

## BUILDING INFORMATION MODELLING: PROCUREMENT PROCEDURE

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**Abstract.** Traditional construction planning is being replaced by the building information modelling (BIM) approach, which seeks to digitalise all the construction procedures, including procurement. Successful implementation of BIM on the market requires the preparation of appropriate procurement documents.

*Purpose* – to suggest the most suitable set of documents for public procurement in the context of BIM by analysing the documents that are necessary for implementing the stages of the building life cycle.

*Research methodology* – in order to achieve the aim of the research, the in-depth analysis of different countries' procurement methodological documents and analysis of the scientific articles have been implemented. The methodology also includes expert interviewing, which was done in order to analyse the investigated standards.

*Findings* – After analysing the procurement procedures of Norway, Spain, France, Poland, the United Kingdom, the Netherlands, and Finland, a set of documents, including Employer's Information Requirements (EIR), BIM Execution Plan (BEP) and BIM protocol, was considered as the most suitable for BIM-based procurement processes. In addition, the basic principles of ISO 19650-2:2018 do not reflect the specific conditions of each country, so it is appropriate to examine the possibility of providing guidance in individual national annexes that reflects the peculiarities of national procurement.

*Research limitations* – some research limitations were related to the challenges to access the literature, particularly the regulatory documentation associated with the public procurement procedure in a singular Country. Also, the difficulties with and accessing the document in the English language. However, in most of these cases, the document overview was analysed or translated from the native language.

*Originality/Value* – existing related studies are mainly oriented on a particular region/country, and no general overview of European countries regarding BIM procurement procedures has been implemented. Additionally, a significant scientific contribution of this research is the review of the fundamental standards, which includes the general specification for information management in construction projects using BIM. Implemented analysis can serve as a basis for other authors to implement their research concerning their region, to suggest the most appropriate and suitable set of documents.

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*Practical implications* – this study contributes to the preparation of the Lithuanian market for the implementation of BIM and could help policy-makers to prepare the most appropriate procurement documents.

**Keywords:** building information modelling (BIM), BIM standards, Employer’s Information Requirements (EIR), BIM Execution Plan (BEP), public procurement.

**JEL Classification:** O3, R3.

## Introduction

Europe is about to adopt Building Information Modelling BIM for public contracting, as was promoted by the European Union Public Procurement Directive (Maltese et al., 2017). Hence, BIM is being analysed by different governments and public procurers as it has been treated as a “strategic enabler for cost, quality and policy goals” (Osello et al., 2019). There are scholars who investigate global transformation to digitise public procurement procedures, including BIM procurement (Ermolli & De Toro, 2017; Vornicu, 2019). Other scholars examine the methods of public procurement (Bergmann & Schenkel, 2018; Porwal & Hewage, 2013). However, a limited number of scientific studies analyse the public procurement documents with a clear pathway towards the BIM approach.

It is noteworthy that BIM is a relatively new concept; hence, there are not many countries that have already implemented BIM, and the most significant ones are European countries. For instance, Austria, the Netherlands, the United Kingdom prepared BIM or digital modelling standards (Austrian Standards, 2015; Kosandiak & Philip, 2018; Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2012). Other countries, such as France, Ireland, Portugal, developed roadmaps for a transition to BIM (European Construction Sector Observatory, 2017; National BIM Council, 2017).

There are countries where BIM is already mandatory. For example, in Spain, BIM is mandatory for public building tenders (Ineria Management, 2019). Moreover, many countries are about to make BIM mandatory in the nearest future. For instance, in Germany, BIM became compulsory by the end of 2020 for all transportation projects (CoBuilder, 2016). Lithuania is not an exception. The application of BIM methods will be mandatory in the design, construction and installation of public sector buildings and mobile facilities (electricity networks, gas pipelines, communication lines, cables and their duct systems). The first phase of digitisation started from 2021 January 1 (The Ministry of the Republic of Lithuania, 2020). However, in Lithuania, a clear BIM public procurement procedure is not defined yet, and the necessary documents are not prepared. Hence, the current study aims at making a review of the procurement procedures, white papers and other related documents of the countries that have already adopted BIM and identify the most appropriate procurement documents for the Lithuanian market.

## 1. Review of procurement documents of European countries using BIM

Public procurement plays an essential role in stimulating the broader use of BIM, as well as renewing innovation and sustainable growth, involving small and medium-sized enterprises (SMEs), and spending taxpayers’ money more cost-effectively. Public procurers are the main

drivers of change, with the public sector being the largest single customer in the construction industry. This non-competitive, transparent and non-discriminatory group of principals can invest public funds and ensure higher value for taxpayers and stimulate the market through public procurement (EUBIM, 2017). Below is provided with an in-depth analysis of several European countries, which actively started or already implemented the procurement methodological documents for BIM. The main idea of the analysis was to identify the most appropriate methodology for the Lithuanian market.

*Norway.* In 2017, new public procurement laws and regulations came into force in Norway based on the European Union Public Procurement Directives 2014/23/EU, 2014/24/EU, 2014/25/EU (The European Parliament and the Council of the European Union, 2014a, 2014b, 2014c) as Norway is a part of the European Economic Area (EEA). The aforementioned Directives were incorporated into national legislation, which is aligned with the existing EU legislation. One crucial point to be taken into consideration is Article 22(4) of Directive 2014/24/EU: “Member States may require the use of specific electronic tools, such as of building information electronic modelling tools...”. In such cases, the contracting authorities shall offer alternative means of access [...] until those tools become generally available [...]” (The European Parliament and the Council of the European Union, 2014b).

According to International Comparative Legal Guides [ICLG] (2020), public procurement in Norway is governed by the Public Procurement Act and related legislation: The Public Procurement Regulation for the public sector and Utility Regulation; Defence and Security Regulation. In addition, Regulation on Concessions was adopted based on Directive 2014/23/EU (ICLG, 2020).

In Norway, two standard contracts are used (ICLG, 2019; Standards Norway, 2011, 2018): i) NS 8405:2008 Norwegian building and civil engineering contract; ii) NS 8407:2011 General conditions of contract for design and build contracts.

BIM is not covered by public procurement law, but there is a BIM *Statsbygg* manual for public procurement (Statsbygg, 2013). That is, the preparation of all tender documents should follow the BIM requirements as outlined in *Statsbygg Building Information Modelling Manual*, which describes the BIM concept for visualisation, area size measurement, and energy performance analysis.

*United Kingdom (UK).* According to the UK BIM program (Isikdag et al., 2012), one of the most important decisions taken was the recognition that in order to change the industry, the first and foremost step that is required is to change project requirements. Standards frameworks alone were not sufficient to promote the restructuring of the entire sector. Proper actions for communication helped establish the necessary contacts with the industry, but the primary strategic tool has been public procurement according to the UK BIM program. In 2011, under the framework of the UK BIM program announcement was made that from 2016 all public construction projects funded by the central government would require the use of BIM. Between 2012 and 2015, the value of publicly funded projects that meet the BIM Maturity Level 2 requirements has increased significantly from around 100 million GBP to over 9 billion GBP (EUBIM, 2017). This gradual increase in the number of public projects requiring BIM Maturity Level 2 was necessary to increase the supply chain's capacity and the public sector customers. The next step was for BIM public procurement

guidelines' development and training within the United Kingdom BIM Work Group, public sector contracting organisations, and industry. The continuous and increasing use of public procurement has been a useful tool in driving a change in industry behaviour to bring out the digital transformation. There was no minimum threshold for the size of projects for which BIM requirements would apply and, as believed, helped promote SMEs' participation and the sector as a whole. A wide variety of assets were used in the early stages to ensure that learning activities could cover the entire built environment (EUBIM, 2017).

The UK Department of Justice uses the Two-Stage Open Book as a critical strategic procurement document (Cabinet Office, 2012). The Two-Stage Open Book defines a so-called two-stage approach that combines the client, consultant, cost adviser, contractor and core supply chain into one team with the common goal of delivering the best possible product for the best budget (Mosey, 2014). The client provides a brief estimate of costs and invites the suppliers to the tender and bidding process according to the framework contract. In the first phase, several contractor teams compete for a contract. Teams are selected based on their ability, competencies, financial stability, experience and financial capacity. In the second phase, the chosen team develops an open book proposal that meets the customer's requirements and costs. This process involves independent peer review to check essential aspects, such as whether the scope of work is well defined or the risks of the results are presented. (Udom, 2012). If improvements are necessary, the principal and contractor are asked to review the submitted bids (Udom, 2012). The main objective of this model should be to further reduce the costs of contractors for the bidding (procurement) phase (Cabinet Office, 2012). This saves costs and fosters efficiency before construction begins.

Other relevant BIM documents are Government Soft Landings and Project Bank Accounts (Ministry of Justice of the UK, 2014). Project bank accounts are also part of the Government Construction Strategy and discuss a new way of paying for supply chain members. Below is an example of BIM procurement based on a two-stage open book.

First, the project team develops a BIM model from existing 2D documents for the purpose of the competition (BIM Task Group, 2013). Tenderers are invited to a BIM Planned Procurement Seminar, usually in the Ministry of Justice, to familiarise themselves with the tender process (BIM Task Group, 2013). During the competition, the client assists the bidders, for example, by extracting Construction Operations Building Information Exchange and finally asks for his initial model proposal (BIM Task Group, 2013). The principal then selects the main contractor and signs the Project Partner Agreement. Finally, the price is agreed upon, and a contract is signed (Ministry of Justice of the UK, 2014).

Based on the UK analysis, it was found that the most commonly used BIM procurement documents are: Employer's Information Requirements (EIR); BIM project execution plan; BIM protocol (annex to the contract) and other documents. More details about it in the section about standards.

*Denmark.* Denmark is considered to be one of the leaders among EU countries in terms of implementing BIM as BIM requirements are put in public procurement law since 2007 (European Commission, 2019). According to the Public Procurement Act, the Danish government adopted a regulation (1365), which was approved in 2007 (supplemented by the ICT (Information and Communication Technologies) Regulation 1381 in 2011 and the ICT

Regulations 118 and 119 in 2013). These regulations aim to promote the integration of ICT into the construction sector, thus increasing its productivity. In practice, the use of BIM in public sector renovation projects has been mandatory since 2008 January 1, and in state-supported social housing projects – from 2009 January 1. Since 2011 June The Danish Parliament has extended the necessary use of BIM to all local and regional projects with an investment amount of more than € 2.7 million. And a lower threshold of € 677000 was set for public projects (Hore et al., 2017). Since 2013 in April, BIM has been mandatory in the implementation of national, regional, municipal projects, including projects related to social housing (Byggeri Informationsteknologi Produktivitet Samarbejde [bips], 2014). The Danish government has involved academia and industry in the drafting of regulations through consultations and pilot projects. This has helped to ensure that BIM requirements are relevant and applicable to the industry, which can play a vital role in the implementation of BIM (McAuley et al., 2016).

*Spain.* Spain has a BIM commission, supported by the Ministry of Public Works, for BIM industry, which are applied to buildings from 2018, and for infrastructure from 2019.

The Country Report Spain for European Commission about the Environmental Implementation (2019) (European Commission, 2019) states that in 2008 The National Action Plan for Green Public Procurement was adopted, with a target of 25–100% of Green Public Procurement (GPP), depending on the product group and the implementation phase. Green procurement criteria have been developed at the national level for the following product groups: construction and maintenance, energy, transport, office equipment, paper and publications, furniture, cleaning products and services, and events. On the 7th of December, 2018, the Council of Ministers approved the government's Second Green Public Procurement (GPP) National Action Plan 2019–2025 (Office of Prime Minister, 2011). The plan includes 20 products, works, and service groups, including building construction and management, road construction and maintenance, electricity supply, printing equipment and computers, cleaning products and services, air conditioning systems and transportation.

*France.* The French government has taken a different path, suggesting the optional 2015 plan for the digital switchover in the construction industry (hereinafter referred to as the plan). By not imposing a “BIM” requirement in their public procurement law, the French Government sought to ensure that small and medium-sized enterprises (SMEs) (with limited access to BIM) did not hinder access to public procurement (Architects.org, 2018). The plan aims to promote BIM as a useful construction sector measure for sustainability and limit construction costs. In this way contributing to the needs of the construction industry to build and renovate cheaper and faster. The plan includes a 20 million EUR budget from the Building Insurance Compensation Fund (“Fonds de Compensation de l'Assurance Construction”) (Rakennustieto, 2001), which led to its implementation. This plan was drawn up for three years and applied to all construction companies operating in France (European Commission, 2019).

*Poland.* The Polish government has taken a binding but flexible approach to implementing BIM. In 2016 an amendment to the Public Procurement Law had been announced, stating that “the contracting authority may require the use of electronic data modelling tools or similar tools when awarding construction contracts. In that case, the project owner must

allow the use of such tools until such tools become publicly available” (RICS, 2018). Therefore, the Polish Government, unlike the Danish government, does not systematically require BIM. Since the announcement of the amendment, the Polish government (including its agencies) has announced few tenders related to BIM. In 2017 The Polish National Highway Agency (The Generalna Dyrekcja Dróg Krajowych i Autostrad GDDKiA) launched the pilot projects requiring the use of BIM for the development of the Zatory bypass on the national roads DK28 and DK44. The Polish State Railways (Polskie Koleje Państwowe PKP) also actively consults with the industry on the use of BIM in national railway infrastructure (Europtima, 2018).

*The Netherlands.* The Dutch public procurement law focuses on large contracting entities working with BIM. These institutions use BIM as an asset management and maintenance tool, so their BIM requirements are different from those used as a design tool or collaboration tool. These contracting authorities use Employer’s Information Requirements (EIRs) to provide their BIM requirements, specifying what data they need, how they want it, and when.

Other large Dutch employers who work with BIM are usually hospitals and schools. However, whether those hospitals and schools are required to comply with the Procurement Act depends on whether they are contracting authorities within the meaning of the Directive (The European Parliament and the Council of the European Union, 2014b). Most schools in the Netherlands are considered to be contracting authorities within the definition of the Procurement Act and the Procurement Directive (Lexology, n.d.).

However, if the authorities are not considered to be a contracting authority within the definition of the Directive, in some cases, they use forms known as “private” procurement by the Dutch. In such cases, the procurement documents, as well as the principles and rules set out in those specifications, will determine whether the rules of the Public Procurement Directives and the Law on Procurement will apply. An example of a private purchase with a BIM component can be found in the Dutch case “Rechtbank Zeeland West Brabant” (Brugeman, 2018a, 2018b, 2019; de Rechtspraak, 2016).

*Finland.* Almost all construction contracts in Finland are based on the General Conditions for Building Contracts (Korpiola & Sipilae, 1998), and the consultancy contracts are based on the General Conditions for Consulting KSE 2013 (Holmberg, 2014).

The most commonly used purchasing methods for building construction are the following (Halonen & Kovarskyte, 2017): Fixed price contract; Complete turnkey contract; Project management contract with a guaranteed maximum price.

The most common form of contracting and purchasing is the contract between the client and the general contractor for the work. A general contractor usually invites a variety of subcontractors.

It is also widespread to use split contracts. Under them, the client employs several contractors under separate contracts. Divided contract structures can also be combined under the supervision of a prime contractor by subordinating contracts in cases where the construction work is split into two or more simultaneous contracts (for example, prime contractor and subordinate air conditioning contractor). Subordination means an arrangement whereby the client delegates tasks related to joint management, site and schedule management to a prime contractor under a three-party subordination agreement.

In addition, the following contracts and models are used in Finland in the context of BIM (Bolpagni, 2013; Halonen & Kovarskyte, 2017; Lahdenperä, 2012; Petäjaniemi & Lahdenperä, 2012):

- Integrated project delivery (IPD) or alliance contracts are a relatively new and rapidly growing trend in major projects. The Alliancing (PA) project, also known as “Alliance Contracting”, is a contract based on a “multilateral” agreement between the project partners with parties taking joint responsibility for design and construction, and the works are implemented through so-called a “joint organisation”, with all parties taking responsibility for both positive and negative risks.
- Engineer Procure Construct (EPC) or Engineer Procure Construction Management (EPCM) contracts are commonly used in industrial construction projects.
- In the energy sector, a very specific “Mankala” company model is commonly used. The Mankala model is a special cost model where an energy-generating company is jointly owned by several parent companies, which share together the operating costs of the subsidiary proportionally. The subsidiary then sells the generated heat and electricity to its shareholders on a non-profit basis.

Contractual arrangements. The Building Information Foundation (RTS) of Finland is a private non-profit foundation dedicated to promoting proper planning, sound construction methods, and good asset management practices (Rakennustieto, 2001). The fund’s projects, which become profitable independent businesses, are transferred to its parent company – Building Information Ltd, which also operates as a publishing house. Together, the Foundation and the Company form Construction Information Group.

The Building Information Group provides contract templates that are principally used in construction and design work. The templates are based and commonly used in conjunction with the widely used Finnish general terms of construction contracts (YSE 1998) (Korpiola & Sipilae, 1998). These terms and conditions of the YSE 1998 are drawn up in cooperation with most of the central Finnish building societies and are annexed to most Finnish building contracts. They are also applied in the field of design, where the Finnish General Terms of Consultation (KSE 1995) (Holmberg, 2014) are equivalent to the General Terms of YSE 1998.

International projects often use standard forms developed by the International Federation of Consulting Engineers (FIDIC). Local and international projects use standard Finnish contract forms published by the Building Information Group as well as the General Terms and Conditions of YSE 1998 and KSE 1995 (Jaeger & Hök, 2010). FIDIC contract forms are generally used only in cases where the project is partly or totally outside Finland or in the case of an energy sector construction project in Finland.

Despite the fact, that BIM is accepted or about to be accepted in different countries, it should be remembered that there are not only advantages but also disadvantages that need to be addressed. The table of advantages and disadvantages of BIM is presented below (see Table 1).

An analysis of other European countries’ Procurement Guidance Documents shows that not all countries that implement BIM have standard legal documents that allow them to meet Maturity Level 2 requirements. Still, the vast majority have BIM procurement guidelines in place. An absolute majority of the examined countries use a standard contract, which is usually accompanied by an annexe with EIRs drawn up. By imposing the level of maturity

Table 1. BIM advantages and disadvantages (source: Reizgevičius, 2016; Sotham Engineering, n.d.; Eastman et al., 2011; Bolpagni, 2013; Li et al., 2020, added by authors)

BIM advantages	BIM disadvantages
<ul style="list-style-type: none"> <li>– Better planning;</li> <li>– 3D modelling visual capabilities for better decision making;</li> <li>– Increased complexity of design for better quality and proneness of decisions;</li> <li>– Clash detection;</li> <li>– Better project change/addition management;</li> <li>– Less risk for the errors;</li> <li>– Free software for partners;</li> <li>– Reduced resulting time on design and construction;</li> <li>– Reduced resulting cost for design and construction;</li> <li>– Resources saving on design and construction;</li> <li>– Reduced expenditure on energy use;</li> <li>– Sustainable design and construction;</li> <li>– The end-user receives all the information by the end of the project life cycle;</li> <li>– Improved building performance.</li> </ul>	<ul style="list-style-type: none"> <li>– Significant investment in the initial BIM system, including implementation costs;</li> <li>– Lack of trust and cooperation;</li> <li>– Customer non-involvement in all design processes;</li> <li>– No explicit regulation on the ownership of BIM data;</li> <li>– Increased pressure on building process;</li> <li>– High cost;</li> <li>– Instability in temperature;</li> <li>– Low conversion efficiency and complex motor operation.</li> </ul>

requirements defined in legal documents, the Lithuanian market could be subject to a standard contract with an annexe specifying the EIR, as is the case in many other foreign countries. The reviewed countries, in terms of Guidance on BIM, use the same duplicate documents and their elements (EIR, BEP, BIM Protocol, BIM maturity levels).

## 2. BIM information management in the procurement stage according to the Specification PAS 1192-2:2013

In May 2011, the UK government developed a strategy for the digital transformation of the construction sector, which aimed to reduce the cost of public sector assets by 20% by 2016. The strategy calls for “a fundamental change in the relationship between public institutions and the construction sector so that government transactions are always good and the country receives the long-term socio-economic infrastructure it needs” (UK Government, 2011).

The development of harmonised design and construction information is a time-based process, independent from the form of the used procurement procedure. Each task needs to be performed in a certain order to the benefit of all parties involved. This is also called “collaborative work”. In a collaborative work environment, teams are asked to provide information using standardised processes and agreed on standards and methods to ensure uniform format and quality of information, and the information can be used and reused without modification or interpretation.

That is the purpose of the document PAS 1192-2:2013 (The British Standards Institution, 2013), which provides specific guidance on information management requirements for projects using BIM. The requirements in PAS 1192-2:2013 start from the technical specification



of the needs of the new object or the assessment point of the existing object. This is followed by a series of steps in the information delivery cycle and is completed by presenting an information model for future maintenance. Figure 1 provides the information management cycle described in PAS 1192-2:2013.

The procurement phase, separated from the entire information delivery cycle, will be examined in detail further in this article.

The first stage according to the PAS 1192-2:2013 process scheme begins with a *needs assessment*, during which, among other activities, an Employer Information Requirements (EIR) package is prepared, a consolidated document setting out what information, in what form, and at what time, must be prepared and submitted to the employer by the project delivery team. EIR is included in the tender documents so that potential service providers can assess their ability and capacity to meet EIR requirements and present their proposed way of carrying out the project. The ways of information exchange and cooperation requirements are specifically described in correspondent parts of the EIR.

After assessing the client's needs, *procurement procedures* are executed. During the main contractor selection process, bidders must provide details of their approach to the creation and management of project information to demonstrate their proposed approach, team capabilities, capacity and competence to comply with and implement the Employer Information Requirements (EIR). To this end, tenderers must prepare a Preliminary BIM Project Execution Plan (BEP-I), which is a tool for the employer to determine whether the information requirements set by him/her can be met.

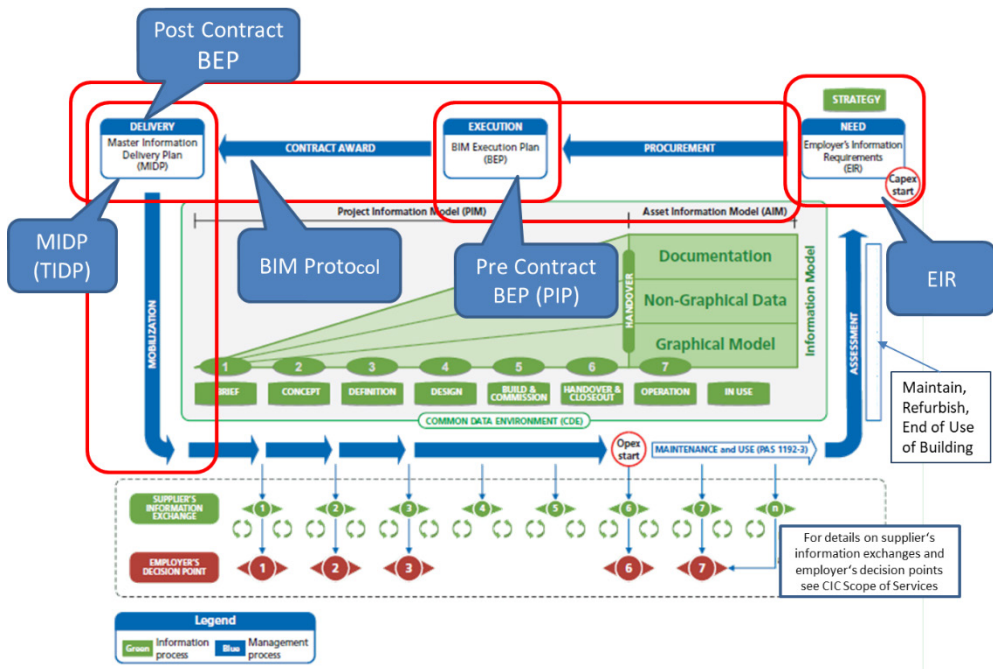


Figure 1. Information presentation cycle diagram, basing on PAS 1192-2:2013 (source: prepared by the author)

It should be added that according to the recommendations of PAS 1192-2:2013, the BIM project implementation plan (BEP) is developed in two stages. The aforementioned Preliminary Version (BEP-I) is being put out to tender to present the information management capabilities of each potential supplier. Subsequently, after announcing the winner of the tender, the company prepares a detailed version of the plan (BEP-II), which explains in detail the supplier's methodology for carrying out the project using BIM; its purpose is to draw up and implement the project program.

The pre-competitive BEP-I includes all the items required by the EIR, which are formulated in the *Project Implementation Plan* (PIP). Potential providers are also required to submit three forms to be completed by all organisations in the service supply chain.

Provider's *Building Information Management (BIM) Assessment Form(s)*. Its aim is to reveal the understanding, BIM competencies and experience of the project team.

Provider's *Information Technologies (IT) Assessment Form(s)*. Its purpose is to reveal the project team's ability and capacity to create and manage information model to assess the suitability of their IT infrastructure to perform these tasks.

Provider's *Resource Assessment Form(s)*. It is used to assess the human resources of project teams in terms of the abilities and capacities of the BIM services they provide.

After evaluating the submitted procurement documents, the winner of the tender will be announced, with whom the contract will be signed. According to the recommendations of PAS 1192-2:2013, a specific annex to the contract – *BIM Protocol* – must be attached to the contract, which makes the minimum necessary amendments to the contractual agreements of existing construction projects, taking into account the specifics of the BIM project. The main task of the Protocol is to create conditions for the preparation of information models of buildings in the defined stages of the project. At the same time, the Protocol aims to help Project teams apply effective collaborative practices.

Once the winner, the project service provider, has been identified, the company prepares and submits to the client a consolidated *Master Information Delivery Plan* (MIDP) on behalf of the entire supply chain, which is based on the *Team Information Delivery Plan* (TIDP) submitted by each member of the supply chain, enclosing their *Information Management Responsibility Matrix* (RMx) indicating the relations between the representatives of the subject areas (disciplines) and the information they prepare.

Figure 2 presents the relationship between the documents used in the information management process.

Once the project team has been selected, and the MIDP and TIDP have been prepared, the mobilisation phase takes place. Mobilisation is important because it allows the project team to ensure that the information management solution pays off before design begins. This includes ensuring that the required documents have been prepared and agreed upon, information management processes are in place, the team has the necessary skills and competencies, and technology supports and enables information management in accordance with PAS 1192-2:2013.

Thus, it can be stated that the *Specification for Information Management* document PAS 1192-2:2013 (assessing the essential contribution of the standard BS 1192:2007+A2:2016 (The British Standards Institution, 2016) *Collaborative production of architectural, engineering and*

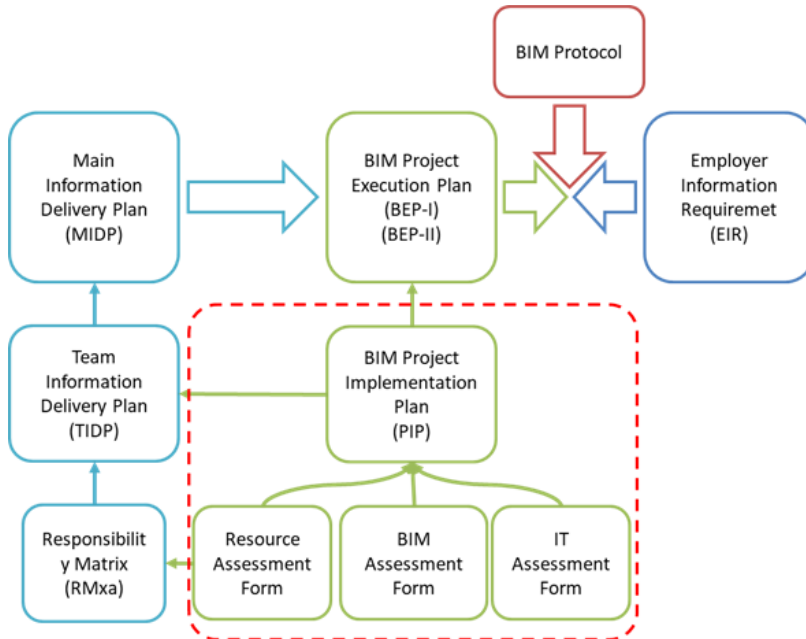


Figure 2. Relationships between documents used in information management (source: prepared by the author)

*construction information. Code of practice*) provides a good basis for forming a set of rules for information exchange in the BIM project, determines the logic of providing this information to project stakeholders, defines the main BIM dossiers, which must be followed during the exchange of information, planning during the development and implementation of the construction project before its final assessment and commissioning.

However, this document lacks a more flexible interface with the processes and stages of a building's life cycle and the activities and procedures that take place during the mentioned processes and stages, that would allow access to these processes and the information flows generated during their activities to formulate rules and standards for their management.

### 3. BIM information management in the procurement stage according to the standard ISO 19650-1,-2:2018

A series of international standards known as ISO 19650-1, ISO 19650-2 (International Organization for Standardization, 2018a, 2018b) "Organization of information about construction works – Information management using building information modelling. Part 1: Concepts and principles and Part 2: Delivery phase of asset" was developed to adopt the best practices of the BS / PAS 1192 series of British standards and BIM normative documents including other national standards.

The first part of ISO 19650-1:2018 provides general concepts and defines the essential principles for how information should be developed, delivered and managed during the life cycle of assets built or under construction, using building information modelling BIM. It is intended for persons involved in the planning, design, construction and subsequent operation of the assets, the so-called appointing and appointed parties at various levels.

An important part of the standard is the definitions of Information Requirements (IR) and the Information Models (IM) developed in accordance with these requirements and the hierarchy between them, on the stages of the asset life cycle, illustrated in the figure below (see Figure 3).

It should be noted that in order to specify the requirements for the information exchange, the authors of the standard use the term “Exchange Information Requirements” for short, the EIR, which immediately brought confusion to the definitions. Moreover, all the classes of Information Requirements (IR) set out in the standard are: Organizational Information Requirements (OIR); Asset Information Requirements (AIR); Project Information Requirements (PIR) are none other than the well-known subclass of PAS 1192-2:2013 Employer Information Requirements (EIR) and such duplication of abbreviations brings a lot of ambiguity and confusion. In turn, the “Exchange Information Requirements” are the general technical, organisational and management aspect of all the above information requirements, which must be formulated according to the requirements of the Employer/Client (appointing party). In this case, it would be appropriate to define the information requirements for the exchange in another abbreviation, e.g. XIR, where X stands for “exchange”.

The sixth chapter of the standard describes in general terms, and in some places too technically and too in detail, the information delivery cycle, harmonised with the asset life cycle, setting of information requirements and planning for information delivery. Admittedly, this standard lacks clarity in the information life cycle description based on the scheme like in PAS 1192-2. Additionally, the scheme itself, which illustrates the concept and principles given in Figure 11 of Chapter 13 („Overview and illustration of the information management

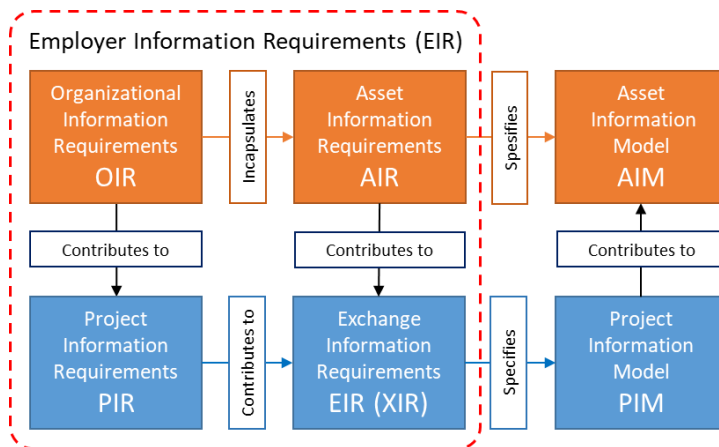


Figure 3. Hierarchy of information requirements

process“), but does not bring any further clarity. What is also interesting, the planning of information delivery is again, but already in other words described in Chapter 10. The content of Figure 8 (“Example of information being provided by whole delivery teams”) and Figure 9. (“Example of information delivery through information exchange to support key appointing party decisions”) is almost repetitive and could be represented in a single illustration. The same can be said about the contents of Figures 6 and 7. Chapter 8 describes the information about “Delivery team capability and capacity”.

All it gives the impression that this chapter is a very compromising one, but at the same time not a complete part of the standard. It is full of declarative and fictional moments, unfinished places and repetitions of the text; at the same time, there are many small and sometimes duplicative details.

Almost all chapters from 7 to 12 of the standard (Ch.7. Project and asset information management roles; Ch.8. Container-based collaborative working; Ch.11. Managing the collaborative production of information; Ch.12 Common data environment (CDE) solution and workflow) could be assigned to one topic – project and asset information management functions and methods using Common Data Environment (CDE) solutions and workflow principles.

It should be noted that this part of the standard also lacks the clarity and logic of another well-known “BIM standard”, referring to BS 1192:2007+A2:2016. In the form given in ISO 19650-1, this part of the CDE description is not suitable for practical application without a detailed explanation in a national annex, similarly as it is done in BS EN ISO 19650-1:2018 *National Annex* document. This also applies to the entire ISO 19650-1:2018 standard. It is not enough to have a version translated into the national language (eg. LST EN ISO 19650-1:2018), a clear and logical commentary on this standard adapted to local practices and legislation is required – a *National Annex of LST EN ISO 19650-1:2018* standard.

The second part of the standard, ISO 19650-2:2018, is much more specific and clear. It sets out specific principles for information management during delivery phase of assets to enable the contracting authority to establish (*Employer*) *Information Requirements* (EIR) and to create the right business conditions and collaboration environment for the assigned parties to develop the information efficiently and effectively.

The information management process related to the asset delivery phase is applied according to the project development stages, which the Client and the Project Teams intend to apply in a coordinated manner. The information management process (see Figure 4) must be applied to each assignment, regardless of the stage of the project.

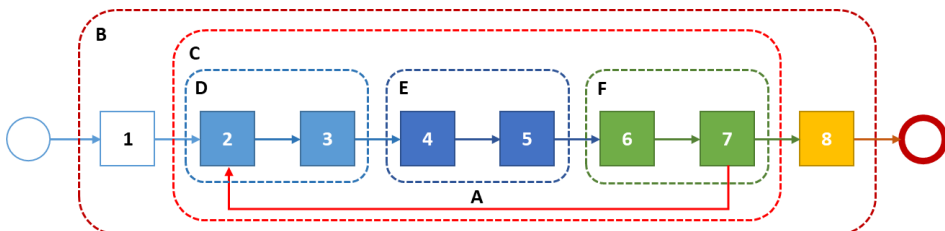


Figure 4. Process of information management. (source: prepared by authors)

Figure 4 illustrates the procurement activities for each assignment. Attention should be paid to the first four activities: 1 – *Needs assessment*; 2 – *Call for proposals*; 3 – *Submission of a proposal*; 4 – *Appointment*.

The first activities include preparation for procurement: appointment of responsible persons to perform information management functions, determination of *Project Information Requirements* (PIR); preparation of the project's information delivery milestones; an indication of project information standards; identification of methods and procedures for the development of project information; identification of project CDE; and some other key activities.

In Activity 2, specific procurement documents – a call for tenders – are prepared, taking into account the specific project and procurement procedures. They also formulate qualification requirements for the supplier based on the EIR.

In Activity 3, the submission of a proposal, during which the supplier submits the initial project implementation plan (BEP-I) mainly in response to the Employers PIR and provides documents proving its compliance with the required competence, capacity, and qualifications.

Activity 4 – Designation, where a contract is awarded to the supplier who has submitted a valid tender after the final evaluation.

All activities in the first four (and all other phases) are identified in a quite detailed manner, simply sub-items in ISO 19650-2:2018. However, the legislation and procedures governing their implementation depend on the specific nature of the project, its complexity, the form and method of chosen project's implementation. In addition, although the principles are similar, public procurement is regulated differently in each country. It is, therefore, necessary to consider the differences of the framework in separate regions. Considering this – it is appropriate to develop National guidelines and recommendations for procurement procedure in BIM implementation.

As mentioned above, it is appropriate to follow the standard ISO 19650-2:2018 when organising public procurement, which is carried out at the phase of property delivery. While maintaining the basic principles of the standard, it is appropriate to draw up national annexes containing the necessary guidelines adapted to specific local conditions and legislation, summarising the peculiarities of public procurement in each country. Guidelines could also provide individual case studies for the preparation of inherent procurement programs, depending on the nature and complexity of the projects to be implemented.

## Conclusions

The current paper aimed at analysing the procurement documents of different countries in order to choose the most appropriate that could be considered for use in Lithuania in the context of BIM procurement. The following countries were investigated in the study: Norway, the UK, the Netherlands, and Finland. The way governments have incorporated (or excluded) BIM requirements into their procurement laws reflects their and sometimes the interests of the industry. Although the governments of each of the countries have taken different approaches to the inclusion of BIM requirements in public procurement, they have all played a key role in promoting the first stages of BIM implementation. The implementation

of BIM methodology, whether mandatory or non-compulsory, has dramatically accelerated, with governments showing their initiative and willingness for the construction industry to implement BIM.

An overview of BIM methodological documents in European countries showed that there are three primary procurement methodological documents:

- a standard legal document used in the UK, Norway, and Lithuania (usually adapted on the particular region);
- BIM procurement guidelines published in the UK;
- Standard contract and annex, which exist in most countries except Lithuania.

After comparing the methodological documents of the selected countries, the list of procurement documents suitable for the Lithuanian market is proposed:

- Employee Information Requirements (EIR) standard form;
- Model standard annex to the contract (BIM protocol) and guidance document on its application to public procurement;
- Guidance document on the development and use of BIM Implementation Plan (BEP) in public procurement.

Notwithstanding the clear guiding principles of ISO 19650-2:2018, it is appropriate to develop national annexes containing the necessary guidelines adapted to specific local conditions and legislation, summarising the particularity of public procurement in each country. They could also provide individual examples of how to develop appropriate procurement programs and a balanced package of procurement documents for this purpose, taking into account the nature of the projects, their complexity, the stage and the chosen form of project implementation.

After analysing the literature review, existing related studies are mainly oriented on particular region/country, and no general overview of European countries regarding BIM procurement procedures has been implemented. In this research, a comprehensive overview is done, and a list of procurement documents suitable for the Lithuanian market has been proposed.

Additionally, a significant scientific contribution is the review of the fundamental standards, which includes the general specification for information management in construction projects using BIM. Implemented analysis can serve as a basis for other authors to implement their research concerning their region, to suggest the most appropriate and suitable set of documents.

To sum up, this study contributes to the preparation of the Lithuanian market for the implementation of BIM and could help policy-makers to prepare the most appropriate procurement documents

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