MINISTERSTVO
PRŮMYSLU A OBCHODU

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BIM Implementation Strategy in the Czech Republic

Contents

1 Foreword

This strategy was elaborated on the basis of Government Resolution No 958, on the importance of the Building Information Modelling (BIM) method for building practice in the Czech Republic and the proposal for further steps in its implementation, of 2 November 2016. In the Strategy, the Government expressed its support for the introduction of the BIM method in the Czech Republic in connection with its influence on the growth and competitiveness of the Czech economy and ordered the Ministry of Industry and Trade (MIT), with the support of other ministries, to elaborate the BIM Implementation Strategy in the Czech Republic.

In addition to the MIT, the Ministry of Transport (MoT) through the State Fund for Transport Infrastructure (SFTI) and experts from the BIM Expert Council (CzBIM) contributed to the elaboration of the Strategy. The Strategy was consulted with a broad stakeholder group represented in the BIM Inter-Ministerial Expert Group (IEG BIM), which was established under the MIT.

Motto:

Introducing the BIM method will save the cost of building, renovation and operation of structures. By introducing the BIM method into the non-digital construction sector, the State, as a good manager, will be able to build and maintain more structures for the same money than ever before.

2 Introduction

Construction is a strategically important sector for the economy of the Czech Republic in terms of production, job creation and construction and maintenance of the public space. However, it is one of the least digitized sectors with a stagnant rate of labour productivity. There are systemic deficiencies in the construction process regarding the level of cooperation, poor management of information and lack of investment in technology, research and development. These deficiencies result in a low efficiency of public spending and a higher financial risk due to possible unforeseeable expenditure overruns, delayed delivery of public infrastructure and additional changes to building documentation. BIM (Building Information Modelling) is one of the effective tools for fulfilling the principles of sustainable construction throughout the structure's life cycle. This applies to both the conceptual design phase, as well as construction phase, operation phase and the phase after the structure's lifespan. BIM is also very beneficial when changing completed structures (renovations).

The implementation of the BIM method has similar importance to the construction industry as Industry 4.0 does for industrial sectors. BIM can sometimes be simplified as "digitization". It resembles the revolution of the technological and digital process that took place in the manufacturing sector in Europe between 1980 and 1990, resulting in an increase in productivity and resulting quality. BIM combines the use of computerized 3D modelling with information about structures to improve collaboration, coordination, and decision-making in their construction and operation. For contracting authorities, this means that the construction and administration of buildings should be more effective, the risks of cost overruns in (especially public infrastructure) projects lower, and the transparency of the use of public funds higher. Closer cooperation between all stakeholders combined with mutual trust is necessary. One of the positive effects of BIM processes is that it leads to partial changes in thinking and attitudes.

BIM is becoming the global language in the construction industry, as it allows for a higher level of cooperation across borders. It is assumed that BIM will become a common method of public procurement in the world, and construction contracts in general. In order to maintain the competitiveness of the Czech construction industry, it is necessary to respond to the emerging trend.

In 2014, the European Union recognized the usefulness of BIM for the public sector, as this method helps achieve higher efficiency of spending and promotes innovation. Directive 2014/24/EU on public procurement has allowed contracting authorities across Europe to request the use of BIM when awarding public contracts. In the Czech Republic, this has also been possible since 1 October 2016 through Act No 134/2016, on public procurement.

An increasing number of European governments and public sector organizations are setting up programmes to promote wider use of BIM at national and regional levels. Government policy and public procurement provide significant support to motivate positive changes in the sector.

3 General information about BIM

3.1 What is BIM?

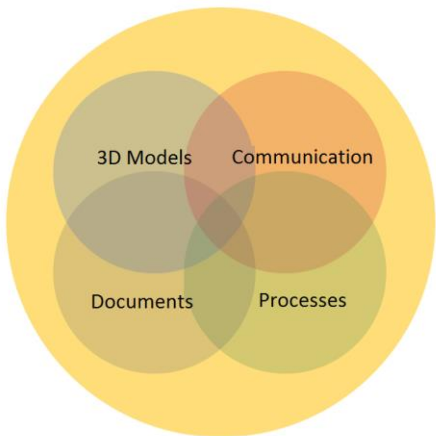
The principles of information modelling have been known since 1974 and have moved from the theoretical level to practice in recent years. This is primarily due to the potential of information modelling that brings savings, risk reduction, the use of efficient technologies and management systems based on data analysis. The abbreviation “BIM” has been used more widely only since 2002. Building Information Modelling (BIM) is a process of building, using and managing building data throughout its lifecycle. “M” can also be understood as “Management”, which may better explain what the use of BIM allows, i.e. primarily the management of information about a building (structure). It is necessary to distinguish between BIM as a model (a form of database) and BIM as a process that uses the BIM model to exchange and share information, but also to manage it. Similarly, “B” from the BIM abbreviation is not only limited to buildings. It does not just mean a building, but to construction and construction process in general. Information modelling as a method of work is generally applicable to any structure. It may be used not only in the building construction segment, but also in transport construction, water construction and special and civil construction in general.

The Building Information Model can be imagined as a database of information, which may include complete data from the initial design, construction and management of buildings and potential modifications to completed structures (renovations) to their demolition, including the environmentally-friendly removal of the building and restoration of the area to its original condition. In other words, all the information that can be used throughout the life cycle of the building. All participants in the building process contribute to this database. To maximize the BIM benefit, none of the parties involved in the life cycle of the building should refuse to use the BIM model and enter current data to it. The key advantage of this collaboration and access to information about the structure is collaboration without losing data and maintaining access to its current version. This does not mean that everyone has to put all their knowledge and data into the model. However, they should share information that is needed for other participants in the construction process.

Often, the 3D model itself is often mistaken for the building information model, even among professionals. Here, we need to realize that BIM essentially includes not only the actual information, but also rules for handling such information, and the 3D model is just one of many ways to present this information.

Non-geometric and complementary information (we say “parameters”, “attributes”, “properties”) of the individual elements of which the 3D model is composed can include design, material and utility properties, position in the construction schedule, unit price, schedule of inspections and replacements, investment and operating costs and more. In this way, you can create a model of the real object, which serves not only in the design and execution of a building, but also in its operation and maintenance.

The technical heart of the BIM method is the Common Data Environment (CDE), which includes all the information. That is, not only the 3D model and its non-geometric data, but also all other documents, communication between the project participants and their processes in the various phases of the building’s life cycle.



CDE/BIM - Common Data Environment

3.2 Long-term benefits of using BIM

The transition to BIM is associated with a change in current processes, notably through the communication, transmitting and sharing of data. The second area of change is the introduction of new technologies, which enable BIM models to be created, utilized and to effectively promote change in communication and processes across the life cycle of a building. The third important area is BIM's contribution to sustainable construction and total building quality. The most important benefits of using BIM throughout the life cycle of the building are as follows:

- savings in costs and time calculated over the life cycle of the building;
- improving communication between building process participants;
- improving the control of the building process;
- improving the quality of the resulting work;
- avoidance of collisions (their detection before commencing construction) and misunderstandings when working with information generated from old versions;
- increasing transparency and improving access to decision-making at different phases of the life-cycle of the construction (even for non-technical professions working on the project);
- the real possibility of continuous integration of all the necessary professions during the design phase of the project (e.g. budget expert, building administrator);
- environmental protection with an emphasis on energy savings (reducing the energy performance of buildings) thanks to the simulation possibilities at the project preparation phase and the use of data in the case of alterations to completed buildings (renovations) or their demolition;
- easier processing of different variants;
- streamlining the economic management of buildings (projects) from initial calculations, through selection and ongoing calculations to actual invoicing;
- significant documents for the design, installation, operation and replacement of equipment;
- availability of up-to-date information in one place;
- support for the development of the national infrastructure database for spatial information.

Investments in the creation of a comprehensive multidimensional model is much more efficient than in existing solutions thanks to wider distribution over time. This is despite the fact that the initial investment in creating a BIM model is typically higher than in the traditional method as it is today (2D documentation, spreadsheets, printed documents), and may require more time and expertise from the designer.

Estimated cost savings over the entire life-cycle of a building

Surveys in European countries show savings of 20% of the total cost over the entire life-cycle of a building using the BIM method (source: UK Project Case Studies 2004 for BS1192: 2007). Savings for new buildings or altering existing buildings (renovations) in public administration could be as follows:

Public works contracts in 2015 (complete data for 2016 were not available when the Strategy was being prepared) amounted to CZK 118.7 billion/year (source: Information System of Public Contracts). The savings of 20% would therefore be about CZK 23.7 billion per year in the case of public works contracts. This is an optimistic scenario of savings expected in the case of BIM implementation into public contracts. This involves, in particular, reducing the risk of additional costs due to items not included in the budget.

The basic distribution of a building's costs over its life-cycle is given in Chapter 5.6. Costs are about 2% for the design phase, 34% for the construction phase and 64% for management and maintenance.

Assuming that the 34% share of costs for the construction of new buildings is the above amount of CZK 118.7 billion (for the reference period of 2015), 64% for the management and maintenance represents more than CZK 223 billion. With the estimated average life of buildings of 50 years, the amount for their management and maintenance is CZK 4.4 billion per year. With the above 20% savings, the introduction of the BIM method could lead to expected annual savings in the management and maintenance of buildings built in 2015 of approximately CZK 880 million.

When assessing the total life-cycle costs of a building, the costs of operation account for about 64%. In 2016, total State assets registered by the Office for Government Representation in Property Affairs (UZSVM, source: www.uzsvm.cz, 2016 Annual Report) were worth more than CZK 18.6 billion, of which 3,163 buildings owned by the State (public administration) as of 31 December 2016 had management and maintenance expenditure of approximately CZK 3.3 billion annually.

3.3 Use of BIM in procuring, designing, constructing and operation/management of buildings

The basis of the BIM method is to bring together all participants involved in the preparation, construction and subsequent operation of the building into one cooperating unit and in one place, throughout the entire life-cycle of the building, including the continuity of its individual phases. This can be ensured if each participant has an awareness of the benefits of the BIM method. A summary of the main benefits of using BIM for individual participants is given in the table below.

Process	Use / Benefit
Builder (Investor)	• the possibility to control the project and its costs in all its phases • faster integration of requests and changes • crucial information for decision-making is available at earlier phases • easier communication with other participants • possibility to improve the quality of buildings thanks to SW validation of parameters and properties of the building materials, structures and products used and their compliance with applicable standards
Designer / Chief Designer (Architect, Engineer, Technician)	• more convenient work tools • easier modification of the design based on the requirements of the builder, structural engineer, etc. • easier creation of variants • fast visualizations (no need to recreate the 3D model) • rapid response from structural engineer on design options • rapid energy analysis • smooth transition from a conceptual model to a specific one • eliminating the risk of structural collisions
Designer of the	• easier communication with the designer / chief designer over one model • easier incorporation of changes • easier communication with the builder

construction part	
Designer of technical equipment and the technological part of the building	• easier communication with the designer / chief designer, structural engineer and designer of the construction part over one model • easier incorporation of changes • easier communication with the builder • savings when creating an analytical model • the option of a variant solution • the possibility of energy simulations
Structural engineer	• easier communication with the designer / chief designer and designer of the construction part over one model • easier incorporation of changes • easier communication with the builder • savings when creating an analytical model
Technical and author's supervision	• easier control of the as-built status according to the BIM model • easier communication with other participants • better possibility to record modification and change requests • reduced risk of bad information transmission
Budget expert	• time saving thanks to automatically generated data for creating an inventory of works, supplies and services, including change management • constant access to up-to-date information – more accurate valuation • the ability to quickly create cost variants for decision-making • clearer data logging for financial controlling (plan x reality) • rapid classification of individual construction elements through their easier visualization in the model
Contractor	• access to up-to-date documentation • easier communication with the designers of individual professions over one model • checking compliance with the time and financial plan • reducing the number of collisions found during construction • possibility to prepare prefabrication • easier and clearer breakdown of the supplies and works carried out by subcontractors, their coordination and control • more precise ordering of materials and thus lower waste generation
Facility manager	• the current building model filled with information on individual construction products and components, including the supplier, and information on their maintenance • simple reporting of construction products and elements, etc. • possibility to extend the model to include specific data for the FM

	• simplified decision-making in operation, maintenance and alterations to the completed building
Public administration	• all the benefits that apply to the builder • possibility to automatically check compliance between the design and mandatory requirements (using model validators) • more efficient use of public funds • reduced risk of cost overruns in public works contracts • increased transparency of construction projects • an easier simulation of the energy performance of the building and the optimization of its energy efficiency • the possibility to link different construction-related government registers for better infrastructure planning • simpler and more reliable communication and presentation of project plans in public hearings • support for the development of the national infrastructure database for spatial information.
Building certification	• savings when creating an analytical model • possibility of automatic control of some aspects of the model • simpler quantification and more effective assessment of some aspects of the sustainable construction concept

Generally, getting new benefits naturally requires going through a change and refinement process. This is all the more true for the BIM method because it affects almost all the roles related to the building. The more sophisticated the standardization / legal framework and education, the faster the whole process will be and thus the expected processes will start to show in real life. Well prepared and evaluated pilot projects can play a significant role here (see chapter 5.13).

The main general contribution of properly applied BIM is expected at the level of a gradual change in the contemporary confrontational environment in the building industry to one of cooperation. If the collaboration is properly established, secondary effects emerge, which lead to increased mutual trust, sharing of the necessary information, elimination of duplicate work, and thus increased work efficiency. The funds that these benefits can save are significant.

The above benefits then mainly accrue to the builder (investor), who gains real insight into all phases of preparation, design, construction and management of the building. He is thus able to continuously evaluate the progress towards the planned schedule, set-up and progress towards the planned costs of preparation and construction and, last but not least, to have an overview of the estimated operating costs of the building. This information, which can be reached in the early phases of the building's life cycle, will allow more efficient and longer-term allocation of the funds needed to complete the construction and its operation.

3.4 Life-cycle of buildings

The lifecycle of a building is the time period from the creation of the project plan through design, construction and use to demolition. It includes 4 basic phases – pre-investment, investment, operation and demolition.

Construction project					
Pre-investment phase		Investment phase		Operation	Demolition
Initiation	Definition	Design	Construction	Operation	Demolition
Life-cycle of buildings					
Project phase				Operation	Demolition
				Life-cycle of the use of a building	

Phase of a building's life-cycle

Compared with the current data processing method, where data life usually ends by passing a printed version of the validated as-built documentation, the BIM data is intended for further use for the operation phase of the building. The data model primarily benefits building operators, as the model includes, among other things, all important building components, including their specific position and parameters. With a consistent and correct use of the BIM method, the facility manager needs only a few steps to obtain for particular equipment e.g. all the data from the execution and handover (all change requests, defects, or unfinished work) related to it, including how they were handled. The data is thus available to all the involved in the current version throughout the life-cycle of the building. Thus, facility management can use the data not only to optimize operation, but also to timely plan maintenance work, inspections and alterations to completed buildings (renovations).

3.5 Specifics for transport structures and other types of infrastructure and special structures

Modelling of structures using appropriate SW in more than two dimensions is a method well known in a number of design studios, geodetic companies and transport structure contractors. Especially in the case of larger projects, this method allows achieving higher efficiency in the preparation of building documentation, fewer errors and the preparation of documents for geodetic works and automation of construction processes.

Transport structures

The Ministry of Transport of the Czech Republic (MoT) and its subordinate organizations, such as the State Fund for Transport Infrastructure (SFTI), Road and Motorway Directorate (RMD), Railway Infrastructure Administration (RIA), and the Waterways Directorate (WD) are responsible for the construction, modernization, repair and maintenance of the transport infrastructure (category 1 roads and motorways, railways and waterways). In line with the technical policy and the development needs of the MoT, the ministry, in cooperation with the SFTI, RMD, RIA and WD continuously creates new and updates (revisions, amendments, additions) existing regulations in the field of transport infrastructure. The MoT's technical regulations, based on the latest and proven knowledge of science, technology and practice, are designed to deliver optimal and rational solutions, particularly in terms of uniformity, economy, quality, reliability, service life, health and environmental protection, safety of persons, works and building structures. The technical conditions, which are part of the ministerial regulations, allow faster introduction of new knowledge into practice compared to Czech technical standards (ČSN), more detailed and complex processing, depending on the needs of the sector and individual managers. These materials and their revisions, and thus the revision of the BIM requirements and the actual information models of buildings, are key to their further use.

The standardization of BIM processes and the use of information models of buildings is important for transport construction for several reasons. The first important factor is the considerable extent of the road, rail and waterways networks. Compared to other types of buildings, the large volume of property is further enhanced by the fact that transport infrastructure is predominantly owned by the State and local authorities. The role of contracting authorities in the case of state-owned transport infrastructure is played by only three very important investment organizations (RMD, RIA, WD). Transport structures carried out by these contracting authorities are funded through the SFTI. The above indicates that there is a high degree of concentration of powers and responsibility for transport infrastructure structures, which can be considered as the second important factor. Both of these factors may mean that the decision on using information models of transport structures will be simpler; on the other hand, the actual implementation of BIM processes into practice will be more demanding, with more risks than in the case of buildings, and will require solutions tailored to the needs of the State administration of each particular infrastructure.

In preparing this solution, we will also need to take into account other facts. An important specific aspect of transport structures is their spatial location and the need to manage information models as geographic data. In transport construction, we mainly talk about interconnected line construction works, unlike in the case of building construction, dominated by point structures (located mainly on a concentrated area with a more complex internal arrangement). This specificity is related both to SW tools used for the preparation of information models and to the tools used for their use during project implementation. To manage these data, geographic information systems are used, which will have to have a clearly defined link to the information model of the construction work. Also, building structures do not have such a sophisticated system of standardization as is the case with the technical conditions for transport structures.

For all transport structures, public interest protection, economical and efficient spending of funds, transport safety, necessary uniformity of parameters, reliability, service life and quality of the work, security and data protection must be ensured. In order for these to be ensured, the requirements for building information models and methods for transport infrastructure structures should be in line with the National Strategy.

The State Fund for Transport Infrastructure has set up an expert working group composed of representatives of the MoT, MIT, RMA, RIA, WD, academic community and experts nominated by professional associations and unions. Simultaneously with this Strategy for the implementation of the BIM method in the Czech Republic, a sectoral strategy for the implementation of buildings information modelling for the transport sector is being prepared under the auspices of the STFI, with pilot projects being prepared for implementation in 2017.

Public energy infrastructure works

The public energy infrastructure includes, in particular, power transmission and distribution systems, gas transmission and distribution systems, district heating and oil and oil products transport structures (oil pipelines and product pipelines). The power transmission and distribution system consists of overhead lines (conductors with support points – masts, including other equipment), underground lines (electric cables in the ground) and substations incl. transformer stations. The gas transmission and distribution system consists of pipelines with facilities (compression, transfer and control stations, distribution nodes and track closures). In the heating industry this involves thermal pipeline networks and transfer stations. Oil pipelines and product pipelines are underground pipelines with service facilities, end-points and control station of the line system operator.

Similarly to the transport structures, these are lines, i.e. line structures, which is a fundamental difference compared to building structures. Facilities located on power lines, such as compressor stations, substations and others, contain mostly technological objects, and administrative and other buildings in the area.

It can thus be stated that, in terms of their construction execution, line power structures are very simple in design, where the need to use the BIM method is still to be assessed. The BIM method is expected to be used in buildings that are part of the public power infrastructure.

Water management structures

The BIM method can also be applied to selected water management structures. These are, in particular, important structures of water management infrastructure, which are similar to building / traffic structures. These structures are predominantly point structures, whose characteristics do not change over time depending on natural conditions, or change in a controlled manner. These are structures such as dams, large weirs and water reservoirs, sailing chambers, hydro plants, waste water treatment plants, complex flood protection measures or significant waterway modifications, etc.

On the other hand, there are water structures that are structurally simple, they are considerably influenced by natural effects (water flow, sedimentation, etc.) during their lifetime, and are therefore often unpredictably shaped and functionally unstable. These include, for example, structures of common watercourse modifications, trough reinforcements, simple flood dams, ponds and small water reservoirs, small objects on watercourses (e.g. limnigraphs, measurement profiles, transverse thresholds, gravel grooves, slides, fish passes, etc.), as well as activities such as certain revitalizations of watercourses, dredging of deposits, vegetation reinforcements, etc., as well as repairs and maintenance of the above. Often, because of their size, they are constructionally simple but very costly. For these types of structures, increased input investments in BIM modelling would apparently not outweigh the low amount of information that the BIM model would contain.

For the above reasons, it would be advisable to set up an expert group for BIM with a focus on water management structures, made up of representatives of the Ministry of Agriculture and organizations associating project organizations, contractor companies, owners and operators in the field of water management structures, which would simultaneously serve as a consultative and advisory body in in this area.

The example of water management structures clearly shows that the application of the BIM method must also take into account the type of structure. This circumstance will be analyzed in the context of the further development of BIM (pilot projects) and the mandatory use of BIM in public procurement will be specified according to the conclusions of the evaluation of pilot projects and taking into account the specific aspects of individual types of structures. An important variable will also be the detail level of BIM for each type of structure.

4 Analysis of the current state

4.1 Implementation of BIM in Europe

The BIM is not implemented only in the Czech Republic. The activities for setting the conditions and rules are emerging around the world, and plans are being prepared in individual countries to implement BIM either for public procurement or for the entire construction industry. In some countries, the rules are already in place, other countries the states focus on managing their public assets, or on technical standardization. Approaches vary also according to the stage of development of the local construction market. The following table shows the selection of European countries active in BIM implementation:

Country	Rules prepared from	Focus (BS vs Infrastructure)	Note	Financial support / Costs
Norway	2007	building structures and infrastructure	mandatory in public procurement since 2010	N/A
	Stattsbygg, Norwegian Public Roads a National Rail Administration			
Finland	2001	building structures	focused on State administration buildings and their FM, mandatory since 2007 (1st version of requirements), update of COBIM 2012 requirements	N/A
	2015	infrastructure	the BIM model as part of the transport digitization plan (2016–2018), the so-called INFRABIM requirements	
	Senaatti Properties, Finnish Transport Agency			
Denmark	2007	building structures and infrastructure	mandatory for State public procurement over EUR 2.7 million (DKK 20 million) from 2011; from 2013 update of requirements for “digital structure” (from DKK 5 million for State PP, DKK 20 million for regions and municipalities)	N/A
	bips (Byggeri Informationsteknologi Produktivitet Samarbejde), The Palaces and Properties Agency, The Danish University and Property Agency and Defence Construction Service			
Netherlands	2010		mandatory over EUR 10 million from 11/2011, BIM Loket (gateway) from	N/A

			2015 – source of BIM information, emphasis on interconnection with GIS	
	Dutch Building Information Council (BIR), Central Government Real Estate Agency (Rgd Standard for Building Information Modelling)			
United Kingdom	2011 - 2016	building structures and infrastructure	BIM Level 2 mandatory from 2016; 2017–2020 is for verification pilot projects; Digital Build Britain for BIM Level 3 is currently being developed	N/A
	BIM Task Group and RIBA (Royal Institute of British Architects)			
France	2015	building structures and infrastructure	at the central level, focused on good examples and evaluation of completed projects; now expected to be mandatory from 2017	EUR 20 million for 3 years
	Plan Transition Numerique dans le Batiment			
Federal Republic of Germany	2015	mostly infrastructure	2017–2020 pilot projects, BIM mandatory from 2020 for all public procurement projects	EUR 30 million for pilot infrastructure projects
	Platform Digitales Bauen			
Spain	2016	building structures and infrastructure	government strategy is delayed, strategy 7/2015, mandatory from 2018 for building structures, 2019 infrastructure	N/A
	Ministry of Public Works			

The expanding interest in the BIM method can be illustrated by the map of countries that are involved in the technical standardization for this area within the International Commission ISO/TC59/SC13 (blue states – ISO members; yellow states – observers). At the same time, countries that already have mandatory BIM use at different levels are also marked. The year is the deadline for introducing mandatory use of BIM in individual countries.

In European countries, there is an evident effort to combine local conditions and new approaches, but at the same time the effort to establish mutual communication and sharing of experience. Therefore, at EU level, the EU BIM Task Group has been set up to produce recommendations based on country-specific information. However, the specific BIM implementation system must be addressed by each country itself. The Czech Republic has its representative in this group.

After a comparison of different approaches, it can be stated that the most appropriate approach for the Czech Republic will be one based on the implementation of BIM by the public sector. The respective ministries will be responsible for the tasks arising from this Strategy (see Chapter 6.2). The MIT will ensure coordination and communication between the responsible ministries, professional institutions and the commercial sector in order to avoid fragmentation, inefficient duplication of activities and, in particular, the ambiguity of the necessary sub-steps to meet the overall objective.

The basis should be technical standards made at international level, with their minimum adaptation to local conditions. The determination of the content and level of detail of the information model should be made on the basis of practical requirements and verified on selected pilot projects. The content of the model should also include the requirements and statements of all the authorities concerned which are necessary for the siting and permitting of the structure.

Based on experience from countries where BIM is already in use, it seems that it is essential for public administration to work with people and manage change in the implementation of their existing activities. One of the key means of implementing BIM in public administration is the support and implementation of pilot projects. Through pilot projects, the builder gains experience in the awarding, control and implementation of BIM projects. This experience is further evaluated and taken into account in the materials being prepared. It is also thanks to pilot projects that the market environment is cultivated and the market outputs are gradually standardized. The basis for the successful implementation of BIM throughout the life cycle of a construction project (here, project does not mean only the actual design phase of the project) is the consistent deployment and use of a common data environment (CDE) available to all project participants. CDE is the information and communication center. Only in this way can the project information (including a 3D model linked to other non-geometric data) be controlled, ensuring that all up-to-date information is available to the investor in one place.

Perhaps the most affected area will be the cooperation of individual participants in the construction process. Here, it is possible to learn lessons and start as soon as possible with massive awareness-raising explaining the nature of the changes with the gradual use of the BIM method (see chapter 5.12). Another area concerned will also be the way documentation is handed over. The aim is complete digitization of the construction sector and electronic transmission of information. The EU countries aim at a transition of communication with State administration from paper to electronic form. By comparing different countries and by consultations, it has been verified that individual countries are dealing with very similar issues, each country just emphasizes a somewhat different aspect of implementation.

Recommendation:

- *provide for the activity of a State publicly co-funded organization which will in particular ensure the fulfilment of the tasks resulting from this Strategy*
- *publish the requirements, procedures and methodologies using technical standardization, or other documents, as they are more advantageous compared to legislation (to be used only in the necessary cases, e.g. in connection with the drafting of the new building law and related regulations)*
- *draw inspiration from the experience of foreign pilot projects and already implemented projects that used BIM for at least a part of the process and to look for incentives for expert discussion on the possibilities of their use in the creation of Czech methodology*
- *define clearly and comprehensibly the obligation to use BIM for public works contracts financed from public budgets, from a certain size and type of structure with a sufficiently long preparatory period (see chapter 5.11)*

4.2 Implementation BIM in the Czech Republic

The BIM method started to be discussed more extensively in the Czech Republic in 2011. This was due to the activities of innovative design companies that saw their development in 3D, but, at that time, without any further use of the data throughout the structure's life cycle. There has not been much talk about the transfer of BIM data and its meaning.

At present, there are already designs of structures that are reported to have been prepared using the BIM method. An interesting thing was also the award of a special prize for the use of BIM for the 2016 Building of the Year award. In most cases, however, the use of BIM was only partial for separate stages of the construction process. Moreover, given that national standards are not defined, participants in each project have to agree on their own conditions, which is in many cases beyond their professional and time capacity. This leads to the creation of data sets that have a different content and structure of data and whose use is problematic in later stages of the project. Since 2012, we have seen the gradual adoption of the ISO and CEN technical standards for BIM (see Chapter 5.8); however, their application also requires the elaboration of examples of use (i.e. create examples of their application in contemporary practice).

In common practice, BIM modelling is most often found in architectural and building solutions of building documentation, and partly also in structural engineering calculations (mostly inputs from the construction part). Similar results are for the "technical equipment of buildings" part, where designers are able to use BIM model outputs (3D) for their designs as input and possibly provide back their outputs in 3D for coordination. For these professions, however, this is very rare, especially because the habits and standards for 2D documentation of technical equipment of buildings differ from the approach in the BIM method.

In the construction phase, some construction companies have already discovered the benefits of sufficient information from the previous phases. Let's list at least the main benefits:

- preventing collisions on the site, the possibility of collision detection already in the design phase
- the possibility of planning the progress of construction and more accurate planning of the required material at a given time and amount
- the possibility to use prefabrication
- the possibility to use automation
- more precise control of completed work and its quality

The areas of valuation and facility management are far removed from the practical use of the BIM method for one common reason – the lack of a technical standard of information contained in 3D models (for more details, see chapter 5.2).

Progressive entities are building material manufacturers. They are spontaneously creating individual libraries of elements. Some manufacturers already have such libraries and catalogs on their websites, but mostly they only create partial data, often intended only for selected SW tools. The actual use of BIM in practice requires the definition of requirements for the properties of construction products and elements for the creation of a BIM model. The Strategy addresses the proposed solution in chapter 5.3.

Generally, BIM is currently used mainly in the commercial sector, especially in relation to creating and working with the 3D model. There are first cautious attempts to implement the BIM Execution Plan and to begin to gradually address and use the basic processes of the BIM method. Real practice is hindered by very little knowledge, media distortions, or narrow commercial interests of some vendors of a particular SW solution.

Educational institutions in the Czech Republic also started to respond to the emerging trend of BIM. Some high schools and universities are trying to introduce BIM into their curricula, but they have to face a number of problems (such as staffing). BIM is also reflected by lifelong learning providers and the growing expertise of consulting companies that help implement BIM. A significant impediment to the proper implementation of BIM in education is a lack of established practice and an ambiguous or non-standardized view of how to properly implement BIM.

Lack of better use of information in the downstream phases of the lifecycle prevents the extension of the BIM method in the Czech Republic. There is a clear lack of basic standards, i.e. rules and procedures, and a shift from the fragmentation of the overall process to cooperation. The solution is not only to define the basic requirements and rules, but also to put more emphasis on increasing the awareness and education of all potential participants of BIM-based projects and especially those who can best utilize the resulting data. At present, the largest activity can be seen in project companies, but a lack of activity can be seen among the contracting entities procuring building documentation, construction companies and construction administrators, i.e. where the BIM methodology would be most beneficial.

An important question that needs to be addressed remains the availability of BIM standards and tools for all those involved in the entire construction process. In general, standards in the form of Czech technical standards are available for a fee. Other standards created within the Strategy will be publicly available for free. The SW tools for building the BIM model are available for a fee. Some SW tools for viewing the BIM model are available for free.

<u>Recommendation:</u>

The recommendations for the Czech Republic can be found in the following texts of Chapter 5.

5 Key topics related to BIM

5.1 Construction 4.0

A much higher efficiency using the BIM method can be achieved if it is part of a more general strategy of digitization of the entire construction industry (Construction 4.0), which is expected to be prepared for the Czech Republic. The adoption of the BIM Implementation Strategy is the first major step in digitizing the construction industry.

Here it is possible to draw inspiration from the industry sector, whose driver is the effort to ensure competitiveness, innovation and productivity gains. Worldwide, one of the main tools to achieve these goals is the widespread use of computer systems. This area has achieved massive development over the last ten years and has offered the industry a huge potential, which it can actually start using for its needs. In general, the term "industrial digitization" is used for the interconnected use of computers, while globally the term Industry 4.0 has been used. The dynamics of these changes and their importance in the formation of the whole society was termed "4th Industrial Revolution".

Countries believe it will strengthen their competitiveness. That is why Industry 4.0 has become the basis for national programmes in a number of countries formulated in 2014–2015 (for example: USA, France, Germany, China, Japan and elsewhere). The Czech study entitled "National Initiative Industry 4.0" was completed on 3 February 2016 and became the basis for Resolution No 729 of the Government of the Czech Republic of 24 August 2016.

It needs to be addressed as a global issue, i.e. "Society 4.0" in all areas of economic and social life, which follows on the Action Plan for the Development of the Digital Market, which was approved by Resolution No 917 of the Government of the Czech Republic of 17 October 2016. In order to effectively implement the agendas associated with the 4th Industrial Revolution, Resolution No 119 of the Government of the Czech Republic of 15 February 2017 approved the establishment of Society 4.0 Alliance, which aims to establish an interministerial coordination mechanism. Among other things, the Alliance should set up work and coordinating committees for each of the 4.0 agendas (it is assumed that a Construction 4.0 committee will be established).

Construction is developing more slowly in this area; both in the Czech Republic and in the EU it belong to sectors where labour productivity is growing slowly. This is probably due to the increasing complexity of buildings and their constructions, responding to various energy, environmental and other requirements, but also by the widespread use of low-productivity workforce. Construction industry is a relatively conservative sector, and this is reflected in its ability to invest resources in innovation in the area of information technology.

In this process, the State can play a very positive stimulating role if the construction industry offers a clearly formulated strategy for the development of its own digitization of processes so that all entities involved in the individual projects can naturally follow it. However, Construction 4.0 does not include only a narrow definition of the "construction industry", but the entire construction process from the conditions for siting the structure and selecting the site, through project and investment preparation, actual construction to operation and maintenance of structures.

It follows from the above that this Strategy is the first part of a comprehensive strategy Construction 4.0, which should cover all the areas affected by construction projects during their entire lifecycle. To illustrate, let us specify only the areas related to the BIM methodology, which are offered in the first place:

- a standardized data format for public procurement tenders;
- linking GIS systems with 3D models, which represent the core of BIM processes;
- Cadastre of Real Estate and land-use planning;
- standardized records of State property administration;
- electronic processes for the siting and permitting of buildings, including related statements and opinions.

The benefits for the State from achieving these goals are so significant that they are worth the major changes that need to be made for them to become commonplace. These benefits primarily include increasing the work productivity, transparency and, above all, the ability of the State to have a controlled approach to current information and to effectively link it in real time to its other agendas.

The term "e-Government" is also related to the above-mentioned topics. In the Czech Republic, this agenda is under the responsibility of the Ministry of the Interior. The notion of e-Government means governance using modern electronic tools to make public administration friendly to citizens, more accessible, more efficient, faster and cheaper. The e-Government pillars were built in the 2007–2013 programming period using EU Structural Funds in line with the Smart Administration strategy. Below is a brief list of the most important agendas that came out of this initiative:

- Czech POINT – contact points providing one-stop access for citizens to a range of documents and services, which were until then obtained at several different offices;
- data boxes – a tool for official electronic communication with the State, which replaced the classic envelopes with a colour stripe;
- national registers – containing up-to-date data, which, in most cases, officials do not have to repeatedly request from citizens.

The next step in ensuring that official matters are available at any time and from any place over the Internet is the gradual deployment of smart electronic forms.

An important topic for e-Government in the field of construction is in particular the electronic permission processes (leading to the siting, permitting and approval of the structure) and the subsequent linking of the building data to existing registers and asset management systems. Many of the tasks required for BIM application can take advantage of existing rules from already functioning e-Government components.

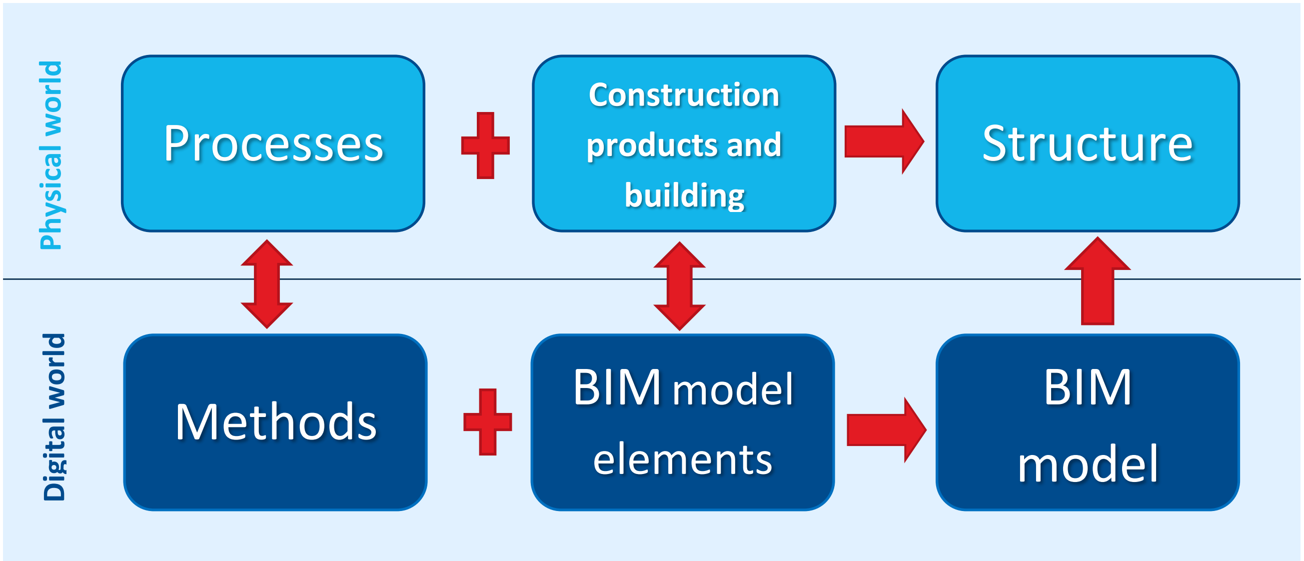
In addition to the topics mentioned above (Society 4.0, e-Government), the Action Plan for the Development of the Digital Market also touches on SMARTCities (SMARTRegions). Smart cities is one of the concepts for applying sustainable development principles to city organization that relies on the use of modern technologies to improve the quality of life and streamline public governance. The SMARTCity concept covers not only energy and transport, it can also be applied to waste and water management, e-Government and crisis management. BIM is one of the tools that can significantly boost the development of these activities. Every structure is part of a larger unit and connected to its surroundings. Using BIM will allow for better coordination, more information on these connections in designing and monitoring the "behaviour" of a structure in use, their comparisons and other activities. The BIM model can therefore be seen as a source of information for further use of structures. In addition, the application of BIM assumes uniform data structured models of structures in a given area. The information is thus available with the same structure and content.

Recommendation:

- *support the introduction of the BIM method as a necessary condition for the future transition to electronic permitting processes of structures and the overall digitization of the construction sector.*
- *maximise the use of already established procedures of related fields such as electronic document transfer, electronic signature, electronic invoicing, data security*
- *in connection with the anticipated digitisation of permitting processes of structures, use the BIM to quantify the financial needs of the entities concerned*
- *set up Construction 4.0 Committee under the Society 4.0 Alliance to coordinate the digitization of the construction sector*

5.2 BIM model

Every structure consists of construction products, materials and structures (elements). The BIM model is a digital version of the actual building. It incorporates geometric data in the form of a 3D model and non-geometric data. Non-geometric data includes a number of management and supporting documents of structures, such as site diary, schedule, OSH documents, outputs from decision-making processes of building authorities, and others. All documents that are part of the BIM documentation are stored in a common data environment (CDE), which forms the source of a valid version of the documentation. Some documents may also be linked to certain elements of a 3D model.



If BIM models are to fulfil their expected role as an important part of the BIM method, and a significant source of structured data for other specialized applications (e.g. pricing, scheduling, facility management), they must be highly standardized. Without standardization of source data, it is not possible to program any interfaces between systems and subsequently offer functionality that significantly improves the efficiency and quality of work of users of specialized applications.

The standardization of BIM models can be divided into two areas – format and content. The format's standard has already been globally established as the IFC format. Therefore, there is no point in considering any national standardization. The IFC format is already part of the Czech system of standards as ČSN EN ISO 16739:2017. Its further updates will now be adopted as part of the EN ISO 16739-x series. It would be appropriate to translate the terminological parts of this standard into Czech so that all participants in the building process use the same terms, and that their meanings are clearly defined when defining certain parameters.

Much more complicated is the standardization of the content of data stored inside the BIM model. There is no single standardization within the EU, so Member States have to address this issue at national level. The determining input for this standardization is the level of detail of the model, i.e. the precise determination of the project phase for which the model is being prepared. It is primarily necessary to determine the purpose of using the model. At present, lack of standardization often leads to models being required in too much detail in relation to their planned use, which may have a negative impact on wider adoption of BIM in the Czech Republic.

For 3D models, the abbreviation LOD is used (Level of Detail, Level of Development, Level of Definition). A new term "LOG" (Level of Geometry) is also starting to be used. The exact definition of these terms is currently being prepared by CEN. There are several other systems defining this standard, but there is no global standard for assigning them to project phases. It is necessary to create a Czech standard and define the levels of structure documentation and their level of detail. For reasons of compatibility, it is necessary to also keep track of developments at European level. It will be effective if the Czech Republic develops national standards drawing inspiration from European countries that may sooner or later be expected to set the trends in terms of standardization and further development of the BIM method (e.g. Great Britain, the Netherlands, Germany).

Information stored in the BIM model can be divided into two groups by its purpose:

- geometric data (visual appearance of an element);
- non-geometric data (properties and parameters of the individual elements of a model, or management and supporting documents of a structure).

The first area of standardization for both groups is the division of the elements into set groups, i.e. their sorting. The second area of standardization is the scope of non-geometric data (LOI – Level of Information) in relation to the LOD (depending on the structure documentation level). This standardization is key to creating an interface for other SW systems mentioned at the beginning of this chapter. An important element supporting this standard will be the creation of a database of required and recommended properties of construction products and building elements (see chapter 5.3).

All information about a structure will be stored in a shared repository – the CDE. The CDE environment means a common environment for one project, not a common environment for all public contracts. It will be up to each contracting authority to choose the CDE in which it will execute its contract and allow all the contract participants to access it. Within the upcoming methodology, specific conditions and rules for the use of CDE throughout the life cycle of the structure, including requirements for the safety of management of stored data by its provider, will be recommended based on analysis and international experience.

Data and information standardized in the form of methodologies and recommended standards are expected to be publicly accessible. Standards in the form of Czech technical standards will be accessible in accordance with applicable legal regulations.

Recommendation:

- *standardize the content of the data for each level of model detail in relation to the relevant building documentation levels*
- *determine a standard for the scope and content of non-geometric data for each type of model element*
- *establish the IFC as a format with nation-wide support for sharing the BIM models among individual participants in the structure's life-cycle*

- *harmonise the terminology*
- *develop a methodology for the selection of the CDE by the contracting authority, including recommendations on the conditions and rules for its use throughout the life-cycle of the structure, also with regard to requirements for data management safety by the CDE provider and archiving requirements*
- *analyze the control documents concurrently used on construction sites and other sources of information and the need for their inclusion in the BIM model*
- *evaluate the methods of keeping a digital construction site diary*

5.3 Requirements for the properties of construction products and construction elements for the creation of a building information model

To support the use of BIM models by entities in the construction industry (manufacturers, project companies, contractors, etc.), it is necessary to ensure the quality of the transmitted data. It is necessary to establish standards for the transmission of information and to clearly define the requirements for the properties of construction products for the creation of the information model of buildings. Without this standardization, the resulting quality of the model being received could vary depending on the type of SW used for building design.

Software interoperability must be ensured, based on neutral and stable open data formats. The IFC format, which meets this requirement, is currently the only common format supported by SW vendors for designing buildings, and complies with ISO 16739 (adopted as ČSN EN ISO 16739:2017). This format also contains the definition of the parameters (properties) of the individual elements of the model, which the SW can already transmit between each other.

Due to the fragmentation of the market for individual types of SW and the ever-developing IFC standard, it is appropriate to set the requirements for the properties of individual construction products as universal, so that they can be processed in any SW, either by manufacturers of construction products, by BIM library processors or by designers. The properties of products can then be linked by means of a database to the IFC format according to ISO 16739. Whoever creates and then transmit a model in the IFC format will not be limited to a specific software solution. The aim is to standardize output, not workflow. This is based on the properties of construction products that are declared by manufacturers in declarations of product properties, declarations of conformity, or in technical documentation. The declared properties of construction products must be based on applicable regulations.

Harmonized construction products are governed by Regulation (EU) No 305/2011 of the European Parliament and of the Council laying down harmonized conditions for the marketing of the construction products. Non-harmonized area of construction products is governed by Government Decree No 163/2002, laying down technical requirements for selected construction products, as amended. At present, the issue of construction products is fragmented, complex and in many cases there are no mandatory properties for the products. Better clarity and simplification of this area will be brought by the forthcoming Construction Products Act, which the Ministry of Industry and Trade should submit to the Government of the Czech Republic by the end of 2018. The regulation also provides for the required properties of construction products. The MIT aims to link these properties by means of a database with the IFC format and the standard described in chapter 5.2.

The database of properties of construction products is the basis for the creation of the database of construction elements, which will form the basis for compiling 3D models and other applications used in the

BIM method, so that individual elements and element databases of information models can be created in a unified fashion. The definition of each database element will contain a geometric representation of the element (LOD) for each level of building documentation and non-geometric data (LOI, minimum level of required information, descriptive data and technical parameters) in a standardized structure for individual element types. In the geometric part, the volume of data is significantly increased by the individual vendors of CAD/BIM systems, which are mutually incompatible. At present, a database of building elements is already being created.

Validation software programs (validators) will constitute a very important functionality ensuring that all data contained in the model conform to the applicable BIM model requirements. This tool will be crucial for contracting authorities procuring building documentation, since it will enable them to create a "one-click" protocol of non-conformities of the information model with specified requirements. Knowledge of this process and the general accessibility of this tool to model creators will lead in the long run to significant efficiency and quality improvements, as they will be able to carry out this control themselves before submitting the model to the contracting authority.

The role of the State should be limited to the management of a publicly available standard describing the requirements for product properties for their incorporation into buildings. These requirements will have to be respected in the creation of information models and individual libraries of BIM model elements and tools for their operation, the creation of which will be left by the State to individual commercial solutions.

Recommendation:

- *create and maintain a portal/database of required and recommended properties of construction products in connection with the forthcoming Construction Products Act*
- *assign the IFC parameters to the properties of construction products in the database*
- *determine the content and structure of minimum required data (both geometric and non-geometric) for individual types of construction elements*
- *ensure appropriate software solutions (validators) to verify compliance of the scope of BIM element properties in libraries with this standard, including their proper designation for effective creation of BIM models. This tool is critical for streamlining project work and minimizing BIM adaptations.*
- *ensure appropriate software solutions (validators) to verify compliance of BIM content with the standard defining the requirements for non-geometric data of BIM elements; this tool is critical to improving and simplifying the control of the BIM models received by contracting authorities*

5.4 Content of the BIM documentation

The BIM documentation, its content and structure should be currently based on Decree No 499/2006 on building documentation, as amended by Decree No 62/2013 and Decree No 146/2008 on the scope and content of the project documentation for transport structures. The Building Act does not have to explicitly mention the existence of the BIM method, it should only create the conditions for the possibility of electronic submission of documentation. Due to the rapid development of information technology, it is better to address specific technical requirements in a different form – e.g. through technical standards or methodologies issued by recognized professional and interest organizations.

Due to the gradual implementation of the BIM method, it is appropriate to initially leave the current 2D documentation as it is, and define the BIM documentation as another possible option. The builder will then be able to choose whether to use the BIM method or the classic 2D documentation. As with the transition from manual to computer-based creation of documentation, we can expect that the BIM method will become dominant after stakeholders become familiar with the new information technologies, and the importance of standard documentation will gradually diminish.

If the BIM method is used, the requirement for as-built documentation will change. Nowadays, as-built documentation can be delivered as a certified copy of the project documentation for the building permit proceedings, with annexed drawings of deviations. For the BIM method, deviations need to be incorporated into the resulting BIM model, otherwise its content is pointless for subsequent management and maintenance of the building because it will not describe the "as-is" state of the building. Individual deviations showing differences and changes between BIM models at different phases of the project documentation must be clearly identifiable so that the "as-built" execution of the building (with modifications or additions) is part of the BIM model. To support the use of the BIM method, it is necessary to create contractual and technical aids (model contracts, terms and conditions, technical conditions), which, if legal requirements are respected, will facilitate and regulate the contractual practice in construction.

No rules are currently in place for the electronic submission of documentation; therefore, all land-use, building permit and use permit procedures are based on "paper" documentation. The content of standard 2D documentation may in some cases be replaced by a clearer and more accurate documentation in the form of a BIM model. Most BIM software tools allow the creation of both standard documentation and BIM model. To fully utilize the BIM, it is advisable to consider reviewing the content of the documentation required for the decision or permission pursuant to the Building Act. There are also no rules for the phase that follows the project documentation – valuation. Here too, it will be necessary to harmonize the requirements so that electronic procurement can be used, as well as contract valuation and further processing (see chapter 5.11). To determine the content and structure of the documentation, it will be necessary to use the results in chapter 5.2 on the BIM model.

The aim of introducing the BIM method is first to introduce the possibility of electronic submission of building documentation (e.g. in pdf), which the current Building Act does not allow. After analysing the needs of building authorities and other relevant authorities associated with full digitization, the digitization of the permitting processes using BIM will be prepared and subsequently introduced. The full implementation of the BIM will follow on the recodification of public building law.

Recommendation:

- *prepare sample contract terms or model contracts*
- *determine the content and structure of the model for issuing a decision/permission pursuant to the Building Act*
- *in relation to the use of the BIM method, assess the need to revise the content of the documentation required for the siting, permitting and approval of buildings and, if necessary, to carry out the revision*
- *evaluate the current situation and propose solutions for the electronic submission of building documentation (e.g. in pdf) in connection with the use of BIM*
- *quantify the financial needs of building authorities and the relevant authorities associated with the anticipated digitization of building permitting processes*
- *propose a way to ensure the integrity of building documentation, i.e. the way of securing the submitted documentation so that it can be demonstrated that no change has occurred after the handover and that the BIM model is not damaged (either intentionally or by mistake)*
- *digitization of building permitting processes using BIM*

5.5 BIM in relation to the budgets, costs and building schedule

The valuation phase (referred to as 5D) will be significantly affected by the introduction of the BIM method. The existing valuation methods and customs have long been rooted in practice in the Czech Republic, and their change will be a lengthy and very demanding process, both for the creators of the new single methodology and for all the positions that calculate price (for example, budget experts). The whole process should be evolutionary but with the appropriate dynamics to ensure that progressive changes are validated in practice, and corrections are quickly integrated into the new valuation methodology. The task of the future professional discussion is the form and level of detail of this new standardized valuation methodology with the possibility of further revisions as the environment evolves; the price should be created in cooperation of all authors of price systems. One of the approaches can be to determine only the basic binding structure descriptor and leave a detailed specification of the technology to individual price system makers.

The overall contribution of the BIM and the concentration of all project data in one common data environment (CDE) provides a real opportunity to effectively involve budget experts in the project preparation process, thus providing relevant financial calculations for the implementation of the entire project from the very beginning. The accuracy and valuation methodology will, of course, depend on the project phase, but sharing information in the CDE will allow gradual refinement, different variants and transparent archiving of the entire process. In order to exploit the full potential of information available in the BIM model built during the design of a building, valuation systems will need to be directly linked to data stored in the IFC format, which is the only open standard for storing BIM models. This means that there must be a methodology to compile a complete list of items describing the whole project, not only a list of products, but also their assembly and above all the structural elements. For each item, a unit of measurement must be clearly defined, and there must be a system to determine its quantity from the geometric (3D) part of the BIM model.

It is clear that the valuation methodology must respect the requirement for subsequent algorithmisation in individual valuation systems. If the process is to be effective and unambiguous for valuation, methodical standardization of 3D modelling and standardization of the structure of non-geometric data on individual model elements will be necessary (see chapter 5.2). Otherwise, the valuation will be very lengthy and demanding, requiring high costs for the inventory of construction works, supplies and services, and BIM benefits will be suppressed.

Linking pricing systems to 3D models will bring accurate and, above all, automated detection and transmission of changes, both in terms of the quantities of individual elements/items, as well as in the detection of elements added to or removed from the model. Here too, the work of the budget expert is an unavoidable part of the process, but it will change, focusing more on compiling the price according to more precise documents, without the need to perform a mechanical work of checking inconsistencies of inputs from all participants in the construction. Change management will therefore be much more effective, but especially completely transparent.

By creating standardized and, if possible, simple valuation methodologies along with the standardization of 3D models, the industry can benefit from significant financial savings due to work efficiency, accelerated process and significant elimination of human error.

Another separate chapter is the final valuation of the inventory of construction works, supplies and services. Here a significant role may be played by potential makers of the price system, who could offer the State administration initial baseline unit prices for individual items, as is currently the case, for example, in the Ministry of Transport. However, it is never to be expected that this database will contain a complete range of valuation items and prices valid for each individual project, so, of course, a qualified budget expert will still be needed for good valuation. Here lies the key quality in a budget expert – to assess each project specifically because each construction project is truly unique and no price system can take this into consideration in its unit prices. This must continue to be done by a qualified professional.

The provision of pricing systems may, of course, continue to be the subject of commercial competition, but valuation methodology should be only one and, therefore, under the control of State administration.

Should the State be able to link this standardized valuation methodology to data standards for procurement tenders (see chapter 5.11), it would gradually acquire valuable knowledge that could subsequently be used efficiently in the evaluation of tenders for similar new contracts or their parts. It is possible to consider here that the State can statistically process these prices and subsequently publish them as its indicative pricing system, while respecting the individuality of each individual project. These documents can serve as the basis for determining extremely low bid price, thereby facilitating decision making and providing a good basis for rejecting possible objections in this respect. Another effect of this approach will undoubtedly be the cultivation of the entire construction process, both in the initial selection phase and especially in relation to potential extra work. These principles could be readily used even for commercial construction.

Scheduling in a BIM environment (referred to as 4D) refers to the interconnection of individual model elements with an externally processed schedule (timetable). It is created by standard scheduling tools. This interconnection between the elements of the nD model and schedule allows the modelling of the construction process, an animation allowing to verify the completeness and correctness of the proposed implementation process and the feasibility of the individual structures or technological units and the scheduling of their execution.

The detail level of the display of each phase of a building project depends on the selected detail level of the BIM model and schedule, i.e. the level of aggregation of model elements and schedule items. The degree of aggregation should reflect the key activities (and real technological and technical requirements for construction) and display options; the schedule should not be too detailed. The degree of aggregation of the schedule items and the breakdown of the 3D model determine the subsequent complexity of linking animation elements. The data structure of both inputs is crucial in this respect for easily linking the schedule with the model.

If the content of the model information is prepared in an agreed standard (see chapter 5.2), it is possible to prepare "universal" rules for the interconnection of elements and items according to which the elements can easily identify each other. This interconnection also allows cost/cash flow simulation according to the schedule in each phase of the construction project as a significant benefit to the builder. This allows the real progress of the project to be monitored for checking the funds. Prepared aggregated cost items (price indicators) are linked to the schedule and model elements. However, this functionality can only be achieved through a rational interconnection between the valuation system, scheduling items and 3D model elements (they must be mutually consistent in structure and content).

By properly interconnecting individual items in the schedule with their image in the BIM model, it is possible to easily see the differences in the anticipated and real progress of construction. This feature is based on the option to create master plans that are uploaded as a schedule to the model. The model is then decomposed into two identical virtual images, which can be compared to each other depending on the construction progress, thus simply demonstrating the progress and any delays/advances in the project. Additionally, it is possible to facilitate the identification of a particular process/activity that caused any delay.

Savings will be ensured by well-defined logistic channels, which can be pre-arranged or modified in advance. This makes it possible to achieve a significant increase in the efficiency of the material supply and to suppress unnecessary down time and delays in handling or storage of incorrectly delivered material and potential full return.

If the BIM model is prepared in unstructured elements and items (cost, time) without the use of established (agreed) sorting methods, the required interconnection of data for animation is very time consuming and professionally demanding, which eliminates any efficiency of data use.

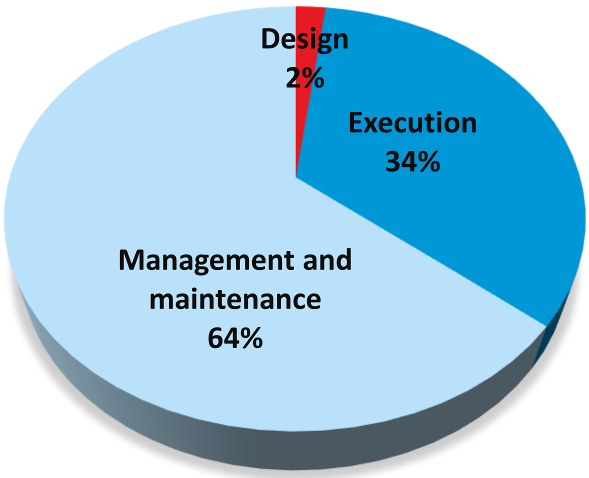
Recommendation:

- *develop a standardized valuation methodology linked to standardized data structures and making it mandatory for public procurement*
- *set up rules for the creation of input model and the minimum scope of data to be included in it, for the purposes of valuation and scheduling of construction*

5.6 BIM and Facility Management (FM)

Cost savings in the building management and maintenance phase (operation phase) were one of the main reasons why the BIM method began to be mentioned in broad terms and why BIM started to be used and evaluated by some organizations. The management and the possibilities for better operation are also mentioned independently in other chapters of this Strategy, but at this point let us summarize the basic arguments and recommendations.

Illustrative cost allocation during the life cycle of a building is as follows (source: BIM Council, 2013).



The figure shows that the operating phase has the biggest impact on the cost of the overall lifecycle of the building. On the basis of foreign experience, the life-cycle cost of the building is expected to decrease. The creation of a building information model, albeit at a higher cost, will be outweighed many times by a more effective way of managing the building during its life cycle, the possibility of creating a healthier indoor environment for building users and better access to necessary information, for example, in the case of alterations in completed buildings (renovations).

Any changes made at the outset, at the concept and initial design phase, which may affect the following phases of a building's life cycle, are carried out at a much lower cost. It is possible to propose multiple variants, perform different simulations, and consider ways of optimization, unlike in the operational phase where we can only respond to problems after they arise and make costly changes.

The main benefits for FMs of using the information obtained from the BIM model can be summarized as follows:

1. better management of the space of the building – BIM allows access to information on building use faster and provides more accurate information;
2. more efficient maintenance – up-to-date information on products and related assets is maintained in the BIM model; faster access to more accurate information is once again its major benefit, because it enables more qualified decision making;

3. efficient use of utilities – using the BIM model makes it possible to compare different solutions and their energy needs. Available information supports various types of operation optimization as well as proposals for improvements. Environmental impacts can thus be better managed.
4. more efficient maintenance (refurbishment) and alterations to completed buildings (renovation) – an updated BIM model is once again a source of more accurate information about the current form of the building and allows the necessary time to be used to prepare different solution variants rather than to seek initial information;
5. better management of the building's life cycle – this point includes the willingness to evaluate the cost of the overall life cycle rather than the mere investment costs. Initial higher acquisition costs can thus be reflected in much lower operating costs of the entire building.
6. more efficient data transfer between the BIM model and the CAFM system.

Given that in the Czech Republic, facility management means in most cases the traditional building management focused on mere maintenance, it is necessary to change the overall approach to this issue if we want to truly enjoy the benefits of BIM. Therefore, if proposals are created which will provide data suitable for the project evaluation phase as well as for operation and use of the building, it is necessary to define their further use in connection with these data. Ideally, the facility manager should already be part of the project team and influence the decisions so that the whole design is in line with the possibilities for a high-quality and economical operation of the building.

Building use is also related to the collection of data for buildings that were not designed and constructed using the BIM method. This means a way of certifying existing buildings. In this case, it seems efficient to create building models when carrying out maintenance work and changes in building use.

In order to register State real estate assets, the so-called "CRAB" (Central Register of Administrative Buildings) was established in the Czech Republic. It was supposed to address the absence of a national register of administrative buildings of the State, their occupancy and the deployment of civil servants. On the basis of the information obtained, the register enables maximum use of buildings owned by the State administration. In the Czech Republic there are currently over 670 State institutions administering real estate owned by the State. With some exceptions, these entities manage their property under the same legislation. For the first time, CRAB has introduced a single methodology for the registration of administrative buildings and, for some institutions, it has become the primary system for their registration. In connection with the implementation of the BIM method, it is recommended to evaluate the use of BIM models and other available features for the CRAB system so that the stored data can also be used for managing State assets and related activities.

Act No 219/2000, on property of the Czech Republic and its representation in legal relations, as amended by Act No 51/2016 (hereinafter the "State Property Act"), as amended, with effect from 1 March 2016, lays down the existence of a central register of administrative buildings. It is an information system for the organizational units of the State and the State-owned organizations within the scope of the State Property Act (hereinafter the "State organizational units"), which is intended for the effective and economical use of administrative real estate. Government Decree No 41/2017, on the data of the Central Register of Administrative Buildings, which regulates the structure and the scope of the data kept in the register, now provides that if a State organisational unit carries out new documentation or certification of the State and execution of a building or modifies the existing documenting or certification of a building registered in the CRAB, the State organisational unit is required to record the documentation or certification data into CRAB in the required format within one month after the end of the documentation and certification or their modification. In the case of new buildings that are registered in the CRAB, the State organisational unit shall, after the building has been put into use, provide the Office for Government Representation in Property Affairs with a copy of the project documentation in electronic format in accordance with the Building Act. It is therefore necessary, when creating the rules for the certification of existing buildings using the BIM method, to ensure the compatibility of the rules with the CRAB system, or to initiate an amendment to the Government Decree.

The whole issue of using the data generated in the previous phases of the building's life cycle will bring the maximum effect in the operation phase, but is probably part of a later application. However, it is necessary to consider facility management when preparing the rules of the previous phases.

Recommendation:

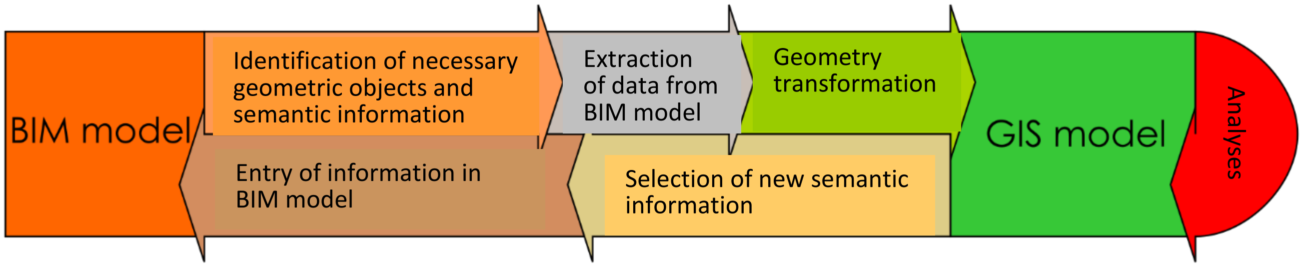
- *improve the as-built documentation system from a set of documentation with changes to an updated BIM model*
- *evaluate the use of BIM models for CRAB, evaluate the possibilities of FM functions and separate them from mere record-keeping*
- *encourage the participation of facility managers during the initial phases of design, in particular in the case of public contracts*
- *propose rules for the certification of completed buildings by the BIM method*
- *update the management and FM system for transport structures using the BIM method*

5.7 Connection to Geographic Information Systems (GIS)

Until recently, most of the GIS (Geographic Information Systems) were based on 2D objects and attached information, with analytical and visualization tools and procedures adapted to them. In GIS, however, interest in three-dimensional modelling is growing, and the number of applications using 3D data is increasing. The most common applications are for 3D cadastre and urban modelling. Data for GIS is often expensive to purchase, and in relation to time-varying data, keeping data in the current form is another insignificant cost item. The cheapest, of course, is data that does not have to be created. It means to use existing data if it is available and use it directly, or to create data derived from it, which will be suitable for further work. The BIM models are undoubtedly a significant and rich source of 3D building data.

GIS models are more focused on general spatial information, whereas BIM models are narrowly focused on information about buildings and construction-related processes. The main differences between BIM and GIS models are the method of creation and scale, and the related level of detail. The BIM model is usually designed as a complex model that is as realistic as possible, so that it can be used to analyze and plan project implementation. By contrast, geographic information systems work with inductive models based on existing data from different sources, allowing analysis on a model based on existing environmental data and spatial and semantic relationships between objects in that environment. GIS is also typically used for modelling on a smaller scale (larger area) than BIM.

Yet both these approaches converge at the level of modelling of buildings, building complexes and cities. Therefore, their interoperability and the possibilities of mutual use of data and analytical possibilities need to be addressed. The following figure shows how analytical capabilities of GIS systems can be used (connection to external spatial data, spatial analyses) in a way where the analysis results are projected into the original BIM model so that the results can be used later in the building design process. Similarly, BIM models can be used directly for GIS applications for State administration, where information from BIM models can be useful wherever spatial information on buildings is being used.



The existing GIS standards include the CityGML, and the INSPIRE data models (primarily data specifications for buildings, utility networks and transport networks), which are based on the CityGML specification in building modelling and further develop and refine it. Ultimately, BIM models could be published in accordance with Directive 2007/2/EC of the European Parliament and of the Council establishing an Infrastructure for Spatial Information in the European Community (INSPIRE), which is transposed by Act No 123/1998, on the right to information about the environment.

For the use of BIM models in the GIS area, a joint project for TC 211/WG 10 and TC 59/SC 13 – ISO/AWI 19166, Geographic Information – BIM Mapping to GIS (B2GM) is being prepared within ISO. This international standard defines a conceptual framework and mechanisms for mapping of information elements from the Building Information Model (BIM) to Geographic Information Systems (GIS) to access the required information based on specific user requirements. It will include three mechanisms:

- BIM for GIS Element Mapping (B2G EM);
- BIM to GIS LOD (Level of Detail) Mapping (B2G LM);
- BIM to GIS Perspective Definition (B2G PD).

Existing international standards for GML (ISO 19136:2007), CityGML (OGC Standard) and Industry Foundation Classes (IFC, ČSN EN ISO 16739) are expected to be used.

In connection with the GIS, it is necessary to mention the link to the strategic document of the Ministry of the Interior "Action Plan of the Strategy for the Development of Infrastructure for Spatial Information in the Czech Republic 2020", whose annex is Measure 63 – Implementation of Buildings Information Modelling (BIM) for contracting authorities, analysis of the current state and proposal of the methodology of data transfer between building life cycle phases, including the determination of the necessary source space information and use of the generated data. The MIT is responsible for the implementation of this measure.

Recommendation:

- *ensure the usability of data from BIM models for GIS systems of public administration, including the usability of models for the needs of the Cadastre of Real Estates (3D cadastre, the possibility of more accurate records of apartments)*
- *examine the possibility and need to publish BIM models owned by the public administration pursuant to Act No 123/1998, on the right to information about the environment*
- *enable the publication of GIS data in IFC format (ČSN EN ISO 16739) for use in BIM software (from terrain model to land area limits)*

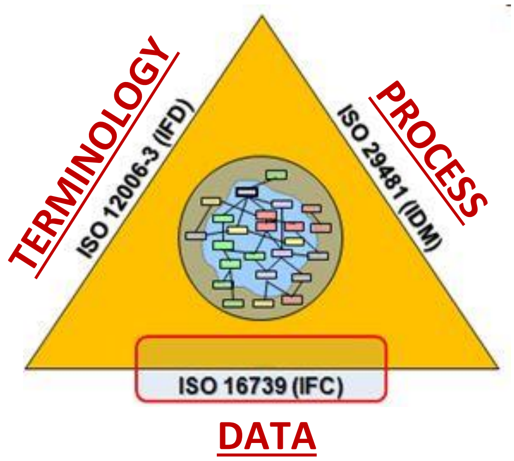
5.8 Technical standards

For the functioning and development of a healthy competitive market environment, general rules are necessary in most fields, defined mainly by generally binding legal regulations, by technical standards, or other reference documents. Czech Technical Standards (ČSN) are documents that provide rules and requirements for general and repeated use.

The rules set out in normative documents represent both a basic framework for effective division of labour, involvement and cooperation between individual participants in complex activities, such as design, construction and management of buildings, and a framework for the required quality of specific outputs, products, services and buildings. Compared to legal regulations typically aimed at generally-binding regulation based on public interest, the creation of technical standards stems from market needs, formulated through stakeholder representatives, and is based on consensus while respecting the legal framework. An important aspect is the effort to gradually harmonize the needs of the global or European market, which at the national level leads to the gradual adoption of international and European technical standards as a means of gradually removing obstacles to trade and ensuring the free movement of goods and services.

Technical standards for BIM are created by combining incentives from the buildingSMART alliance and individual states presented to ISO and CEN. At the national level, the Technical Standards Committee TNK 152 “Organization of Information on Buildings and Information Modelling of Buildings (BIM)” started in 2016 at the Office for Standards, Metrology and Testing (ÚNMZ).

Foreign experience has shown that it is appropriate to set the necessary rules in the form of technical standards; the same is also recommended in the Czech Republic. Amendments to laws and their implementing regulations is typically more time-consuming and should only be used to establish the very basic rules. Specific technical conditions and instructions can develop faster, so it is better to publish them in the form of technical standards or other documents. The main areas to be addressed by technical standards or other additional documents are terminology, processes and data (see the following figure):



Recommendation:

- *ensure the transposition of international technical standards and, in particular, the technical standards of the EN series, including translation into Czech, due to the wider acceptance of the whole methodology and the possibility of drafting contracts and business terms with the same terminology – see Annex 2*
- *use standards/TNI to address data structures, format and content of data required for individual phases of construction projects including the recommended processes, the method of transmitting information (handover reports) and the method of their validation*
- *financially support the participation of Czech experts in the working groups of technical standardization organizations at international level to be able to influence emerging technical standards*

5.9 Ownership, copyright

For copyright and ownership of models, the whole issue can be divided into two basic areas, which are closely related:

1. copyright;
2. ownership of the resulting models.

In connection with the use of the BIM method, the question of ownership of the created models and copyrights is very often discussed; these can be summarized in three areas:

1. copyright for the design;
2. copyright and ownership of the building model;
3. copyright for used libraries and catalogs used in the SW to create the BIM model.

In interpreting the provisions of the Copyright Act, it is important to distinguish two things. Firstly, the applicable Copyright Act has taken over from international conventions the separation of personal rights and property copyright. Personal rights are not transferable and the author cannot give them up. However, he can grant the right to use the work. Anyone who orders the project can only acquire "property rights". The exercise of property rights therefore passes to the ordering party. These rights include the right to use the work in the agreed manner and for the agreed permissible purpose. Architectural and urbanistic works therefore always fall into the category of made-to-order works.

In terms of the copyrights for the design of the building, basically nothing changes in comparison with standard documentation. The actual BIM model of a building and the libraries used are basically databases that are also covered by the Copyright Act. The ownership of the model, the use of libraries, and the subsequent modifications of the BIM model can be addressed through contract or business terms, or by creating model contracts. The use of the BIM model and its further processing should therefore be permitted to the person who orders it.

The resulting models may be dependent on the attached libraries that may have been made to order or by a creator other than the author of the overall aggregate model. This problem applies to BIM models, which are stored in native formats of individual SW tools. For further processing of the BIM model, it is usually necessary to provide this library together with the model submitted in the native format. The creators often charge a fee for the creation of such a library. The person ordering the database (usually the manufacturer of construction products) decides on its free use.

In the case of an open IFC format, the resulting BIM model stores the result of the entire design, and the model is not dependent on the presence of the source library. The elements from libraries which are used are stored here as elements with their technical data in the same context in which they are located in the building.

Considering that it is based on international regulation of copyright protection, the solution lies in defining a uniform interpretation of all issues rather than creating independent local rules. The topics discussed are the actual project documentation in the form of a BIM model that can be used to continue with works. Other topics are the use of other databases and libraries for model creation and their submission to other project participants, and supplementing models or libraries to include the required additional data. Recommendations may be issued as methodological guidelines or as model annexes to contracts.

Recommendation:

- *review legal issues relating to property rights and copyright*

- *create models and templates of contracts and protocols for uniform application and reduction of different interpretations*

5.10 Mandatory/voluntary use of BIM

Foreign experience shows that the most appropriate way to start using the BIM method on a large scale, in particular for the needs of the State, is to establish an obligation to use it from a particular date for newly procured public service contracts (building documentation) and public works contracts. A number of areas addressed in the context of the introduction of BIM abroad (SW tools, standardization) have already developed significantly, so it seems appropriate to introduce the BIM obligation after a five-year preparation period. This step will be a clear incentive for all organizations that want to offer the State solutions to meet this objective. The unambiguity and unquestionably mandatory use of this step is crucial in order for this incentive to be accepted and for the whole process of preparation to actually start.

Simultaneously with the announcement of the obligation to use the BIM method in public procurement, it will be necessary to assess and clearly define the scope of the obligation and more precise specification of what will be required as BIM. This issue will be further specified according to the evaluation of pilot projects, also taking into account the specific aspects of individual types of buildings (see also the conclusion of chapter 3.5).

The easiest way is to link the obligation to the investment costs of the building. Here, this can be a reasonable limit for above-the-threshold public works contracts (within the meaning of the Public Procurement Act) financed from public budgets, including the drafting of their preparatory and project documentation, taking into account the evaluation of pilot projects and the specific aspects of each type of building. The most complicated parameter is the specification of what the BIM should specifically contain. There are three basic areas that need to be defined:

- the obligation to conclude the BIM Execution Plan – a contractual document;
- require the submission of a 3D model that meets the currently applicable standard specifying the content and structure of the model at the required level of detail and in an open IFC format;
- the obligation to use CDE (common data environment) for the transfer and sharing of project information.

By meeting all three requirements, the contracting authority (e.g. the State) gains transparent control over the progress, preparation and execution of the building, and, in particular, upon the handover of the building, it obtains all the up-to-date information it can use to operate, manage and maintain the building.

At the beginning of the preparatory period for BIM implementation, it is highly advisable to gradually start implementing a limited number of pilot projects (see chapter 5.13), which provide significant feedback to the preparation processes. This will increase the real added value of the BIM methodology from the beginning of the application to the standard practice.

Recommendation:

- *set the obligation to use BIM for above-the-threshold public works contracts (within the meaning of the Public Procurement Act) financed from public budgets, including the drafting of their preparatory and project documentation from 2022, taking into account the evaluation of pilot projects and the specific aspects of each type of building.*
- *set the minimum scope of the BIM obligation for public works contracts, namely:*

- *the obligation to conclude the BEP – BIM Execution Plan – a contractual document;*
- *require the submission of a 3D model that meets the currently applicable standard specifying the content and structure of the model at the required level of detail and in an open IFC format;*
- *the obligation to use CDE (common data environment) for the transfer and sharing of project information.*

5.11 Public procurement

Article 22(4) of Directive 2014/24/EC of the European Parliament and of the Council on public procurement (hereinafter the "Directive") and Section 103(3) of Act No 134/2016 Sb., on public procurement (hereinafter the "PPA") expressly allows the use of BIM tools for the award of public works contracts, public project activity contracts and design contests. However, for a smooth and seamless use of BIM, it is necessary to address several related issues / provide methodological support to contracting authorities and suppliers.

Availability of BIM tools

A crucial issue that needs to be addressed is an obligation on the availability of BIM tools. At present, given the degree of IT development in the Czech Republic and the EU, BIM tools can be considered to be available to all suppliers who have made reasonable efforts in this respect (in line with one of the fundamental principles of the rule of law – "vigilantibus iura", i.e. the law comes to the assistance of those who are vigilant with their rights). There are a number of SW applications on the market that are classified as BIM tools. Some of them support work with the open, standardized IFC format. Since the SW applications for BIM also allow the creation of classic 2D documentation, many designers use it today. Therefore, it can be assumed that in the case of public contracts pursuant to Section 103(3) of Act No 134/2016, on public procurement, the required formats will be readily available. However, this fact and any obligation of the contracting authority to provide access to the required formats should be checked.

Amendments to legal regulations

In terms of BIM deployment, there is currently no need to update the PPA, but it cannot be completely ruled out on the basis of further analysis or practical experience. It is necessary to assess whether an amendment to Decree No 169/2016, on determining the scope of documentation of public works contracts and the inventory of construction works, supplies and services with a bill of quantities is necessary or appropriate. It is worth considering whether the above Decree should not specifically define the scope of the documentation when using BIM tools. Another question is whether in this case it is necessary to insist on the submission of "standard" 2D documentation within the scope defined in Section 2 of the Decree. The revision should apparently also be covered by the provisions of this Decree relating to the inventory of works, supplies and services with a bill of quantities.

Methodological support

Methodologies should separately address the use of BIM for public project activity contracts / design contests, and for public works contracts. Consideration should also be given to the creation of model tender documentation.

In case of project activity / design contest, it is necessary to address in particular:

- the definition of the subject-matter of public contract – it is necessary to specify how the request for specification in the BIM should be formulated; among other things, it is necessary to ensure that the use of BIM tools does not interfere with the neutrality of setting technical conditions;

- the question of aggregation of performance – how does BIM use impact the issue of awarding individual levels of building documentation (aggregation);
- setting qualification requirements – the methodology should include the recommended qualification criteria, in particular in relation to the supplier's references and the experience of those involved in the performance of the public contract (i.e. what performance will be recognized as relevant to BIM);
- setting evaluation criteria – the methodology should also address the issue of tender evaluation in relation to the experience of the team members who will be involved in the performance of the public contract (what building design / experience are relevant or which should be taken into account in the evaluation).

For public works contracts, the following needs to be addressed:

- definition of the subject-matter – it is necessary to define what requirements follow for the contractor from the BIM obligation in the execution of the building; any obligations should also be reflected in the draft business terms (draft contract);
- setting qualification requirements – the methodology should include the recommended qualification criteria in relation to the contractor's references and the experience of those involved in the performance of the public contract (i.e. what performance will be recognized as relevant to BIM);
- setting evaluation criteria – explore whether the use of BIM tools can influence the setting of evaluation criteria, whether their use for example in the life cycle cost assessment, or whether the experience of those involved in the procurement can be exceptionally assessed.

Recommendation:

- *verify the obligation concerning the availability of BIM tools*
- *set minimum requirements for the content of the model for the purpose of awarding and evaluating public contracts*
- *prepare model tender documentation and model contract terms*
- *ensure that the preparation of BIM project documentation is followed by approval processes, the removal of requirements for documentation with duplicate data*
- *develop a methodology for contracting authorities with a recommended and agreed procurement procedure requiring the use of the BIM method, including a methodology for qualification requirements, tender evaluation, etc.*
- *determine the use of a uniform standardized data format for the inventory of works, supplies and services with a bill of quantities for the procurement of public works contracts*

5.12 Education

Education is one of the key areas for the quality, speed and achievement of the expected benefits associated with the implementation of the BIM method. Although in the media BIM is much associated with IT technologies, the success of its implementation depends on the human factor. In general, more than 50% of success in the implementation of any software solution is due to good education and change management, i.e. working with people.

For the BIM method, this is all the more true given the more complex spectrum of entities and roles involved in each project and their continuous changes for each individual project. This places great demands on the general knowledge and skills of people involved in the BIM project implementation and their ability to apply these general principles to the specific conditions of an individual project. There will never be a single global SW solution or exactly the same methodology, so the standard will be that one worker will have to combine different SW tools for different projects.

Education programmes concerning the familiarisation with the BIM method should not omit the fact that international and European BIM standards, relevant methodology and foreign literature is based on principles, processes and terminology of project management and system engineering. Both of these areas should be part of BIM education.

Foreign experience suggests the importance of cooperation between educational institutions and practice. Without examples of best practices and practically proven knowledge base, BIM cannot be successfully implemented. The introduction of BIM in practice, therefore, is crucial for BIM education.

The current environment offers a number of effective ways to implement BIM education. The basic means are educational institutions, individual professional portals operated by professional organizations or unions, as well as commercial entities. Very effective means include video channels, webinars, with social networks playing an important positive role as well.

Education can be divided into two basic groups – current workers who will be participants in the revolutionary change and should therefore undergo a change management process, and new workers to be prepared by secondary schools, higher vocational schools and universities. We should also not overlook the education of craftsmen and construction workers.

For the first group, the key to success in changing their working habits is the change management within each organization. Basic education for each role should be provided by professional and interest organizations, which should be followed by individual training within each organization. It can be expected that a large number of commercial entities will be created in this area to provide this training and counselling. An important input to the education of public administration employees will be an unambiguously defined BIM methodology framework in line with the legal framework to provide workers with a secure environment for their decision-making and work. The effectiveness of the education process will be significantly positively impacted by a clear and comprehensible methodology for state organizations and the standardization of data formats, which will reduce IT skills requirements.

For the second group, there is a need for specialized subjects dealing with BIM issues. The aim is to understand the principles, the links and the necessity of individual processes and activities to implement the BIM method. Pupils and students will be introduced to examples of good practice from abroad, the structure of standardization, its essence, the possibilities of using technologies and the changes that make use of BIM models in building practice. For higher education, the lesson should not be focused on mere use of a particular SW tool for creating a 3D model. This is the task of software companies or, possibly, the task of secondary vocational schools. An important aspect for a proper understanding of the BIM method for pupils and students is to provide more comprehensive insights into the whole life-cycle of buildings, not just a relatively short design or construction phase. For real practice, a graduate who knows the principles and can learn their application in real projects will be of great value. To create educational programs for individual schools, it will be very important to ensure cooperation between schools and real-world practice, preferably through professional and interest organizations and their involvement in the educational process. The overall strategy for education should be elaborated in the form of a separate material in cooperation with experts. The material should address specific measures for the introduction of BIM into the Czech education system.

In order to ensure a wider awareness of the BIM method, its benefits and need, including its importance in the transition to Construction 4.0, it is necessary to prepare an awareness-raising campaign throughout the implementation period. This should allow for an intensive discussion and understanding of the benefits brought about by digitization in the construction industry. The main focus of the campaign will be to provide a clear description of the changes that will occur for the individual jobs involved in the implementation of the construction projects. The campaign will be complemented by appropriate workshops or seminars to enable rapid sharing of best practice, publishing in specialised journals, or the publication of practical manuals, etc.

Recommendation:

- *prepare a general methodology for the implementation of BIM in organizations, which can be tailored individually to the conditions of each organization*
- *to specify a general methodology for the implementation of BIM for public administration and to provide its authorities and organizations with change management experts to help individual authorities and organizations to change the processes involved*
- *introduce a system of education of State administration and self-government workers in the context of changes in their working practices in the implementation of the BIM method, including the use of the life-cycle cost criterion*
- *specify the scope of professional qualifications of new BIM qualifications in the National Register of Qualifications*
- *organise a media campaign aimed at awareness-raising on the benefits of using the BIM method for the construction sector, with an emphasis on investors, designers and contractors*
- *introduce a coordinated system for the education of pupils and students of secondary, tertiary and higher education institutions in the BIM issues in all contexts*
- *offer secondary, higher vocational and higher education institutions a platform for sharing experience and the creation of accredited programs of further education for pedagogical workers related to BIM in cooperation with practitioners*
- *create a system of education of managers of public administration and self-government buildings, focusing on greater attention to commissioning and use conditions, taking into account the complexity of contemporary buildings*
- *educate the supply chain on BIM issues*

5.13 Pilot projects

Pilot projects are the first key practical activity in implementing the BIM method into practice. It is important not to delay them, because the knowledge gained from practical implementation will be very valuable for completing the methodology, standards and sample documents before wide adoption. Experience from abroad states that the risk associated with launching a pilot project before fully completing methodology and standardization is offset by the great benefit of gaining practical experience and learning from them.

At the beginning, it seems ideal to identify several pilot projects, both for transport and for building construction. Transport structures already have selected these projects and the BIM application for some of them is ready to launch.

The objective of pilot projects at this early stage of the implementation should be to verify partial activities in changing the processes and work flows of individual workers in connection with the processes of other entities involved in the preparation and implementation of the project. It will be very important to specify for each project exactly the partial objectives from the BIM method, which the project should verify in practice. Here, moderation is key – do not want too much or too little. The first areas for pilot project verification are working with a 3D model and gradual learning of how to work with the common data environment (CDE) to verify its true contribution to the clarity and transparency of processes and information. Both activities, after mastering the initial training, should significantly confirm the benefits in terms of the effectiveness of the work of all project participants.

The BIM is based on a new and ultimately simpler form of collaboration of all partners involved in building projects when passing, sharing and approving documents and information. Here, the sooner things start to change in pilot projects, the sooner it is possible to eliminate negatives and share positives so that they drive more massive deployment of BIM.

It is important for pilot projects to prepare model contractual and operational documents. If there are public contracts among pilot projects, it will be necessary to address problems that may arise from the fact that there is no practical experience with BIM public procurement and its use may lead to higher financial costs in the initial phase of project implementation.

Recommendation:

- *identify pilot projects and phases in which the BIM method will be applied and tested*
- *specify the exact partial BIM targets that each project has to verify*
- *create a platform for sharing the knowledge and experience of teams working on pilot projects*
- *prepare business terms*
- *identify possible conflicts with the existing method of contract preparation and propose a solution*
- *use pilot projects to verify and evaluate the BIM use objectives in public procurement and to reflect experience in the obligation to use the BIM method in public procurement*

6 Schedule for the gradual introduction of BIM in the Czech Republic

6.1 Schedule of recommended measures

	2017	2018		2019		2020		2021	2022	2023	2024	2025	2026	2027
Basic organizational measures	II.	I.	II.	I.	II.	I.	II.							
Approval of the BIM Implementation Strategy in the Czech Republic by the Czech Government	■													
Creation of the Construction 4.0 Committee under the Society 4.0 Alliance	■													
Pilot projects														
Selection of pilot projects	■	■	■											
Implementation of pilot projects		■	■	■	■	■	■							
Evaluation of pilot projects					■	■	■	■						
Basic technical measures														
Implementation and creation of standards including terminology	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Evaluating the use of the BIM Model for the current CRAB system		■	■											
Announcement of the IFC format as a nationally supported format for BIM model			■											
Review of legal issues of copyright			■											
Creating a standard for LOI and LOD scope for building documentation phases			■	■										
Assessment of the need for legislative amendments related to BIM implementation			■	■										
Creation of database for required properties of construction products				■	■									
Proposal of rules for certification of completed buildings owned by the State					■									
Creation of standardized methodology for BIM use in organizations					■	■								
Creation of methodology for the selection of CDE by contracting authority					■	■	■							
Reflection of amendments to related legislation in the implementation of the BIM method					■	■	■	■						
Creation of a methodology for the implementation of BIM in public administration						■	■							
Public procurement														
Creation of model contract terms or model contracts for public procurement				■	■									
Creation of model tender documentation				■	■									
Determining the minimum scope of award under BIM obligation for public procurement				■	■									
Creation of a BIM methodology for the award procedure of public contracts				■	■	■	■							
Establishing a single data format for the inventory of buildings, works, supplies and services					■									
Creation of a valuation methodology					■	■	■							
Imposition of a BIM obligation for above-threshold public works contracts								■	■					
Permitting processes														
Assessing the current state and proposing solutions for digital submission of PD				■	■	■	■							
Introduction of digital submission of PD (e.g. in pdf)								**						
Calculation of financial needs of building authorities and relevant bodies				■	■	■	■							
Preparation of digitization of building permit processes using BIM								**						
Ensuring digitization of building permit processes using BIM								**						
GIS														
Determination of NIPI and BIM data relationship in relation to IFC								■	■					
Ensuring the usability of data from BIM models for NIPI development										■	■	■		
Ensuring connection of the BIM model to the Real Estate Cadastre													■	■
Education / Promotion / Awareness-raising														
Creation of a BIM education system for secondary schools and higher vocational schools		■	■	■	■	■	■	■						
Support for the introduction of BIM education into university study programmes		■	■	■	■									
Specification of BIM professions in NQF			■											
Creation of a platform for sharing experience of teachers and professionals with BIM			■	■	■									
Media campaign			■	■	■	■	■	■	■	■	■	■	■	■
Creating a BIM education system for state administration and self-government				■	■	■	■							
Creating an education support system in the BIM supply chain								■	■	■	■			

**** In relation to the new amendments to public construction law**

6.2 Responsibility for the implementation of measures

Basic organizational measures

Setting up the Construction 4.0 Committee under the Society 4.0 Alliance - Set up the Construction 4.0 Committee under the Society 4.0 Alliance to coordinate the digitization of the construction industry; initiate the establishment of a working group to prepare the Construction 4.0 strategy for the Czech Republic. Responsible party: MIT

Pilot projects

Selection of pilot projects – select pilot projects, specify their limited number, specify the exact partial objectives in terms of the BIM method to be verified by each project. Responsible party: MIT in cooperation with other ministries

Implementation of pilot projects – launch and implement selected pilot projects. The pilots will be implemented by individual Ministries; the MIT expects consultations and controls of progress of work on the BIM model. Responsible party: ministries in which the pilot projects will be implemented, in cooperation with the MIT.

Evaluation of pilot projects – evaluate pilot projects and draw feedback based on which the methodology will be revised. Responsible party: Ministry of Industry and Trade in cooperation with other ministries where the pilot projects will be implemented.

Basic technical measures

Implementation and creation of BIM standards including terminology – ensure continuous adoption and translation of technical standards (as of 31 March 2017, see point 8.2) to the Czech standards. Responsible party: MIT

Evaluation of the use of the BIM model for the existing CRAB system – evaluation of the possibilities of connecting the BIM models to the CRAB system, evaluation of the available functions for optimization of operation, connection of the BIM availability request in the IFC format to meet the requirement for open and available data. Responsible party: MoF (Office for Government Representation in Property Affairs) in cooperation with the MIT

Announcement of the IFC format as a nationally supported BIM model – declaration of IFC format as the required open format for building documentation. Responsible party: MIT

Verification of legal copyright issues – examine legal issues relating to property and copyrights and determine the ownership of BIM models. Responsible party: MoC

Creating a standard for LOI and LOD scope for each phase of building documentation – set a standard for the scope of non-geometric data/property (LOI) for each type of model element, including the actual level of detail required for each construction phase (LOD), including the harmonisation of terminology. Responsible party: MIT in cooperation with the MoRD and MoT

Assessing the need for legislative changes in the context of BIM implementation – assess whether the requirements for BIM model creation and use are reflected in already existing laws and implementing regulations – see chapter 6.3. Responsible party: MIT in cooperation with other ministries

Creating a database for required construction product properties – create a portal/database of required and recommended building product properties in relation to the forthcoming Construction Products Act, including the assignment of IFC parameters and creation of validators for compliance with the scope and format of data for object libraries. Responsible party: MIT

Proposing rules for the certification of finished buildings owned by the state – design the basic structure of the data (content and scope of data) stored in the BIM model created during building certification. BIM models must be defined in context according to the purpose of their use, or the register used (CRAB, cadastre, etc.). Responsible party: MIT in cooperation with other ministries

Creation of a standardized methodology for the use of BIM in organizations – prepare a standardized general BIM use methodology, which each organization can proportionately personalize according to its size and focus. Responsible party: MIT

Creation of a CDE selection methodology by the contracting authority – develop a methodology for the selection of the CDE by the contracting authority, including recommendations on the conditions and rules for its use throughout the life cycle of the construction. Responsible party: MIT

Projection of amendments in the related legislation in the implementation of the BIM method – implementation of draft legislation amendments and the process of their creation to support the creation of the BIM model in laws and implementing regulations. Responsible party: MIT in cooperation with other ministries

Creating a methodology for introducing BIM use in public administration – to be implemented in response to the gradual introduction of the BIM method into practice. The basic scope of methodologies must correspond at least to the minimum extent of use of BIM when introducing the obligation to use the BIM method. Responsible party: MIT

Public procurement

Creating model contract terms or contract templates for public procurement – create recommended model contract documents for using the BIM method in public procurement to ensure uniform application and standard approach to handling possible situations, including avoiding their various interpretations. Responsible party: MIT in cooperation with the MoRD and MoT

Creating model tender documents – create a model tender documentation with the definition of requirements for the use of BIM as a tool for contracting authorities. Responsible party: MIT in cooperation with the MoRD and MoT

Determining the minimum scope of award under the BIM obligation in public procurement – determine the minimum scope of award with the obligation to use the BIM method for public works contracts: - obligation to conclude the BEP (BIM Execution Plan), - submit a 3D model compliant with an approved standard that determines the content and structure of the model at the required level of detail and in the open IFC format, - obligation to use the CDE (Common Data Environment) for transmitting and sharing project information. Responsible party: MIT in cooperation with the MoRD and MoT

Creating a BIM methodology for the award of a public contract – Develop a methodology for contracting authorities using the BIM method to ensure that it complies the assessment of all procurement rules. Responsible party: MIT in cooperation with the MoRD and MoT

Determining a uniform standardized data format for the inventory of works, supplies and services - determine the use of a uniform standardized data format for the inventory of works, supplies and services with a bill of quantities for the procurement of public works contracts. Responsible party: MIT in cooperation with the MoRD and MoT

Developing a standardized valuation methodology - develop a standardized valuation methodology linked to a standardized data structure and making it mandatory for public procurement. Responsible party: MIT in cooperation with the MoRD and MoT

Obligation to use the BIM method for above-the-threshold public works contracts – obligation to use the BIM method for above-the-threshold public works contracts (within the meaning of the Public Procurement Act) financed from public budgets, including the drafting of their preparatory and project documentation, taking into account the evaluation of pilot projects and the specific aspects of each type of building from the beginning of 2022. Determination of the minimum scope of the BIM method to meet this obligation. Responsible party: MIT and MoRD in cooperation with the ministries concerned

Permitting processes

Assessing the current state and proposing solutions for electronic submission of PD – assessment of the current state and proposing solutions for electronic submission of building documentation (e.g. in pdf) in connection with the use of BIM. Responsible party: MIT and MoRD in cooperation with the ministries concerned

Electronic submission of project documentation (e.g. in pdf) – introduce the submission of project documentation to the building authorities and relevant authorities in electronic form (e.g. in pdf format) including the method of ensuring the integrity of this documentation. Responsible party: MoRD in cooperation with the MIT and relevant ministries.

Quantification of financial needs of building authorities and relevant authorities – quantify the financial needs of building authorities and relevant authorities in connection with the anticipated digitization of the permitting processes of buildings. Responsible party: MIT and MoRD in cooperation with other relevant central State administration bodies.

Preparation for the digitization of building permit processes using BIM – use of the BIM method as a necessary condition for transition to electronic permitting processes. Responsible party: MoRD in cooperation with other relevant central State administration bodies.

Ensuring digitization of building permitting processes using BIM – Responsible authority: MoRD in cooperation with the MIT and other relevant central State administration bodies.

GIS

Determination of the relationship between NIPI and BIM data in relation to IFC – determine the relationship between NIPI and BIM data, create a connection to IFC data (ČSN EN ISO 16739) for use in BIM tools (from terrain model to surface territory limits). Responsible party: MIT in cooperation with the MoRD and MoI

Ensuring the usability of data from BIM models for the development of NIPI – ensure the usability of data from BIM models for the development of NIPI (national infrastructure for spatial information) systems including the verification of compliance with land use limits. Responsible party: MoI in cooperation with the MoRD and MIT

Ensuring connection of the BIM model to the Real Estate Cadastre – ensure the connection of the BIM models to the Real Estate Cadastre (3D cadastre, more accurate records of apartments). Responsible party: Czech Office for Surveying, Mapping and Cadastre.

Education / Promotion / Awareness-raising

Creating a BIM education system for secondary schools and higher vocational schools – methodically help schools to coordinate the inclusion of the new BIM technologies and processes into education curricula in construction-focused education and to create conditions for the implementation of the BIM method in teaching, including the involvement of practitioners. Support the ability of pupils and students to work together in a team. Responsible party: MEYS in cooperation with the MIT

Support for the introduction of BIM education into university study programmes – Support universities in including the new BIM technologies and processes into their study programmes focused on construction. Create accredited further education programmes on BIM for pedagogical workers in cooperation with practitioners. Responsible party: MIT in cooperation with the MEYS, which will consist mainly of consulting activities, sharing of knowledge and existing tools.

Specification of BIM professions in the NQF – specify the scope of professional qualifications of new BIM qualifications in the National Register of Qualifications Responsible party: MEYS in cooperation with the MIT

Creating a platform for sharing teachers' experience with BIM – offer a platform for mutual learning (e.g. interactive portal, workshops, seminars, etc.) for secondary, higher vocational and higher education institutions and the creation of accredited BIM training programmes for pedagogical workers in cooperation with practitioners. Responsible party: MIT in cooperation with the MEYS, which will consist mainly of consulting activities, sharing of knowledge and existing tools.

Media campaign – launch a media campaign to raise awareness of the benefits of using the BIM method for the construction sector. It will also include the publication of results from pilot projects, experience and good examples, surveys showing development. Responsible party: MIT

Creating a BIM education system for state administration and self-government – introduce a system of education of State administration and self-government workers in connection with changes in their working practices in implementing the BIM method. Responsible party: MIT

Creating an education support system in the BIM supply chain – introduce a system for the education of supply chain workers (designers, suppliers, manufacturers) in the context of changes to their workflows in implementing the BIM method. Responsible party: MIT in cooperation with the MoT

6.3 Legislation related to the introduction of BIM

It will be appropriate to assess whether or not the requirements for creating the BIM model and its use for the purposes of permitting processes and public procurement in the construction sector will be reflected in the related regulations:

Act No 360/1992, on the pursuit of the profession of authorized architects and the pursuit of the profession of authorized engineers and technicians in construction, as amended (the Authorization Act) is not required to be amended due to the introduction of the BIM. Its amendments can be brought about by unifying terminology, introducing electronic communication and other influences.

Act No 183/2006, on land-use planning and building regulations (the Building Act), as amended, will probably be recodified in the following years. For this reason, it is recommended to also assess the need for a possible amendment in connection with the introduction of the BIM method as part of this recodification.

Decree No 499/2006, on building documentation, as amended by Decree No 62/2013; an analysis will be made of the need to complete the possibility of making documentation in the BIM system and, if necessary, adjustments to its scope if BIM method is used.

Decree No 146/2008, on the scope and content of the project documentation of transport structures. There will be similar amendments as in Decree No 499/2006.

Decree No 169/2016, on determining the scope of documentation of public works contracts and the inventory of construction works, supplies and services with a bill of quantities is necessary or appropriate. It may be necessary to adjust the scope of documentation for public contracts using the BIM method. It is also necessary to revise the provisions relating to the inventory of works, supplies and services with a bill of quantities in Sections 3 to 12 of the Decree relating to the BIM model.

Act No 499/2004, on archiving and filing services and amending certain laws, refers to electronic forms and data format of digital data, but refers to an implementing regulation.

Act No 227/2000, on electronic signature.

Act No 300/2008, on electronic acts and authorised document conversion.

Decree No 645/2004, implementing certain provisions of the Act on archiving and filing service and amending certain laws.

Government Decree No 41/2017, on data of the central register of administrative buildings.

6.4 Estimation of costs

The measures resulting from the 2018 timetable will be implemented by the Ministry of Industry and Trade in cooperation with the Office for Standards, Metrology and Testing (ÚNMZ). The estimated funds needed to implement the measures for 2018 is CZK 13 million.

Funding of pilot projects is foreseen from the chapters of the relevant entities, i.e. ministries where the pilots will be implemented.

In order to ensure the measures for 2019 and beyond, it is necessary to elaborate a detailed work plan to be developed in cooperation with the ÚNMZ and other stakeholders. Based on this document, it will be possible to more precisely determine the financial costs of individual concrete works for subsequent years. The ministries concerned, which are responsible for individual measures in the timetable, and other central State administration bodies will finance their needs within their budget chapters for the relevant year.

7 Conclusion

Upon completion and evaluation of the pilot projects, the documents (standards, methodologies) will be updated, including the incorporation of the new knowledge. We expect the next stage of BIM implementation to follow, in which the functionality of the BIM method will be verified. The experience gained from the use of the BIM method during the operation phase of buildings and its subsequent consideration in the initial phases of building life cycles will be essential.

BIM is a big topic because it affects a large number of entities in and outside the construction sector. For this reason, its successful introduction requires closer cooperation among all professions across the construction sector. We expect the BIM implementation to generate a great response from the stakeholders. It is important to note that BIM is at the same time a huge challenge allowing a major transformation towards the digitization of the construction industry.

Digitization / IT technology is evolving so rapidly that in relation to the design, implementation and operation of buildings using the BIM method there will be additional challenging objectives for the next period that will need to be addressed in the future.

8 Annexes

8.1 Annex 1 – Terms, definitions, abbreviations

3D model – a digital representation of a physical and/or functional part of a building design in a structured form (similar to the structure according to ČSN ISO 16739). It contains only geometric data appropriate for building visualization.

BEP – BIM Execution Plan – a document describing the basic project parameters, roles, responsibilities of the participants, basic conditions for passing BIM models, the tools used and basic terms.

BIM – Building Information Modelling/Management It is a process of designing, building and managing a building that uses electronic object-oriented information. Source: Product data definition, April 2016, Steve Thomson.

BIM model – a digital representation of a physical and/or functional part of a building design in a structured form (similar to the structure according to ČSN ISO 16739). It may include geometric and technical or other non-geometric data required for permissible use purposes. The model is part of the BIM project documentation.

buildingSMART – An organization founded in October 1995 in the US; formerly known as the International Alliance for Interoperability (IAI), it is an association of organizations involved in the construction of buildings and facility management. The main goal is to define shared information about buildings for its entire lifecycle. The organization includes architects, engineers, contractors, investors, building owners, building managers, SW manufacturers, government institutions, research laboratories, universities and other members. They are involved in the creation of ISO standards for BIM, local chambers often work with governments to develop strategies and plans. The Czech Republic does not have its own representation in this organization, many BIM experts are in contact with this organization.

CAFM (Computer Aided FM) – asset management systems.

CEN (Comité Européen de Normalization) - abbreviation indicating the European Committee for Standardization (ECS); CEN is a non-profit organization associating European countries (similar to ISO at international level) and its task is to create, develop, maintain and disseminate comprehensive sets of technical standards and specifications applicable to European countries. In 1991, the so-called Vienna Agreement between CEN and ISO was signed to prevent duplicates (or conflicts) between CEN and ISO standards. Over the last decade, CEN has been taking over ISO standards to replace its own CEN standards; new technical standards are often developed in close cooperation with both organizations. Source: http://cen.eu.

CityGML – an open XML-based data model designed to represent and transfer 3D city models. Its basis is Geography Markup Language, version 3.1.1 (GML3). CityGML is not only designed to display the geometry and graphical representation of a city model, but also contains information about topology, semantics, and attributes.

ČSN – protected designation of Czech technical standards. The creation and publication of ČSN is currently provided by the Office for Standards, Metrology and Testing (ÚNMZ). This office represents the Czech Republic and Slovakia in the ISO and CEN organizations. Source: http://unmz.cz.

Collision Detection – The process of checking a digital model of a building. The result of the check is a list of places where it is necessary to modify the design of the technical solution so that the individual constructions are not in conflict with each other

EU BIM Task Group – a group of representatives of European countries established by the European Commission, which deals with the alignment of BIM use for public procurement. Part of the work is also to find common principles for contracting authorities and plan developers for BIM implementation, proposals and recommendations for public procurement, skills development, and examples of the benefits of BIM and "transition to digital technology" for policy makers and public clients. Source: http://eubim.eu.

FM (facility management) – the term "asset management" is also used for transport structures; this involves the integration of processes within the organization to ensure and develop the agreed services that support and increase the efficiency of its primary operations. Source: ČSN EN 15221-1:2014.

Geometric data – data that determine spatial information (location, shape, and relationship) to other buildings. They may be in the form of a vector or raster data model. In common practice, the term 3D model is also used.

GIS (Geographic Information System) - geographic information systems are information systems designed for work with data that are represented by spatial or geographical coordinates. They allow data collection, storage, sorting, editing, analysis and subsequent display. Outputs can include maps in both digital and paper form, three-dimensional model of territory, or dynamic animation of a particular phenomenon. They are often linked to web map applications.

GML – a standard defined by the Open Geospatial Consortium (OGC), for describing geodata allowing data sharing and integration. It is based on XML and serves for modelling, transferring and storing geographic information.

Change management - an area that focuses on changes and their implementation in organizations. Change management builds on general management, builds on social psychology and organizational behaviour, uses sociotechnics, and also touches on the culture of organizations. Changes are a basic feature of life of organizations, which need to be able to deal with primarily rapid changes in the environment. Experience shows that natural changes (even well-meant ones) are one of the most common causes why they lose control over projects. Source: http://managementmania.com.

IFC (Industry Foundation Classes) – data format for data sharing in construction and facility management. The IFC format is used for exchanging and sharing data and building data between applications developed by different SW developers. The IFC specification focuses on the support of the various fields involved in the construction project throughout the life cycle of the building. IFC definition is given in ČSN EN ISO 16739:2017.

INSPIRE (INfrastructure for SPatial InfoRmation in Europe) – an initiative of the European Commission which aims to create a European legislative framework needed to establish the European Spatial Information Infrastructure in accordance with Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community.

ISO – International Organization for Standardization. Its members are individual countries represented by their national organizations involved in the development of technical standards. This international network of organizations based in Geneva coordinates the organization, creation and publication of approved technical standards. Source: http://iso.org.

Metadata – Data that provides information about other data.

Native/proprietary format – a file format specific for a SW tool that processes information and data at the agreed level of detail and for the given purpose.

Non-geometric data – descriptive information, properties and attributes or time information describing the qualitative and quantitative characteristics of a building.

Valuation – the process of creating price for individual parts or building elements in all phases of the building's life cycle. Methodology and valuation method differ from one stage to another.

Certification – The process of gathering information about the actual state and the creation of certificates. Certificates are records of tangible and/or intangible assets for its efficient operation, maintenance and refurbishment. The purpose is to monitor the asset life cycle, its management and optimization of its use. In the case of buildings, the construction and technical condition is also recorded, and the certificate serves as a basis for planning further life-extending and benefit-increasing processes.

BIM model element – digital representation of a building product or building element.

Permissible purpose – reason of use related to the design, construction, operation or maintenance of a building.

Combined model – an overall model composed of interconnected different stand-alone models.

Common Data Environment (CDE) – digital storage for storing and sharing of all common building information. It can contain all the necessary information and documents that are created and shared not only during the design and construction process, but also during the subsequent stages of the building's life cycle.

Construction project – the construction project includes the overall purpose of the building, it is not just a part of the design (project documentation).

Building element – part of a building with a characteristic function, shape or position, e.g. floor structure, wall structure, road structure, etc. (source: ČSN ISO 12006-2), which is composed of one or more construction products and, as a rule, it is designed by a designer as unique for each project.

Building product – product intended for permanent installation into a building, e.g. products for load-bearing and partition structures, for technical equipment, etc.

TNI (Technical Standardization Information) – national document or transposed technical report (TR) or a publicly available specification (PAS) of European or international standardization organizations. These are:
(a) A technical document of informative character that contains technical data or technical solutions not included in the applicable standards. TNI generally contains proven data from abrogated standards whose keeping is effective, or technical requirements that are not yet ready to be made into a standard.
(b) In the case of a transposed international or European document – transposition of products of European and international standardization organizations TR and PAS complementing a set of standards and specification under the acronym TNI. The identification of these documents is similar to the transposed standards (TNI/TR and TNI/PAS). Source: http://unmz.cz.

Technical equipment of buildings – a set of selected facilities creating the indoor environment of buildings. Technical equipment of buildings includes distribution lines and management of various forms of energy, heating, ventilation, air conditioning, cooling, gas distribution, water and sewerage, central vacuum cleaners, wiring (measurement and regulation, electrical wiring, lighting, security technology, control systems for all technical equipment, lightning rods, telephone lines, TV signal lines, computer networks, etc.) and other technical equipment in buildings (lifts, etc.).

Level of geometry (LOG) – the agreed detail of the geometric data of each part of the model and of the construction elements used. The abbreviation used and designation will follow developments in technical standards. The original abbreviation was LOD (Level of Detail).

Level of information (LOI) – the agreed detail of non-geometric data (technical, price, time, etc.) of each part of the model and of the construction elements used. Often, this term is also abbreviated LOD – Level of Development. The abbreviation used and designation will follow developments in technical standards.

Level of Development (LOD) – agreed stage – stage of development of building documentation. LOG and LOI to be used should be agreed for each phase. The abbreviation used and designation will follow developments in technical standards.

8.2 Annex 2 – List of technical standards

- ČSN EN ISO 29481-2:2017 Building information modelling - Information delivery manual - Part 2: Interaction framework (issued by transposing the original EN version of the ISO standard)
- ČSN ISO 29481-1:2014 Building information modelling - Information delivery manual - Part 1: Methodology and format (issued by transposing the original EN version of the ISO standard)
- ČSN EN ISO 16739:2017 Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries (issued by the mere announcement of the EN version of the ISO standard)
- ČSN ISO 12006-2 Building construction - Organization of information about construction works - Part 2: Framework for classification (translated)
- ČSN ISO 12006-3:2014 Building construction - Organization of information about construction works - Part 3: Framework for object-oriented information (issued by transposing the original EN version of the ISO standard)
- [6] ČSN ISO 16757-1:2017 Data structures for electronic product catalogues for building services - Part 1: Concepts, architecture and model (translated)
- ČSN ISO 22263:2014 Organization of information about construction works - Framework for management of project information (issued by transposing the original EN version of the ISO standard)
- ČSN ISO 16354: 2014 Guidelines for knowledge libraries and object libraries (issued by transposing the original EN version of the ISO standard)
- prEN ISO 19650-1 Information management using building information modelling - Part 1: Concepts and Principles (in preparation)
- prEN ISO 19650-2 Information management using building information modelling - Part 2- Delivery phase of the assets (in preparation)

Note: List as of 30 June 2017. The current state of technical standards for BIM is subject to changes according to the development of technical standardization and their list is available on the ISO, CEN and UNMZ website (www.seznamcsn.unmz.cz under the 7301 classification mark).

8.3 Annex 3 – Literature

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- MIKŠ L., MIKŠ R., TICHÁ, KOŠULIČ, Optimalizace technickoekonomických charakteristik životního cyklu stavebního díla, Akademické nakladatelství CERM, Brno, 2008, ISBN 978-80-7204-599-0
- Strategy Paper for the Government Construction Client Group from the BIM Industry Working Group, UK
- Handbook for the introduction of Building Information Modelling by European Public Sector – a handbook prepared in 2017 in a pan-European collaboration between representatives of public sector organizations from 21 EU countries, members of the EU BIM Task Group, with the support of the European Commission
- Government Construction Strategy – Government strategy for construction in the United Kingdom, May 2011
- Level 3 Building Information Modelling – Strategic Plan – Strategic Plan for BIM in the United Kingdom, February 2015
- Plan Transition Numérique dans le Bâtiment – Building digitization plan in France, June 2015
- Stufenplan Digitales Planen und Bauen - Digitization plan for the preparation and construction of buildings in Germany, December 2015
- Webiste of CEN [online], 2017 [cit. 08/03/2016]. Available at: http://standards.cen.eu
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- Website on INSPIRE [online], CENIA, Czech Environmental Information Agency, 2017 [cit. 08/03/2017]. Available at: http://inspire.gov.cz/