digitalisation.

4. Introduce strategies for impact and influence of data collection and measurement of its effectiveness

- Risk-based assessment should inform allocation of resources and legislation reform: Ultimately, risk assessment could alert different agencies and shareholders of existing of potential problems, enabling preventing action.
- Define clear goals and an evaluation methodology for digitalisation: Clear outcomes and their measurements essential information of the state of the digitalisation process and evidence for continuing support of the process and necessary funding.
- Introduce a feedback loop algorithm that connects permitting and supervision: This would allow VTPSI to move away from ex post intervention to a more preventive approach and improve permitting (by updating risk categories if they do not work in practice).
- Elaborate strategy to integrate changes in data collection and analysis as soon as implementation of BIM starts: By leveraging the rich data available through BIM, authorities and other stakeholder in the construction industry can gain deeper insights into the construction process, leading to more efficient and effective decision-making.

II. Analysis of Building Information Modelling: Moving from Phase I to Phase II of the BIM-LT project

5. **Introduce a plan for data collection, treatment and sharing**

- Develop, share, and implement common data standards for the construction sector: as NSIK is elaborated revisiting regulatory datasets to meet standards. Moreover, common data standards for plans, drawings, specifications, and other construction-related documents would facilitate sharing and using this information across the whole construction sector. It could also facilitate the use of advanced technologies such as Building Information Modelling (BIM)
- Prioritise application cases and define data collection and structuring: A prioritisation of application cases for the Ministry of Environment would lead to defining the data to be structured and collected. This prioritisation can respond to the policy objectives of the MoE.
- Define prioritisation of information to be treated in the Common Data Environment: As infrastructure is limited, prioritising and defining scope enables breaking down the process into narrower targets. This can be done through pilot of specific sectors or categories of buildings to be later extended

6. Elaborate a roadmap and timeline of BIM implementation (Phase II)

- Define clear goals and objectives: This vision ensures that BIM implementation is aligned with the Ministry of Environment's, and other involved stakeholders' mission and vision.
- Further evaluate viability and feasibility: This allows the Ministry of Environment to allocate the appropriate budget, staffing, and technology resources for the implementation of BIM based on the timeline.
- Determine implementation steps and monitoring progress: Elaborating pilots and ways to assess their success allows the tracking of key milestones, identifying any deviations from the plan, and making necessary adjustments.

III. Other Digitalisation Methods and Measures

7. **Create an overarching centralised database of construction projects:**

- Overarching centralised online database: By collecting and storing information on ongoing and completed construction projects, it would be possible to easily identify trends and problems in the construction sector, which could help improve regulatory design and supervision.
- Engage multiple stakeholders from private and public sectors in the digitalisation process: This would improve information flow and sharing, and create trust, cooperation, and highlight the gains from participating in the digitalisation process. Public-private partnerships would facilitate digital solutions, helping to leverage expertise, resources, and innovation.

I. Data Analytics Maturity on Construction Permits and Supervision: redirecting VTPSI towards more effective and risk-based operations

The State Territorial Planning and Construction Inspectorate (*Valstybinė Teritorijų Planavimo ir Statybos Inspekcija*, VTPSI)[1] faces the challenge of developing a more preventive and risk-based approach to inspections, within its current legal mandate. Currently, the inspectorate is not always able to direct its limited resources to areas of greatest risk as it must perform several functions in low-risk areas, which are not essential for its main purposes and interests it intends to protect (safety, human life and health, environment).

These constraints come largely from a lack of interconnectivity and communication between the agencies involved in the construction regulation process from permitting, through construction material and labour condition inspection, construction completion, to in-use phase. In fact, VTPSI is charged with five main responsibilities spanning the entire planning and construction cycle: performing inspections, controlling the legality of construction permits, issuing construction completion acts, handling complains, providing consultation, and advising territorial planning and construction and other administrative services in construction. While the inspectorate is not responsible for issuing permits, it supervises its issuance compliance and performs a risk assessment calculation to monitor likelihood of non-compliance. This contributes to the inspectorate being perceived as a rather formalistic watchdog/supervising agency focused on document-oriented checks, rather than an advisor. Through revisiting the role and use of its collection and processing of data, however, the inspectorate could have an impact that nears more closely

[1] Valstybinės teritorijų planavimo ir statybos inspekcijos prie Aplinkos Ministerijos nuostatai, https://www.e-tar.lt/portal/lt/legalAct/TAR.4F86CB964826/asr.

its mission of protecting safety, human life, health and the environment. The following recommendations, therefore, aim at moving in this direction.

Recommendation 1. Enhance a data-driven practices culture and strategies

Recommendation 1.1: Continued documenting and endorsement of a data-driven strategy

To plan inspections and evaluate construction permits, sites, and building structures, VTPSI relies on information systems (Infostatyba, *Gates*) and a risk assessment system (RVIS). The users of the information systems are varied and include municipalities, inspectorates, citizens, construction companies, architects, design engineers etc.

Since 2020, the VTPSI has targeted an internal transformation process to identify strategic goals accompanied of strategic indicators of their implementation. Ever since, the Inspectorate has implemented several changes and has outlined other clear steps for the year of 2023. The current strategic plan is set for the years of 2020-2024.[2]

In this context, the recommendation pertains to the continuing design of a clear set of targets for digitalisation and a roadmap of steps to achieve them. Such an effort would make the process more transparent, understandable, inclusive, and feasible.

After the first round of recommendations by the OECD in November 2022, the VTPSI has set several steps to implement changes in 2023 aimed at enhancing its digitalisation and improving its image and functioning.[3] As digitalisation and restructuring are long term goals, efforts in systematising the transformation process must be continuous. Thus, the creation and dissemination of a clear evaluation of the inspectorate digitalisation current maturity and advancement goals, including a timeline and a roadmap is recommended.

An illustration of such an effort was presented during the February 2023 mission to Vilnius, when OECD team presented the SAP digital government model for illustration.[4] The SAP model contains six dimensions (strategy, data, technology, culture, influence and impact) and five maturity levels (ad hoc, prepared, demonstrated, proven, and intelligent). The dimensions are described as follows:

- Strategy — Presence of a documented, funded and endorsed strategy for data-driven policy and practice
- Data — Data is seen, treated and managed as a strategic asset
- Technology — Analytics platform and capabilities enable evidence-based decision making
- Culture — Presence of executive-level sponsorship and grass-root support for data-driven practices
- Influence — Decisions are routinely based on data-enriched evidence
- Impact — Agency ability to influence legislative change based on data-driven insights

By applying the SAP's framework, it is possible to observe that VTPSI has set a digitalisation strategy containing a vision for data-driven policy and practice. While a more detailed presentation of the application of this model to VTPSI is presented below in Box 7 (page 20), this recommendation, based on SAP's

[2] Pasiulymai del esminių reformų statybos valstybinės priežiūros srityje (comments by Vytautas Ambrazas, May 2022). 2020-2024 METŲ ILGALAIKĖ VEIKLOS STRATEGIJA (lrv.lt)

[3] According to recent VTPSI plans shared with OECD by Vytautas Ambrazas on February 9th, 2023.

[4] SAP Institute for Digital Government (2008). Maturity Model for Data-driven Government. Ryan van Leent

model, anticipates that to keep advancing its project of increasing its digitalisation maturity, VTPSI needs to continue documenting and endorsing data-driven policies practice—as done in the two documents cited above. Ultimately, data and information collection should serve as a basis for agency's strategy itself, an objective that can be achieve if goals are clearly outlined from the beginning and measurements of effectiveness have been pre-selected, and that they can be monitored using data.

Recommendation 1.2: Reduce Manual Input of Data in all Stages of Construction Inspection and Supervision

The Lithuanian government has envisioned the digitalisation of construction regulatory activities for more than three decades. The launching of Infostatyba and the creation of VTPSI has consolidated this project and increasingly enabled the digitalisation of data input. The latest upgrade of the process was endorsed in 2021, however, some data uploading and construction supervising steps are still done manually.

Digitalising the whole process through the use of emerging technologies is recommended, as it would improve accuracy, standardise data input and enhance efficiency. Clean and accurate data is also essential for improved data analytics and can have positive impacts on resource allocation and cost reduction.

For instance, during construction supervision, inspectors are required to fill out questionnaires and fact checking acts. On these forms, most of the input relates to documentary checks and violation of acts. There is, nonetheless, a space where description of violations can be provided in case of observed non-compliance. The completion of the descriptive part is completely open-ended, which makes systematisation of information difficult. To tackle this problem, inspectorate staff manually reads the input once or twice a year and synthetises them. Moreover, drones are available, and inspectors have access to smart devices for conducting inspections, which allows for inspectors to fill in questionnaires on their devices and information to be directly entered in Infostatyba. However, they still have the option of using paper forms during their visits, in which case they have 10 days after inspection to transfer the data to Infostatyba.

VTPSI should eliminate the manual entries and digitalise the whole process; an effort that requires investment in, training, and culture creation for the use of smart devices. The digitalisation process, moreover, goes beyond transferring existing questionnaires and fact check forms to an online format. As the inspectorate intends to review and digitalise these tools in the second half of 2023,[5] redesigning of the forms so that they both embody the inspectorate mission and furnish data collection and analyses (that is, to include question that may inform actual risk involved rather than the current focus on bureaucratic checks) is highly desirable.

Recommendation 1.3: Provide Digital Capability for Authorities and other Stakeholders of the Construction Sector

This recommendation pertains mostly to a reinforcement of a data-driven culture within and beyond the VTPSI and the Ministry of Environment. In fact, a successful digitalisation transformation requires the involvement of several private and public stakeholders of the construction sector. By providing training and apprenticeship programs on digital technologies as well as creating an environment of online coordination and cooperation, it would be possible to improve efficiency and productivity, while preparing integration in a progressively digitised regulatory system.

VTPSI's response to OECD's November 2022 recommendations shows a strong willingness to enhancing a data-driven culture while simultaneously improving the agency's image constructing an identity of an

[5] According to recent VTPSI plans shared with OECD by Vytautas Ambrazas on February 9th, 2023.

advisor in construction and environmental matters. According to its plan, by the end of 2023 the inspectorate will release an annual publication that provides guidelines of territorial planning and construction sector for professionals. In addition, training sessions for supervised entities also are anticipated for the end of the year. The Inspectorate, moreover, intends to introduce several online services to its menu to improve its dialogue and communication with the public.

These steps are indeed crucial not only to support the agency's realisation of its mission, but also to create a cooperative environment among construction stakeholders which can facilitate the interconnectivity of information platforms and data sharing in the future. Consequently, this recommendation item incites the investment in creating spaces for dialogue and training both online and in person to improve the flow of information among different stakeholders. Latvia has introduced a digital system to coordinate different stakeholders. Box 1 shows how the country implemented a platform to integrate 87 institutions, with a heavy focus on training and communication.

Box 1. Latvia's Construction of a Digital Culture

The Latvian State Construction Control Bureau (SCCB) was created in 2014 with the purpose of ensuring quality and safety in construction. The SCCB is also responsible for the management of the Building Information System (BIS) since 2017.

The BIS is a public portal that:

- ensures information exchange among the persons participating in the construction process
- maintains necessary registers for construction and building operational process
- provides access to the registers and e-services necessary for the construction and building operational process

The public portal's realisation has been staged in two phases with continuous updating to contain eleven registers (e.g., building inspectors, construction merchants, to managers of residential houses) and encompasses 28 other databases. BIS is a good example of public-private cooperation and a rich source of information for several stakeholders of the construction sector.

The achievement of such successful cooperation, counting on 87 institutions in 2023, demanded a heavy investment in communication and training from the SCCB. In fact, the Bureau has so far supported 272 working groups (involving 442 members), trained 3742 users through the organisation of 64 online training events and webinars.

Source: https://www.bis.gov.lv

Recommendation 2. Integrate existing and new technologies to support digitalisation

Recommendation 2.1: Reorganise a Digital Platform to Increase Transparency and Avoid Duplication

The previous set of recommendation introduced some indications of recommended actions for the dimensions of technology and data. This recommendation builds from that, to propose a reorganisation of digital platforms and use of information technology for permitting, supervision and inspection of construction procedures.

Regarding permits, for example, there is a lack of interoperability between KPEPIS (information system used by Cultural Heritage Department) and Infostatyba. The lack of interoperability is leading to duplication of work and creating unnecessary delays. Namely, in construction works which have elements of cultural heritage protection—either due to their location in a heritage zone or due to major repairs, restoration/preservation or even reconstruction cultural heritage buildings—two separate permissions are required from the Cultural Heritage department: one via KPEPIS and the second via Infostatyba. In addition to this, builders are required to obtain two permits: one from the municipality and another from the Cultural Heritage department. Often, due to their lack of knowledge of the second requirement, builders get entangled in long drawn litigation or declaration of illegal property after construction. Greater information sharing between the two information systems could to some extent offset this problem. However, a single permit system (i.e., a building permit integrating cultural heritage permission when/where relevant) would significantly reduce burdens and avoid litigation.

In sum, restructuring existing digital platforms to form a centralised digital platform for the submission of all building permits could increase the transparency and efficiency of permit issuance. Applicants should be able to comply with all requirements by logging in a one-stop-shop platform, while respective agencies have access to an interoperable platform. This could reduce waiting times, avoid duplicated work from different governmental agencies, diminish lack of information, facilitate the follow-up of requests, and improve the relationship with the public.

Recommendation 2.2: Improve Integration among Regulatory Services

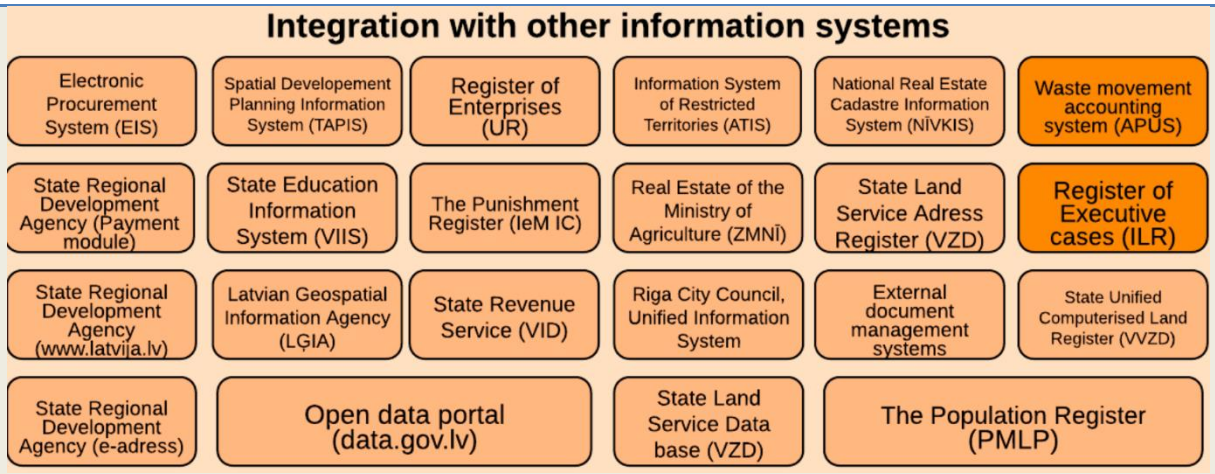
Infostatyba is already a large step towards integration of several databases and sources of information and continues to envelop additional databases. For instance, in 2022 there was a restructuring of the information system to integrate risk assessment of workers in the construction sites, documented by the State Labor Inspectorate—under Ministry of Social Security and Labor—with the VTPSI systems.

A comprehensive data sharing framework should be developed to enable seamless sharing of data among different authorities and stakeholders in the construction sector. Information from authorities such as SSVA, State Consumer Rights Protection Authority, the municipalities, State Labor Inspectorate, and State Tax Inspectorate should be directly furnished to VTPSI to populate its risk assessment system (RVIS), similarly, the latter should loopback to other construction sector authorities and stakeholders.

The deficiencies of information exchange results in difficulties understanding the source of construction issues over time. Both the VTPSI and the Ministry of Environment report not having enough diagnostic information, that is, information about why problems happen. This lack of information is partially due to the lack of integration of some institutions into Infostatyba. For example, municipalities are responsible for the in-use inspection of buildings, however, the pertaining data is not stored in Infostatyba, depriving VTPSI and other national authorities of this information. Extending, thus, Infostatyba through a software component dedicated to municipalities is, thus, recommended.Another important system integration could originate from SSVA's project Building Data Bank, which would store and share data about in-use phase and is expected to have direct link to Infostatyba.

Box 2. Latvia's BIS through Private-Public Collaboration

Implementation and upgrade of the BIS in Latvia have included an encompassing publicly owned online platform that is integrated with pre-existing and new databases.



The State Construction Control Bureau (SCCB) utilises the data collected to calculate risks of non-compliance or risky construction. Based on a model that determines low, medium and high risks of different sources, a risk-based alert is sent to the competent authority, so that it can allocate personnel to inspect the risky subject. Risk assessment calculations serve, moreover, to determine authority response's timeframe: urgent for high-risk subjects and according to staff availability for low risk.

Source: Information shared by Latvia's State Construction Control Bureau.

A redesigning of the centralising digital information boosted by newly data sharing sources due to increased cooperation among public authorities as well as with private stakeholders is highly recommendable to facilitate the work of authorities, disseminate information more easily, and optimise resource allocation.

Recommendation 2.3: Introduce new technologies to collect and share data

Governments across OECD have increasingly introduced digital technologies, such as Internet of Things (IoT) sensors, drones, or artificial intelligence (AI) to collect and share data about construction projects.

Building from *recommendations 2 and 3,* the present recommendation entails exclusively using smart devices during inspection and for filling out fact check formularies. Such change would allow for more effective and uniform data collection and directly input of geolocation information in Infostatyba (currently, location input is done manually and creates ambiguity and lack of consistency). Other technologies that would allow the automatic analysis of GIS data, pictures taken by drones, and 3D models to create a list of potentially illegal construction sites would also be beneficial solutions for supporting inspections and supervisions. According to VTPSI, some municipalities and institutions are already using drones in their operations, however, not only the data collected is not shared with the Inspectorate, but also a common investment in devices of the sort to be shared among different authorities has not been envisioned. Consequently, the government's allocation of resources may benefit specific authorities and not others or may become highly inefficient if several agencies are buying the same devices for similar purposes instead of collaborating to pool financial resources, gain price negotiation power with service providers, and promote shared use of collected information.

Another pointed issue regarding introduction of new technologies relates to construction managers' daily logs. Until May 2023, construction managers' diaries were paper based. Although from May 2023 onward

diary inputs must be done digitally—an important step of digitalisation and opportunity for data collection to inform supervision decision-making—the inspectorate does not have access to this information because it will be stored in a network of online remote servers (such as cloud computing, the Latvian government, for instance, use a governmental owned network), thus not structured according to State's rules, causing difficulty for matching and mapping the datasets. Moreover, although VTPSI has access to the books, the data is not shared automatically with Infostatyba, which prevents the application of machine learning tools to evaluate this information.

These two points demonstrate that despite the introduction of new technology, data collection and sharing is advancing in the right direction, however, needs to be pursued with greater might to achieve desired outcomes. Consequently, introduction of new technologies must be accompanied of greater collaboration among construction sector shareholders, both public and private. Finally, regardless of the specific technology used, it is important to establish a standardised framework for data sharing and develop policies and procedures to ensure the privacy and security of shared data.

Recommendation 3. Continue improving the quality, relevance, and consistency of data streams

VTPSI has created the Risk Management Information System (RVIS) with the objective of performing risk-based inspections by using data from Infostatyba, Avilys (document management system) and the risk management system of the State Labour Inspectorate. The inspectorate estimates the risk of non-compliance during most stages of the construction process up to the issuance of the construction completion act. The purpose is for VTPSI to carry inspections based on priorities and risk categorisation, however, both the calculation of RVIS and its impact on inspection scheduling have suffered from shortcomings. The present section discusses the former—dealing with matters of data quality and technology implementation—whereas the following section assesses the latter, pertaining to impact and influence.

Recommendation 3.1: Revisit the Risk Assessment Model

Since May 2022, VTPSI has eleven risk assessment models in place to classify the level of risk of non-compliance and violation of construction regulations. The models deal with construction managers and contractors, project design, project managers, builders, expertise contractors, SLD[6] permit issuance violation, special construction, non-special construction, and maintenance manuals. Risk criteria are determined by factors such as location of activity, history of violations, risk incumbent to the technical supervisor/ head of construction, among others (see Box 3). While the current calculation is highly intricated, it could be optimised.

The first recommendation in this regard entails revisiting the risk assessment model to include, and clearly distinguish measures that relate to impact and probability. In fact, among the nine existing risk assessment models, some are only based on probability—currently only the model of violations of SLD issuance, non-special, and special construction count on criteria of probability. Meanwhile, the models that contain both usually provide an arithmetic calculation of risk, rather than a geometric one (see Box 3). Namely, impact and probability are combined through addition, rather than multiplication, which results in a distribution of risk, where most situations require medium degree of attention, whereas rare are the occasions that either require little attention or demand immediate response. These methods of calculation may lead to inefficient allocation of resources by leading to either underestimation of the potential impact of risks, neglect of activities of high-impact and low-probability, or over-focus on activities of low-impact and high-probability.

[6] Construction permit

Box 3. Revision of Risk Assessment Calculations

Taking the algorithm for assessment risk of non-compliance of SDL issuance as example, the presence of probability and impact are both detected as shown in the column entitled “Evaluation”:

Group no.	Group	Criterion no.	Criterion	Criterion description	Evaluation
R2.1	Municipal administration	K1.	The history of violations related to the issuance of SLDs found during the inspection of SLDs issued by the municipal administration	It is assumed that municipal administrations in which violations are often committed are more likely to commit violations in the future. For this reason, they are given a higher risk score. The weighted sum of 2 years is calculated, thus giving weight to violations committed two years ago.	Probability
R2.2	Construction	Q2.	Riskiness of construction by category, type of construction, purpose of buildings.	It is assumed that the categories, types of construction and the purpose of a certain structure are more risky when assessing the probability of recurrence of violations and the impact of possible violations	Impact
		Q41	The type of area where construction is taking place	Certain construction areas are assumed to be more risky due to higher potential exposure (scale of damage)	Impact
R5	Builder (customer)	I1	Builder risk group	-	Probability
R2.(II)	Projects	I2	Designer risk group	-	Probability
R2.(III)	Project manager	I3	Project manager's risk group	-	Probability
R3	Expertise contractor	I4	Expertise contractor's risk group	-	Probability
Table R2 (illegal issuance of SLD) overall risk assessment score					
Algorithms					
Total risk assessment score	=K1.*R1.+Q2.*R2.+Q41*R41+I1*R(I)1+I2*R(I)2+I3*R(I)3+I4*R(I)4				

The calculation of the score (highlighted in yellow) shows that despite presence of criteria of different nature, they are both treated similarly. A score that would emphasise impact more than probability would multiply elements of the two different categories as show below. The multiplication unveils projects with high impact, while also reinforcing the character of projects in both extreme (high and low risk), avoiding a nuanced perspective where most projects would fall within the medium risk category.

Total risk assessment score	=(K1.*R1+I1*R(I)1+I2*R(I)2+I3*R(I)3+I4*R(I)4) X (Q2.*R2.+Q41*R41)		

(probability features ↓ impact features)

Source: Information provided by VTPSI

Finally, the models should be consistent—for instance, all the models evaluating actors of construction sector (managers, experts, etc) multiply mostly factors related to violation and accidents (with no differentiated degree of gravity) by the history of inspections of the actor in question when no violations were found. This method gives a higher weight to inspected actors showing no violation, however, there is no variable measuring the gravity of these violations.

Recommendation 3.2: Update Check Lists and Use them to Populate Risk Assessment Calculations

Related to the last point, all existent models input the number of accidents as a probability factor where the accidents counted are collapse of a structure in the construction. However, the model does not take into account the level of gravity (impact) past accidents. If part of a structure collapsed, the total area impacted, number of people insured, percentage of total structure represented by the part could all enter the models as measures of impact.

The recommendation to revisit this point could be related to the revision of inspection checklists to include entries of different type of accidents/violation to be evaluated for their (actual or potential) impact. In a way that the additional information collected about the sources of construction problems troubling Lithuanians' health, safety and environmental surroundings would enrich the model of risk assessment.

While current data collection focuses on legal compliance of permitting requirements, a more impact-oriented data collection would provide historical information of reasons for incidents, failures, and accidents in the construction sector.

Recommendation 3.3: Revisit Categories and Relate to Risk Assessment Algorithms

While revisiting the risk assessment, it is relevant to rethink building categories together with other authorities to increase the number of categories so that types of construction within a category share more features in common. Greater level of granularity on risk assessment can render it more precise while simplifying the algorithm basis.

The redesigned categories should, thus, reflect in the algorithms, which can be based on a first moment unique formula containing probability and impact of a set of potential accidents to include categories in a second moment as an impact measurement.

Today the existent categories in Lithuania are special, non-special, and simple (group I and group II). The newly-to-be-designed categories should be reflected in the risk assessment calculations as well as permitting and supervision, optimising the organisation of the respective regulatory bodies and their resource allocation.

For a larger discussion on risk categories please refer to Output 3.

Recommendation 3.4: Rethink Mechanisms of Data Extraction, Sharing and Storage

The extraction, sharing and storage of data are three interrelated points that permeate many issues, including the calculation, precision, pace of updates of risk assessment and, consequently, its rate of usage and impact. The goal is for agencies to identify the most critical risks that require immediate attention, prioritise their resources, and take appropriate actions to mitigate these risks.

Today, although all data input in RVIS for the calculation of risk is digital, risk calculations are performed only once a month. The reason behind it relies on the fact that extraction of data from Infostatyba is not automated, while its data is stored in a state cloud server, extraction are centralised by and outsourced to IT specialists. It is recommended, thus, to put in place a publicly owned (and managed) online network of remote servers (cloud computing) and make collaborations to automatically receive data from other public institutions and private organisations, which would allow extraction, sharing, and treatment of data by different construction stakeholders.

This would imply that VTPSI would share its risk assessment with other agencies and municipalities in a way that automated dashboards and alert systems would inform and require action of respective authorities. Meanwhile, VTPSI would have access to the information collected by other agencies as well.

Currently, PP[7] and SLD permits are issued by municipalities, subsequently construction supervision is handled by the inspectorate until the issuance of the construction completion act, then in-use supervision

[7] PP construction permits are granted after a project is made public and no popular/neighbour-based concerns or impediments are issued.

and management are delegated to municipalities. While VTPSI and the Ministry of Environment do not have access to in-use digital information (instead, the inspectorate only has access to reports produced annually by municipalities), if complaints are reported, the VTPSI must respond, regardless of the level of assessed risk, within 20 days. A better integrated database could offer reports on performance of respective responsibilities and delegate investigation of complaints to more appropriate bodies rather than overburden VTPSI inspectors.

In sum, the recommendation entails revising the data collection, sharing, and storage to tap in its capability to make organisational changes.

Recommendation 4. Introduce strategies for impact and influence of data collection and measurement of its effectiveness

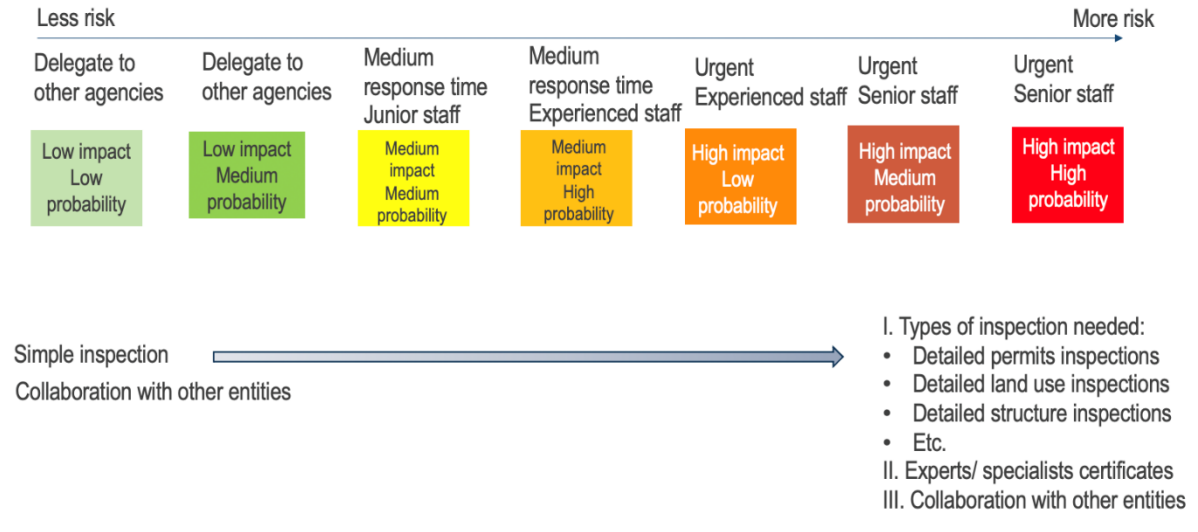
Recommendation 4.1: Risk-based Assessment Reflects on Resource Allocation and Legislation

Ultimately, as described above, risk assessment should alert different agencies and stakeholders of existing of potential problems, enabling preventing action and reducing centralisation of inspection in VTPSI, thus, reducing the burden over its agents.

The inspectorate is responsible for checking the legality of building permits issued by municipalities, either on its own initiative or in response to a third-party complaint. The VTPSI investigates about 2,500 complaints annually, which absorbed about 29% of the inspectorate's time resources, meanwhile about 37% of time was spent on construction supervision, 10% on territorial planning, 7% on investigation of building permits, and only 3% on prevention in 2020.[8] More importantly, the lion's share of such complaints concerns low-risk constructions, falling into the categories of 'non-special' and 'simple' buildings. Following best practices, reaction to complaints of minor issues should be addressed either by a private organisation or by municipalities, or yet another decentralised body, alleviating the overload on VTPSI's staff and liberating resources for the inspectorate to dedicate to prevention, territorial planning and construction supervision (see Box 5)

[8] This is an annual average of number of complaints investigated between 2015 and 2021, based on the VTPSI annual report 2021.

Box 5. Adjusting contents and participants of inspections by the level of risk



For that end, laws on supervision would need to be reviewed, a topic further discussed in Output 3. Changes in this direction can be done gradually through a pilot, by, for instance, using data to evaluate a few municipalities who tend to have complaints related to least risky issues and evaluate issuance of permits, common types of during construction and in-use issues, number of complaints and evaluate the resources that have been used for no-impact, non-probable cases. Likewise, it is possible to design a pilot to observe the type of complaints that represent low level of treat to safety and health and delegate related investigations to other bodies (such as municipalities), evaluating the results in terms of investigation outcomes and use of resources. One or two studies, with a control group, may be created to analyse the effectiveness of the change within six months or a year to support push of institutional change later.

Another possibility relies in crossing data points that are already present in the current platform to relate municipalities with highest number of complaints or higher impact problems such as demolition with the level of illegally issued SLDs. The analysis allows to identify the effectiveness of the permit issuance. Moreover, further investigation on causes of non-compliance—being it incompetence, lack of understanding of the process, or even corruption at the municipal level—may serve as a guide for VTPSI's strategy to tackle non-compliance, including imposing sanctions.

Ultimately, however, improvement of VTPSI actions in these regards depends on changes in the law on supervision, which could include sanctions for non-compliant actors, changes in the required response of complaints and reduced time for complaints after end of construction (see Output 3 for more detail). Nonetheless, to illuminate the course of action, data analysis is key. It is recommended, thus, to use the data collected to assess co-occurrence between municipalities and construction parties' likelihood of advancing construction with non-compliant permits, on one hand, and the gravity of complaints and issues during in-use phase, on the other hand.

Recommendation 4.2: Introduce a Feedback Loop Algorithm between Permitting and Supervision

This would allow VTPSI to move away from *ex-post* intervention to a more preventive approach and improve permitting (making it evident if permit issuance processes are not effective in practice and proposing possible paths to improve these processes).

Such algorithm would allow VTPSI to monitor compliance with permit conditions more effectively and detect any potential violations in real-time. Moreover, a feedback loop algorithm could work by collecting data from the permitting process and comparing it with data from the supervision process, which identifies discrepancies or issues to be addressed. Nevertheless, to function well, the algorithm must be supported by accurate and reliable data, consequently, VTPSI must establish clear guidelines for data collection and ensure they are consistently applied by all stakeholders.

Box 6. Examples and Applications of Permitting-Inspections Feeding Algorithms

Several governments have applied this type of calculation to increase the effectiveness of their inspection agencies.

For example, the UK's Health and Safety Executive (HSE) has implemented a "risk-based inspection program" that uses data from permit applications and inspections to identify high-risk sites and allocate inspection resources accordingly. The program involves a feedback loop where data from inspections is used to refine the risk assessment model and improve the accuracy of future inspections.[9]

Similarly, the US Environmental Protection Agency (EPA) has developed a system called the Integrated Compliance Information System (ICIS) which connects permit data to inspection data and allows for real-time monitoring of compliance status. The system uses algorithms to identify facilities that are at high risk of non-compliance and prioritises them for inspection.

Source: https://www.epa.gov/enviro/pcs-icis-overview

This could help improve the overall quality and safety of construction projects in Lithuania and facilitate the work of the Inspectorate.

Recommendation 4.3: Define Clear Outcomes of Digitalisation and Measurements to Assess them

To close the loop of recommendations for VTPSI, the design of clear outcomes for the agency's digitalisation process and respective measurements would enable its staff to assess its progress and build evidence for continuing support and funding for digitalisation.

The use of a maturity model, for example, may render the agency autonomous to continually rethink its digitalisation efforts and indicate next steps. Following OECD's (2014) definition of digital government—namely, "the use of digital technologies, as an integrated part of governments' modernisation strategies, to create public value. It relies on a digital government ecosystem comprised of government actors, non-governmental organisations, businesses, citizens' associations and individuals which supports the production of and access to data, services and content through interactions with the government"—it is possible to determined different dimensions for advancement:

- Data production and access: Data quality
- Use of digital technologies: Technology
- Create public value: Impact
- Cooperation with other actors, organisations and the citizens: Culture
- Modernisation strategies: Strategy
- Data-based decision making: Influence

[9] https://www.hse.gov.uk/foi/internalops/hid_circs/technical_general/spc_tech_gen_46.htm

The points above map OECD's definition of digital government and SAP's digital government maturity model to illustrate this recommendation (Box 6). Based on these dimensions, it is possible to evaluate the status of digitalisation and set objects for advanced maturity within three years, for example. After the desired outcomes are defined, a roadmap with clear measurements for each goal should be determined to enable quarterly evaluation of progress.

Box 7. Application of Maturity Model to Define Roadmap and Advancement Assessment Measurements

Once status and objectives are evaluated for each dimension, a roadmap of the actions to be implemented and followed up within a timeframe must be defined. Subsequently, assessment of met objectives must happen continually with possible revisions and elaboration of set outcomes. To illustrate, the blue chart aside represents the current level of digital maturity of VTPSI for each dimension, while the outer green graph represents set objectives for the end of 2024. Based on set objectives for data-driven culture for example, the Inspectorate can design a roadmap: creation of webinars, training sessions for supervised entities, workshop aimed increased collaboration with supervised entities and other regulatory agencies, chatbots for interaction with builders and citizens. Measurement of performance for each of these goals must be defined and monitor over time, to evaluate the Inspectorate's success in advancing its digitalisation process.

Recommendation 4.4 Elaborate a Strategy to Integrate Data from BIM

By leveraging the rich data available through Building Information Modelling (BIM), the VTPSI can gain deeper insights into the construction process, leading to more efficient and effective decision-making. Although, the next chapter is dedicated to BIM, this point is raised in recommendations for VTPSI to create awareness that the agency should be engaged with the implementation of BIM, specially to assess how this new tool can be integrated into its future inspection and data collection strategies.

Three points are specifically listed below, but it is recommended that VTPSI further identifies potential coordination and engagement with BIM.

Finally, a forward-looking recommendation relates to preparing the Inspectorate to benefit from BIM-LT (Lithuanian Building Information Modelling) project. As the Ministry of Environment in collaboration with the Vilnius Gediminas Technical University and Kaunas University of Technology, State Enterprise Lithuanian Road Administration, State Enterprise Turto bankas and Public Body Construction Sector Development Agency have conceptualised the implementation of a Building Information Modelling, the VTPSI's digitalisation roadmap and desired outcomes should consider changes in data collection and analyses to be adopted with the introduction of BIM. In fact, by leveraging the rich data available through BIM, the Inspectorate, and other stakeholders in the construction industry, can gain deeper insights into the construction process, leading to more efficient and effective decision-making.

The Inspectorate should consider incorporating BIM data into its database to improve the quality and completeness of its data, which may lead to more accurate risk assessments and better decision-making. By analysing BIM data, the Inspectorate can benefit from the following:

- gaining further insights into design and construction of building and infrastructure to identify potential safety hazards (i.e., narrow staircase and insufficient ventilation);
- gathering riskiest construction factors to focus inspection in critical areas (i.e., load-bearing walls, electrical systems, fire safety measures);
- comparing BIM data to building codes and regulation to identify discrepancies and take appropriate enforcement actions; and identify and evaluate severity of risks and make recommendations for mitigation measures.

Consequently, designing a clear plan for future integration of BIM data is strongly recommended.

II. Analysis of Building Information Modelling (BIM)

BIM is a digital representation of the physical and functional characteristics of a building or infrastructure, which includes its geometry, spatial relationships, building components, and other relevant information. By leveraging the rich data available through BIM, stakeholders in the construction industry can gain deeper insights into the construction process, leading to more efficient and effective decision-making.

One of the key benefits of BIM is that it enables the integration of data from multiple sources and disciplines, creating a comprehensive digital representation of the entire construction process. By leveraging BIM data, stakeholders can better understand the design intent, construction progress, and asset performance, allowing them to optimise project outcomes and improve overall project efficiency.

In early 2019, the Ministry of Environment of the Republic of Lithuania together with partners have launched the BIM-LT project. The objective of the BIM-LT project is to increase the efficiency of the use of resources allocated to the construction planning, design, construction, operation, and management of public sector buildings by applying Building Information Modelling tools.

With an end date of 31st August 2023, BIM-LT aims at preparing digitalisation measures pertaining to the production of documents defined within four phases: (i) normative documents about BIM implementation; (ii) methodological documents for public procurement and for evaluation and monitoring of BIM benefits; (iii) a national construction information classification system (also known as NSIK); (iv) and training and teaching materials related to the application of the BIM-LT project. As of April 2023, most normative documents have already been produced, NSIK is being finalised, and training has been launched by universities and other partners. The Ministry and its partners are preparing a second phase of the project, which relates to testing and simulating the model in real environment to monitor results to both revise normative documents and produce public procurement documents. The following recommendation, therefore, aim at shedding light on a possible path to implementation of BIM-LT.

Recommendation 5. Introduce a plan for data collection, treatment and sharing

Recommendation 5.1. Develop, Share and Implement Common Data Standards for the Construction Sector

As NSIK is elaborated, it is important to revisit regulatory agencies datasets to make sure that they meet standards, this will facilitate integration of BIM data with other platforms such as Infostatyba and support data sharing among stakeholders. In fact, common data standards for plans, drawings, specifications, and other construction-related documents would facilitate sharing and using this information across the whole sector. This standardisation is also important for the introduction of Building Information Modelling (BIM).

A successful integration of several construction sector platforms depends on the construction of common data standards and can support construction inspections and supervisions by improving data sharing, enhancing quality control, better risk management, improving the efficiency of inspections, and ensuring regulatory compliance.
When finalising the preparation of NSIK, it is recommended to define a checklist that includes best practice guidelines such as making sure that the common data standards: consider stakeholder needs, identify data requirements, ensure data interoperability, standardisation, security and privacy, allows for scalability, and comply with data protection and privacy regulations.

Recommendation 5.2 Pilot, Data Collection and Testing of Selected Application Cases applied to Low-Risk Construction Projects

The architecture and coordination necessary to put BIM in place represent a vast and complex task. The recommendation for the implementation phase is, thus, a common place in digitalisation projects, namely, to start with pilots.

In a way, the Ministry of Environment and its partner have already adopted this strategy as obligation of using BIM applies only to public procurement so far. While that limits the number of construction authorisation application to be analysed, it still represents a large-scale project and does not reduce the variety of data being collected. The recommendation is, thus, to define first specific types of constructions to initiate the analysis and second select a few application cases as priority, to work on related data structuring, storage, analysis and outcome.

Firstly, regarding types of construction, testing and implementation could start with small, low-risk projects that are suitable for pilot testing. These projects, nonetheless, should be representative of the types of projects that will be implemented using BIM in the future.

Secondly, BIM-LT team has identified 33 sets of application cases for BIM. Selecting a few sets of special interest of the Ministry for enforcement purposes could form a good pilot and reduce the set of data to be treated in the initial implementation phase. For instance, starting with the treatment and collection of data within the following sets could smooth initial implementation:

- analysis of the plot (4),
- design and modelling (7),
- engineering calculation and analysis (8),
- structural-technological analysis (19);
- modelling and management construction processes (22);
- and technical supervision of construction works (24).

These application cases were selected because they belong to the most fundamental engineering variables, whereas other application cases may consider economic, environmental, and in-use management factors. Once these group of building are evaluated for the selected application case sets, the data pieces related to these sets to be included in the Common Data Environment should be defined and then treated to integrate construction supervision information systems, aiming to inform analyses performed by different regulatory agencies.

Recommendation 5.3 Define Priorities and Pace of other Application Cases Treatment

Once the integration of data pertaining to the initial pilot is completed, monitoring, adjustment, testing and refinement should be performed.

If the outcomes are satisfactory, scaling up of implementation can be initiated by extending the testing and monitoring phase to other types of buildings. Meanwhile, workshops and seminars to showcase the study and its outcome should be planned to start building a large network of collaboration and boosting interest of other construction sector stakeholders.

Additionally, as the project continues to advance, other sets of application cases can be initiated. The sets can be grouped by theme, for instance, application cases related to safety, health, conformity, or those related to energy, or yet those related to economic issues. Once the groups are determined, defining the order of priority of data treatment and integration into four or five additional may ease the task. For each phase, performance measurement and monitoring of advancement should be clearly established.

When all stages are completed, evaluated, and refined to a satisfactory level, authorities could scale up to other projects other than those under public procurement.

In summary, as available infrastructure and resources are limited prioritising and defining scope enables breaking down the process into narrower targets that will be a part of the BIM implementation roadmap.

Recommendation 6. Elaborate a Roadmap and Timeline of BIM Implementation

Among the documents uploaded on the BIM-LT webpage, several documents regard Phase I, aimed at producing normative and methodological documents, including a BIM maturity model and a timeline. Similar studies should be prepared for the subsequent phases to design a BIM maturity model implementation, with defined targets for each dimension, that is an evaluation of current and desired BIM maturity level, and elaborated roadmap containing a timeline.

Recommendation 6.1. Define Clear Goals and Objectives

Among the BIM-LT normative documents, the desired outcome for the implementation relates to a level 3 maturity, which implies a unified BIM model is used via an online-based environment, allowing all stakeholders to access it and add information according to their role in the project, moreover, along with 4D & 5D dimension, a 6D is included focusing on the management of the building lifecycle. The ultimate objectives for BIM implementation relate to increased efficiency, optimisation of resource allocation, improved elaboration of construction planning, design, implementation, and facilitated management of public sector buildings.

While the desired outcomes for BIM are clear, the means to achieve it are not specified on the documents made available. Definitions of requirements in terms of human resources, leadership, infrastructure, software, hardware, network, legislation and how they will timely support the achievement of the desired outcome is yet to be determined.

Consequently, breaking down the large objective into different dimensions and defining the steps to go from where the BIM-LT project is today to where it wants to be in three years is key to evaluate if BIM implementation is aligned with the Ministry of Environment's, and other involved stakeholders', mission and vision, as well as if implementation is viable and feasible, and to monitor its progress over time.

Recommendation 6.2. Further evaluate Viability and Feasibility

According to discussions with the Ministry of Environment[10], the documents produced are normative and methodological, consequently, further studies and work needs to be conducted to evaluate the viability and the feasibility of the project.

Regarding viability and feasibility, the following points should be considered:

- Technical Feasibility to evaluate the availability and compatibility of software, hardware, and data standards, as well as the capacity of the project team to use and manage BIM effectively.
- Financial Feasibility to measure the costs and benefits of implementing BIM. This includes assessing the initial investment required, ongoing operational costs, and potential returns on investment (ROI).
- Organisational Feasibility to determine the readiness of the organisation to adopt BIM, including staff training, organisational culture, and change management.
- Stakeholder Analysis to assess the ability of stakeholders to use BIM effectively, and whether they have the necessary resources and capacity to collaborate using BIM
- Risk Analysis to identifying risks and challenges related to technology, data security, interoperability, and project management.

These considerations are necessary so that the Ministry of Environment can allocate the appropriate budget, staffing, and technology resources for the implementation of BIM, moreover, the study of viability and feasibility should be based on the implementation roadmap and timeline.

Recommendation 6.3 Determine Implementation Steps and Monitoring Progress of Pilots

This last recommendation is a combination of both preceding recommendations. For each staged pilot and scaling up, the study of feasibility and viability must be evaluated before implementation. Once implemented elaborating ways to assess their success is key to track milestones, identify any deviations from the plan, and make necessary adjustments.

The successful pilots, their monitoring and outcomes, moreover, must be communicated to foster collaboration and coordination among stakeholders in the construction industry. This can include creating a platform for information sharing and communication, as well as encouraging the use of collaborative BIM tools. Communication also serves to showcase successful BIM projects: The project should showcase successful BIM projects in Lithuania to demonstrate the benefits of BIM to the wider construction industry. In fact, while the scope of BIM-LT project is set for public procurement projects, ideally, private sector stakeholders would see the gains and benefits of adopting BIM and a greater collaboration would be promoted; a step that would facilitate supervision and inspection of construction sector in the future.

[10] Held in February 2023

III. Other Digitalisation Methods and Measures

According to the European Commission's 2021 Digital Economy and Society Index (DESI), Lithuania ranks 9th out of 27 EU countries in terms of its overall digital performance.[11] While the DESI report does not provide specific information about the construction sector, it does provide insights into Lithuania's overall digital maturity, which may shed light on its readiness to adopt and implement advanced analytics tools in the construction regulatory sector.

The report highlights Lithuania's strengths in areas such as connectivity, digital skills, and digital public services, whereas areas that require improvements relate to digital integration of businesses, digital transformation of public administrations, and digital public services for businesses. As these shortcomings seem to apply to the construction sector, the following recommendations aim at proposing some steps to bridge these gaps.

Recommendation 7. Create an overarching centralised database of construction projects:

Recommendation 7.1 Overarching Centralised Online Database

Through discussions with members of the Ministry of Environment and analysis of documents, the negative impact of the absence of an overarching publicly owned centralised online database (although Infostatyba has been moved to State cloud servers in November 2021, many construction-related data is still store in private warehouses) is evident. In fact, siloed databases and platforms that are stored in private warehouses reduces the efficiency of the Lithuanian construction sector.

First, storing data in warehouse centralises the power of data extraction to a few IT experts, which prevents updated information to be visualised and discussed in a recurrent (weekly ideally) basis. Second, the deficiency of cooperation and coordination among public agencies and between public and private construction stakeholders disable data sharing and interoperability between different databases. These problems result in duplicated effort and financial expenses for public agencies and a negative view of public bodies intervention, who are perceived as punishers rather than advisors by both private stakeholders and supervised public organisations (like municipalities, for instance). Possibly, stakeholders may not view the benefit of collaboration given that data extractions, depending on the data, are complicated, and prefer retaining the data they collect to themselves or charging to share it.

[11] In descending order, the ranking for the first 15 countries was evaluated to be: Finland, Sweden, Denmark, Netherlands, Luxembourg, Ireland, Belgium, Estonia, Lithuania, Germany, Austria, Latvia, Malta, and Portugal.

This recommendation, therefore, points to redesigning the data storage architecture to the introduction of an overarching centralised database that is stored on a network of online remote servers. This could be achieved either through a new updated version of Infostatyba or simply by creating a new platform that receives and treats data of several other platforms as is the case of the Latvian BIS.

By collecting and storing information on ongoing and completed construction projects, it would be possible to improve the identification of trends and problems in the construction sector, which could enhance planning and enforcement. Overall, an overarching centralised online database can improve the efficiency, enhance data management, increase transparency of the regulatory process, foster cooperation, and reduce costs leading to better outcomes for all stakeholders involved. However, to achieve such an objective improved relationship and cooperation with multiple stakeholders must be established.

Recommendation 7.2 Engage Multiple Stakeholders from Private and Public Sectors in the Digitalisation Process

Engaging multiple stakeholders from both private and public sectors in the modernisation of the construction sector can yield several benefits. Firstly, it would improve information flow and sharing, and create trust, cooperation, and highlight the gains from participating in the digitalisation process. A closer coordination with private stakeholders would facilitate digital solutions, helping to leverage expertise, resources, and innovation and supporting efforts to increase safety and strengthen sustainability goals.

As presented in the first section of the present report, VTPSI is currently engaging in several actions to improve communication channels with supervised entities and with citizens. This is key for creating cooperation as it enables stakeholders to share information, provide feedback, and work together to address issues. This type of initiatives must be maintained and generalised to continue straightening the government agencies' ties with the public.

Therefore, using technology like online platforms for sharing information and data, or other communication technology to hold workshops and webinars, as illustrated by the Latvian experience, are both relevant to advance the project of government digitalisation. Involving construction supervised entities in regulatory decision-making, by understanding their difficulties, questions, and objectives may also prove a path to greater collaboration in the future. Overall, as the government foster a culture of collaboration, promoting transparency and trust, general outcomes and benefits may be improved.