BIM Implementation Maturity Level and Proposed Approach for the Upgrade in Lithuania

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Abstract

Recently, Building information modelling (BIM) proves its capability to solve the raised AEC industry issues. Therefore, several countries and entities pursue to transform into BIM especially the developed countries. Lithuania as a European country has a great challenge to cap up with the surrounding environment to implement BIM. This study aims to determine the BIM maturity levels in Lithuania and supposed the missed steps to upgrade to the next level. Eighteen important Lithuanian construction projects awarded the most successful implementing BIM are chosen as a case study. Face-to-face interviews were conducted with several BIM experts whose work at the chosen projects. The analysis conducted by the most effective theoretical model entitled BIM Maturity Matrix (BIMM). The key findings of this research that Lithuania reached the BIM implementing maturity level 2 while some projects still at level 1 that proves the ability of Lithuanian AEC industry to softly and completely transfer the maturity to level 2 by the recommendation provided through the proposed approach at the end of the paper. These results provide a stunning opportunity to improve the AEC project performance and reap the benefits of implementing BIM. Future studies can develop a framework to improve the BIM implementation in Lithuania softly.

Keywords: BIM; BIM maturity model; BIM stages; Implementation maturity

1. Introduction

The Architecture engineering construction (AEC) industry worldwide is facing a lot of challenges coming from the fragmentation of AEC and other technical, organizational and managerial problems of building

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projects (Ahmed, S., 2018). Since the Computer-Aided Design (CAD) was adopted by engineers, architectures, and designers during the late 20th century; an innovation and digitalization became a big title for the building industry (Ustinovichius, L., et al. 2017; Ahmed, S., et. al.., 2018). The complex analysis of problems revealed that BIM is the magic system to solve more than 70% of the AEC industry problems (Migilinskas, 2017). For example, the lack of interoperability that can highly be achieved by BIM implementation identified as the main cause for design conflicts and delay (Maya, R., et al. 2014). Translated into the innovative term, BIM is a shareable collection of building data, including a three-dimensional (3D) computer model of the entire project. This model includes data about each of the physical building elements that make up the project, including the location, number, and size of those elements. This fact makes of the building information models a shared knowledge resources to support decision-making about a facility from planning to demolition, it is the present and the future of the construction sector (Di Giuda et al. 2015; Zhao, X., 2017). The BIM model allows to analyze the current situation, solve the problems with information management using team-based collaboration between project participants and integrated project delivery, establish Common Data Environment, and initiate use BIM-based procurement (Ustinovichius, L., et al. 2017).

Nowadays many countries across the world are in different stages of implementing BIM and adopting it into their legislation. A lot of efforts have been made by researchers and practitioners to set the BIM implementation criteria. Therefore, authors have reviewed and relied on these works as a tool to analyze the steps taken in Lithuania with a view to arriving at an appropriate model for the systematic development of BIM for better and faster development. The United States has long been a global leader in BIM development and implementation in the construction industry, while the US General Services Administration has pioneered the implementation of BIM on public projects (Smith, P., 2014).

In the other side in the United Kingdom, the government in 2011 has introduced a BIM implementation strategy for the UK construction industry. The objective was to transform the UK industry into a global BIM leader (HM Government, 2012). The Scandinavian region is also a global leader in BIM adaptation and implementation. Norway, Denmark, and Finland embraced the ArchiCAD software early and were amongst the first countries to adopt model-based design (Smith, P., 2014). The Finnish public sector is the main driver in BIM adaptation with Senate Properties Company, which is a major government entity responsible for managing the country’s property assets. The Danish government is a strong supporter of BIM and invests heavily in research and development. In Norway, BIM implementation is led by Statsbygg - a firm responsible for the construction, management, and development of government facilities (Smith, P., 2014). However, the application of BIM is still rare at the initial planning stage (Rafiee, A., et al., 2014). In the Czech Republic, There are still some barriers for BIM implementation: the readiness of BIM (BIM is not prepared well enough for widespread implementation), high training costs (education requirements are unknown and the learning curve is steep), investment in new technology, hardware and software is needed. All this makes BIM learning difficult to achieve (Bouška, R., 2016).

In the other hand, (Novakova, V., et al. 2018) found that if the current trend is not reversed as soon as possible, the Czech Republic will become less competitive in the global economy and dependent on foreign knowledge and technology. BIM practice offers to redefine the conditions of production of technical projects in order to save expended resources and increase productivity (Metallinos, P., Pantouvakis, J., 2018). Whatever, several studies have confirmed that individual efforts by people are

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insufficient to have the best value from BIM implementation, there is a need for complementary methodologies as people-oriented systems, data-driven approaches, and process innovation. (Khosrowshahi, F., Arayici, Y., 2012). Also, BIM implementation in design firms generally faces the lack of clarity in the adoption process, and there is a need for providing specific support services to firms who implement BIM (Shaban, M. & Elhendawi, A, 2018, Hochscheid, E., Halin, G., 2019). As the aim of the research is to identify needed next steps to systematic growth of BIM implementation for better and faster results to become more competitive in the global economy. Maturity models were investigated in order to be used as a scale to measure implemented steps at BIM implementation in Lithuania. Maturity refers to the aspects of BIM ability or quality of use and the features or fields for BIM implementation (Chen, L., et al., 2014). (Yusof, N., et al., 2018) adopted a bibliometric analysis to identify the trends of BIM maturity studies, its models, and indicators for assessing BIM maturity. According to her systematic review, the most productive author of BIM maturity is (Succar, B., 2009b), who published four articles and had highly cited with 335 citations. (Succar, B., 2009b) introduced a comprehensive BIM maturity that consists of BIM capability, BIM stages, BIM competency sets and a roadmap to achieve the main goal of BIM implementation; integrated project delivery (Ahmed, S., et, al. 2018).

Also (Smits W., et al., 2017) analyzed the impact of the BIM implementation on the performance of construction companies in the Netherlands by using the BIM maturity assessment. Their study showed that the existence of BIM planning team is very important to improve the company's project performance. Also, (Azzouz, A., Hill, P., 2017) used Building Information Modelling Maturity (BIMM) to identify the best practices of BIM in 1291 construction projects. BIM is considered as a part of industry 4.0 (Oesterreich, D, T., Teuteberg, F., 2016). In spite of this, (Latiffi, A., et al., 2014) said: most of the construction players in developing countries have not yet implemented BIM, and they mostly concentrated BIM projects in public megaprojects. For this, only models that consider pre-BIM maturities such as NBIMS-CMM, BIMM and the BIM Proficiency Index are suitable for assessing BIM implementation in these countries.

From another side, (Wu, C., et al., 2017) comprehensively reviewed nine of the most typical BIM maturity measurement tools. Although he found that the NBIMS CMM tool was in the first class of assessment because of its Structure which is the simplest among all tools, it had limited scope to BIM technical aspects. The second place was IU BIM Proficiency Index with a simple structure; Easy to implement. but all measures have the same weight, no distinction; also, limited scope to BIM technical aspects; Low flexibility; Lacks field tests, empirical studies and practical BIM MM which coming in the third place was the highly flexible tool selected for BIM users that plan to implement or improve BIM implementations. BIM MM is adjustable for different users' aims. Covers multiple aspects of BIM; Easy to implement; Explains detailed the matching between BIM and organizational strategies. Whatever this method still has lacked field tests, empirical studies and practical and data collections for validation and optimization; authors had one experience with it through (S., Ahmed, 2018) and found it easy to use and can be familiar with the BIM team in a new transforming companies towards BIM. Accordingly, BIM maturity model was chosen as a tool to guide through the systematic implementation of BIM.

BIM Maturity Indicators:

BIMM is a knowledge tool for identifying the current BIM Maturity of the organization or project team and provided criteria in three BIM fields (Technologies, Processes, and Policies). The ability of the

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construction stockholders to operate and exchange information can be assessed by using BIM maturity model which will describe maturity level at the certain project. The prerequisites were defined as trough BIM steps that identify necessary activities, services, and products to meet requirements. Maturity assessment will help to define the implemented steps consequently this will help to define the roadmap for systematic improvement for implementation by knowing the remained not implemented activities.

Authors differed in identifying BIM maturity indicators, where various indicators were proposed due to the multidimensional of BIM usage. BIM maturity indicators facilitate the assessment of projects, companies, and industry implementing of BIM and how to improve the progressing. Although of the difference, all of them has four essential indicators Technology, Process, and Policy or Protocol, and People. Some of them have five indicators and others put more details and reached to eleven one. Anyway, BIM Technology appears in (general BIM technology, software, visualization tools) and BIM Users (competencies, attitudes, motivation, training, and satisfaction) (Wu, C., et al., 2017), the BIM Process consists of two types of interactions: human to human and human to computer. Including workflow, life cycle process. While the organization measures the organizational support, leadership commitment, BIM culture and strategies (Wu, C., et al., 2017). However, BIM output measures the project's performance (cost reduction, speedy completion, improvement of sustainability and functionality, standard) and the life cycles of the facilities (the actual cost of investment, return on investment, ability to deliver on time, stakeholder satisfaction, and ease of use (Abdirad, H., 2017). The BIM performing in the industry represents by growth in BIM implementation, investment, BIM training, and knowledge are some examples of indicators for BIM output (Abdirad, H., 2017). Although of all efforts, clearly still more work is needed to confirm if these BIM maturity models can assess the BIM implementation.

(Chen, P.-H., Nguyen, T., C., 2017) tested three indicators Technology, Process, and Information using structural equation modeling on BIM projects and identified that Process is the most important indicator for evaluating BIM maturity. (Yosuf, N., et al. 2018) shows that the majority of the authors identified Technology and Process as the first top indicators for measuring BIM maturity, followed by Information, People and Policy. Specifically, there is a dearth of studies from the developing world and that focus on People, Policy, Organizational, and BIM output indicators. (Succar, B., 2009) considered one of the most internationally known and most comprehensive models of maturity. According to (Succar, B., 2009) BIM maturity assessment includes TPP (technology, process, and policy) components and it is subdivided into three stages as sown in Figure 1 which are:

BIM Stage 1: Object-based modeling BIM implementation is initiated through the deployment of an 'object-based 3D parametric software tool' similar to ArchiCAD, Revit, Digital Project and Tekla within the three Project Lifecycle Phases. At stage 1 visualization is emphasized through automated generation and coordination of 2Ddocumentation and 3D visualization. Also, basic data exports will be delivered as (ex: door schedule, concrete quantities, FFE costs) and light-weight 3D models (ex: 3D, DWF, 3D PDF, NWD, etc…). Collaboration at Stage 1 is similar to pre-BIM Status and model-based interchanges between different disciplines are not significant as it is limited to not systematic Data exchanges and communication between project stakeholders.

BIM Stage 2: Stage 2 players use many technological ways to do a model-based collaboration with other disciplinary players. The model-based collaboration includes the interoperable exchange of models or

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part-models through ‘proprietary’ formats (ex: between Revit, Architecture and Revit Structure through the RVT file format and non-proprietary formats (ex: between ArchiCAD and Tekla using the IFC file format which may be extended through Lifecycle Phases. Generation of 4D (time analysis) and 5D (cost estimating) studies is the very valuable output of this stage.

BIM Stage 3: Model server technologies (using proprietary ,open or non-proprietary formats) are used in order to rich integration of models which are created ,shared and maintained collaboratively across Project Lifecycle Phases. Analysis of interdisciplinary models can be implemented at the early stages of virtual design and construction.

Figure 1. BIM fields (Succar, 2009)

2. Research Methodology

An extensive investigation for the literature was conducted to determine the most effective tools for measuring the BIM implementation maturity levels. Every tool has its indicators in each stage. As a result of the literature review, the most effective and appropriate tool is BIM Maturity Matrix “BIMMM" (the theoretical model of (Succar, B., 2009)) which is considered (according to the previous studies) one of the most internationally known models of maturity. It helps to define the necessary steps for improving the BIM implementation according to competency criteria, and in a very flexible way. Evaluation analysis of maturity of BIM Implementation was conducted based on the characteristics of BIM implementation in a sample contains 18 projects of important Lithuanian construction projects which were awarded a national award for BIM implementation in Lithuania. Empirical research was done to survey the implemented steps at the projects in addition to surveying local policies regarding BIM in Lithuania to check the maturity stage at all of the technology, processes, and policy fields of BIM implementation. Face-to-face interviews were conducted with some experts in the field of BIM whose work at the companies that participated in the research. The interviews were conducted in a semi-structured manner with the aim of taking individual information and also intersecting the views later. The interviews results developed the data obtained in the research. The result of comparative analysis using BIM maturity model and best international practices results were used to suggest a systematic approach for BIM implementation in Lithuania that enhances the recent practices and guides the main players at construction projects.

3. Results and discussions

Assessment of BIM implementation maturity stages in Lithuania:

Technology field

According to Succar model technology field includes three technology step type to meet the requirements of BIM stages which are: software, hardware, and network (Succar, 2009). And according to each sub-requirement for each step we classified the BIM maturity implementation in Lithuania for 18 studied

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projects, the assessment was according to of used software only due to the limitation of data availability for the other two technology type which is also can be considered secondary factors and supportive tools for software's implementation. The first 3D modeling experiment implemented in Lithuania in 2002- an office building in Klaipeda, the building design was introduced with the 3D static analysis and BIM technologies. The table 1 shows the implemented software's at the studied projects and we classified the maturity of BIM implementation level at projects according to the used software as per three common level stages of BIM implementation. Most of the studied projects were the sample that awarded at national BIM implementation award in Lithuania. The result was that 2 of studied projects at level 1(Modeling) and 15 was at level 2 (collaboration) and only 1 was at level 3 (integration). we can see that 88 % of studied projects are at level 2 or 3 which show medium maturity level for BIM implementation at studied projects in scope of software's. At the modeling and visualization and engineering analysis level there was plenty of used software's like, structural BIM model, Revit 2016, RIB iTwo 2015, Bentley Pro Structures V8i Power Product, Tekla Structures, Revit MEP, Intergraph Visual Design VVD. Also at clash detection, project costing, and collaboration there was specialized software's like 3D simulation in real time (4D), estimation automatically using 5D BIM model principles Tekla BIMsight, Solibri Model Checker/Viewer for communication, Autodesk Navisworks Manage for primary selection and crossing analysis, Design quality control, IFC model, native software format "rvt", Sharepoint-based Collaborative Data Environment (CDE), based on the PAS1192-2 standard. In conclusion, most of the software's steps were met in studied projects but three important steps for next technological improvements would be recommended are the automation of national code checking and compliance evaluation, use of more efficient CDE environment and implementation of a classification system based on ISO12006 and ISO81346 standards within all construction entities types.

Table 1: shows the implemented software's and its maturity level at the studied projects

SN.	Project	trade	BIM tools systems	Maturity level
1	Office building in Klaipėda, 2002	Building	-3D static analysis and BIM technologies	1-Modelling
2	Vilnius Municipality (2003–2006)	Building	-structural BIM model -database (6D) model prototype	2- collaboration
3	MG Victoria administrative (2004–2005)	Building	-3D simulation in real time (4D). -estimation automatically using 5D BIM model principles.	2-collaboration
4	Beržų terasos“ in Vilniuje (2013–2014)	Building	-3 D model high-quality project delivery plans	1-Modelling
5	New Riviera	Building	Revit 2016, RIB iTwo 2015	2-collaboration
6	installation of the co-generation biofuel boiler house, in Kaunas	industrial	• Architectural part: Autodesk REVIT, Build:16.0.490.0 20150717_1515(x64) Building structures part: Tekla Structures, 20.1 version Design part (Technology Tying): Bentley ProStructures V8i PowerProduct, version 08.11.11.616 Bentley STAAD.Pro V8i, version 20.07.11.45 Autodesk REVIT, Build:16.0.490.0	2-collaboration

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			20150717_1515(x64) Heat production and supply part: Bentley OpenPlant Modeler V8i, version 08.11.09.568 Bentley AutoPIPE V8i, version 09.06.02.06 Technological equipment design: Solidworks 2015 x64 Edition Intergraph Visual Design VVD, version 16.0 Danish Exergy Technology A/S, version EN12953 ver.1.0	
7	Joint Centre for Life Sciences in Sauletekio avenue	public buildings	• Architectural model: AutoCAD Architectural • Structural model: TEKLA Structures • Engineering systems: DDS-CAD, MagiCAD, Revit MEP, Autocad MEP • Communication and visualization: Tekla BIMsight	2-collaboration
8	crossroad reconstruction in Jakai	transport infrastru cture	• Autodesk AutoCAD Civil 3D • GeoMap • PTV VISSIM • Bentley Microstation • Ansys • Autodesk 3Ds MAX Design	2-collaboration
9	Gullfaks administrative building	administr ative building BIM project abroad	• Autodesk Revit – facade element modeling and etc. • Solibri Model Checker/Viewer – for communication • Autodesk Navisworks Manage – for primary selection and crossing analysis • Autodesk Robot Structural Analysis – for wind load analysis • SolidWorks / Autodesk Inventor – • bearing parts design and analysis; additional production drawings preparation • Autodesk AutoCAD – for detailed joints	2-collaboration 2-collaboration
10	Apartment houses in Karaliaučiaus 7b street		• BIM model • virtual reality tour	2-collaboration
11	public buildings BIM project	public buildings	• Design quality control • calculation of quantities • simulation of the project made in 5D • supervision developed using the BIM model	2-collaboration
12	Tunnel overpass on A2 road	transport infrastru cture	• Revit Central File • Civil3D program • Dynamo environment	2-collaboration
13	Clarion Hotel Helsinki, Helsinki Tower	public buildings	• Tekla Structures program. • IFC model Project parts coordination was performed by HENT AS using Solibri model checker software.	2-collaboration

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14	shopping center "Žali" in Vilnius	public buildings	• geometric detail level from LOD 350 to LOD 500 The purpose of using BIM in the project is to create the most accurate and detailed model for construction, then transforming it for facilities management objectives.	2- collaboration
15	„Baltas lapas	Residenti al houses	• "cloud" environment using the "BIM360 team" tool. • native software format "rvt". an internal classification has been created, which facilitated the generation and structuring of quantities • "Revit Live" tool has also been used to monitor the complex design of the car park and the location of engineering networks in heavily restricted areas in the VR	3-integration
16	Business center in Kaunas	public buildings	• The information was exchanged in a single .ifc format by storing it in a Dropbox accessible to everyone • Project participants provided information, reviewed, and correlated issues with Tekla BimSight software	2-collaboration
17	Warehouse in Kaunas	Industria l Building s	• BIM protocol was prepared and agreed with the customer with the level of detail of the project • Sharepoint-based Collaborative Data Environment (CDE), based on the PAS1192-2 standard, has also been developed to share, review, approve and assign information to the customer • The 3D integrated model was loaded with a true terrain of the current location with precise road layout and created a virtual reality that helped the customer to determine the visibility of the building from side to side using VR glasses.	2-collaboration
18	ICON Växjö Complex in Sweden	best BIM project abroad	In "Clouds" was exchanged with IFC format data, using all the same coordinate system for all project participants. • design of the building frame, which was developed using Tekla software	2-collaboration

Processes field:

Process step type includes leadership, infrastructure, human resources, products &services (Succar, B., 2009). Some initiatives were found at studied projects at leadership field certainly at management decisions and communication activities as in project NO 15 the "cloud" environment using the "BIM360 team" tool was used and at project NO 16 The information was exchanged in a single IFC format by storing it in a Dropbox accessible to everyone. Solibri Model Checker/Viewer – for communication was used at project NO 9 and NO 13 and Tekla BIM sight was used at project NO 7 for communication. At

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Project NO 18 also the coordinate system was used for all project participants. Also there were some steps regarding products and services, in term of products there was some structured outputs which extended to virtual components like project NO 15 as “Revit Live” tool has also been used to monitor the complex design of the car park and the location of engineering networks in heavily restricted areas in the VR, also at project 17 The 3D integrated model was loaded with a true terrain of the current location with precise road layout and created a virtual reality that helped the customer to determine the visibility of the building from side to side using VR glasses. We couldn't assess steps about infrastructure and human resources due to data limitation. Therefore we found that important steps were taken in the process field towards communication and better emphasize is needed in the scope of products and services.

Policy field:

It includes contractual, regulatory, and preparatory steps (Succar, B., 2009). At contractual scope one attempt was found regarding of responsibilities at project NO 17 as BIM protocol was prepared and agreed with the customer with the level of detail of the project at Sharepoint-based Collaborative Data Environment (CDE), based on the PAS1192-2 standard, has also been developed to share, review, approve and assign information to the customer. In contrast, important steps were found at the contractual scope in rewards by establishing The annual competition "Lithuanian BIM projects" started at 2016 dedicated to select the best Lithuanian company practices using building information modeling (BIM) technology and methodology. The best projects were selected in the following categories (Lithuanian BIM project, 2016):

1. BIM in residential buildings;
2. BIM in public buildings;
3. BIM in industrial buildings;
4. BIM infrastructure (communication infrastructure);
5. BIM in infrastructure. Other engineering structures;
6. BIM project abroad.

Table 2 includes the reward criteria and Table 3 shows the projects scores for the 2018 competition.

Table 2: Reward criteria for BIM implementation in Lithuania

SN	BIM implementation reward criteria	Range	New at 2018	OLD from 2016
			Max. Criteria weights	Max. Criteria weights
1	BIM solutions for the better design solutions. Outstanding usage of BIM in resolving design challenges such as:			
1.1.	Identification of the customer's expectations (customer requirements)	from 0 to 2	2	1
1.2.	Current situation conditions modelling	from 0 to 1	1	1
1.3.	Design in the early stages of decision-making;	from 0 to 1	1	1
1.4.	Modeling of the complex architectural geometry forms;	from 0 to 2	2	1
1.5.	Decisions of irreconcilable design solutions and engineering systems	from 0 to 1	1	1
1.6.	Construction technologies solutions and material selection;	from 0 to 1	1	1

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2	BIM for the green building and sustainability (Green and sustainable). Design Judgment will be made on the outstanding usage of BIM in sustainable design considerations, such as:			
2.1.	Environmental impact assessment;	from 0 to 1	1	1
2.2.	Selection of engineering systems;	from 0 to 1	1	1
2.3.	The energy efficiency assessment;	from 0 to 1	1	1
2.4.	Life Cycle Assessment;	from 0 to 2	2	1
3	BIM innovation (Innovative use of the information in BIM). Innovation is called change compared with the normal market activity			
3.1.	Design phases (different calculations, simulations, decision support systems for technologies variants selection and etc)	from 0 to 2	2	1
3.2.	Construction planning and management inovations;	from 0 to 1	1	1
3.3.	Quality Assurance; (A. Different quality assurance software used at any of separate stage (at least 0.5 points); At design and construction stage (plus up to 0.5); At design, construction and FM stages (plus 1) B. Using the classification system (at least 0.5). Formula A+B should be applied.	from 0 to 1	2	1
4	Changes in the communication process. Used standards, methodologies (Business Collaboration transformation). Outstanding usage of BIM for enhancing standards and workflows in:			
4.1.	At the design phase; (Use of Use Cases, LOD, LOI, Development of BEP, Standards used)	from 0 to 2	2	1
4.2.	The information exchange between the various disciplines (CDE used. File or WEB server-based communication infrastructure used)	from 0 to 2	2	1
4.3.	Construction planning between gen. contractor and subcontractors;	from 0 to 1	1	1
4.4.	Coordination of As-built model development together with customer team	from 0 to 1	1	1
4.5.	Model customization for operational stage and asset management	from 0 to 2	2	2
4.6.	Building lifecycle data collection at the facility management stage (use of different sensors for monitoring	from 0 to 2	2	1
	Overall maximum available points:		28	

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Table 3: projects scores for 2018 BIM implementation award.

BIM construction project number	BIM awards evaluation value
Dwellings 1	9.9
Dwellings 2	6.5
Dwellings 3	7.1
Dwellings 4	5.1
Dwellings 5	5.1
LT_BIM_Projects abbroad1	8.9
LT_BIM_Projects abbroad2	11.9
LT_BIM_Projects abbroad3	13.5
LT_BIM_Projects abbroad4	11.9
Public1: Office	12.1
Public2: Office	10.8
Public3: Office	12.8
Public4: Shopping center with the administration	5.9
Public5: Office	4.9
Public6: Office	3.7
Public7. Special services	4.4
Public8: Office	5.8
Public9: Shopping center	19.4

The criteria of the award included four main scopes that reflect results of BIM practices maturity as following:

1- BIM solutions for better design solutions
2- BIM for the green building and sustainability
3- BIM innovation (Innovative use of the information in BIM)
4- Changes in the communication process

Table 2 reward criteria and Table 3 shows the projects scores for the 2018 competition. The scores ranged between 3.7 and 19.4 out of 28 max points, and this reflects medium maturity level which was founded during assessing maturity at technology field and process field.

Requirements, more emphasis should be put on these criteria to encourage companies to develop BIM implementation in a systematic way.

No initiatives were found in contractual steps regarding risk allocation and insurance.

Regarding national level initiatives Public institution "Skaitmenine statyba" ("Digital Construction") was founded which are an organization that joins associations of the Lithuanian construction sector and coordinates the digitalization process of Lithuanian construction (Official Lithuanian Digital Construction, 2018).

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The Digital Construction institution was founded on March 5, 2014, by 13 associations:

- Lithuanian Builders Association
- Lithuanian Roads Association
- Lithuanian Association of Consulting Companies
- Lithuanian Architects Chamber
- Lithuanian Association of Civil Engineers
- Lithuanian Electricity Association
- Lithuanian Association of Land Reclamation Enterprises
- National Passive Hous Association
- Project Expertise and Fire Safety Companies Association
- Association of Buildings Certification Experts
- Building Product Testing Laboratory Association
- "Structural engineers club"
- Lithuanian EPS Association

And it became in 2015 y. as associate member joined World Alliance "BuildingSMART Nordic chapter. From 2018 is the member of bSNORDIC.

Main directions:

- BIM (Building Information Modeling) methodology development and implementation in Lithuania (EIR, BEP, LOD (LOIN), BIM Stages and Use Cases and etc. templates);
- Implementation of BSI Industry developments: Foundation Classes (IFC); BCF, IDM, bSDD and etc.
- National Construction Classification system development and implementation;
- Organization of International Annual Digital Construction and BIM Regional developments Conferences (from 2012) (Digital Construction, 2018.)
- Organization of BIM Awards Competitions;
- BIM competencies model development, training organization, and certification;

Till the 2018 year no systematic steps were found in the scope of building regulations as codes and standards, also on project guidelines no steps were founded regarding projects benchmarks and best practices and classification in Lithuania. Regarding preparatory steps at the scope of research many conferences and events were held as follows:

From 2012 y. Lithuanian Builders Association arranging conferences in a BIM field called "Digital construction".

From 2014 y. till 2019 Public institution "Skaitmenine statyba" ("Digital Construction") with partners in Vilnius arranging annual international conferences in a BIM field called "Digital construction".

The most important event of the year for "Digital Construction" is an essential part of RESTA – the annual expo of construction.

In the scope of education at the beginning of 2015 new academic year, Vilnius Gediminas Technical University, Faculty of Civil Engineering introduced the first Master's degree program in Lithuania "Building Information Modeling", which is preparing BIM experts. From 2018 already within most of Vilnius Gediminas Technical University construction related bachelors programs were implemented BIM modules. Lithuania still does not have a BIM standard, national construction classification, and universal

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data exchange standard IFC. In Lithuania, the information about building developed using BIM method usually remains with designers. Lithuanian BIM experts say the created information transmission to the customer is a matter of agreement. When transmitting only the information that is regulated by Lithuanian Law on Construction (2017). Within 2016 and 2019 BIM awards experience the majority of design and construction companies are already beginning to apply BIM in the design or construction stages separately. However, 2018 and 2019 experience shows that Lithuania already has few projects (within Shopping center, Industry building, and Offices categorize) were BIM methodology was used from design to construction and preparation for facility management use. And the maturity level of presented projects growing every year.

Suggested approach for systematic growth of BIM implementation:

According to BIM maturity assessment for BIM implementation on best projects in Lithuania, authors found that there is a good use of BIM at level 1 and 2 with a scarcity use of BIM level 3. Plenty of steps at policy and process fields were implemented, but the full integration of services during the project life cycle is still under implementation. Therefore, the needed steps for systematic BIM implementation defined depending on BIM maturity assessment and best international practices literature review results. For technological improvements would be recommended automation of national code checking and compliance evaluation, use of more efficient CDE environment and implementation of a classification system based on ISO12006 and ISO81346 standards within all construction entities types. Therefore more efforts should be done on promoting awareness about BLM (building lifecycle management) in order to achieve fully integrated project delivery which offers better interoperability using international standards about elements coding for better standardization which will allow e-checking for conformance of products. Also at the process field better emphasize is needed in the scope of products and services clearer definition we need to have about outputs and modes of delivery taking into consideration contractual conditions about responsibilities and property rights. The practices at policy field also missed the regulatory field as till the 2018 year no systematic steps were found in scope of building regulations as codes and standards, also on project guidelines no steps were founded regarding projects benchmarks and best practices and classification, therefore government with researchers need to start to develop BIM standard, and national construction classification and universal data exchange standard IFC which will allow to develop national implementation policy that includes best practices and benchmarks that rely on international capability models.

Therefore, the detailed strategic and operational methodology should be developed to support the systematic improvement of BIM implementation by Lithuanian companies that include Lithuanian BIM standards with better effort and more details about not yet implemented steps which we identified in this study certainly at the field of polices which was less mature among three BIM implementation fields. Figure 2 describes the suggested next steps:

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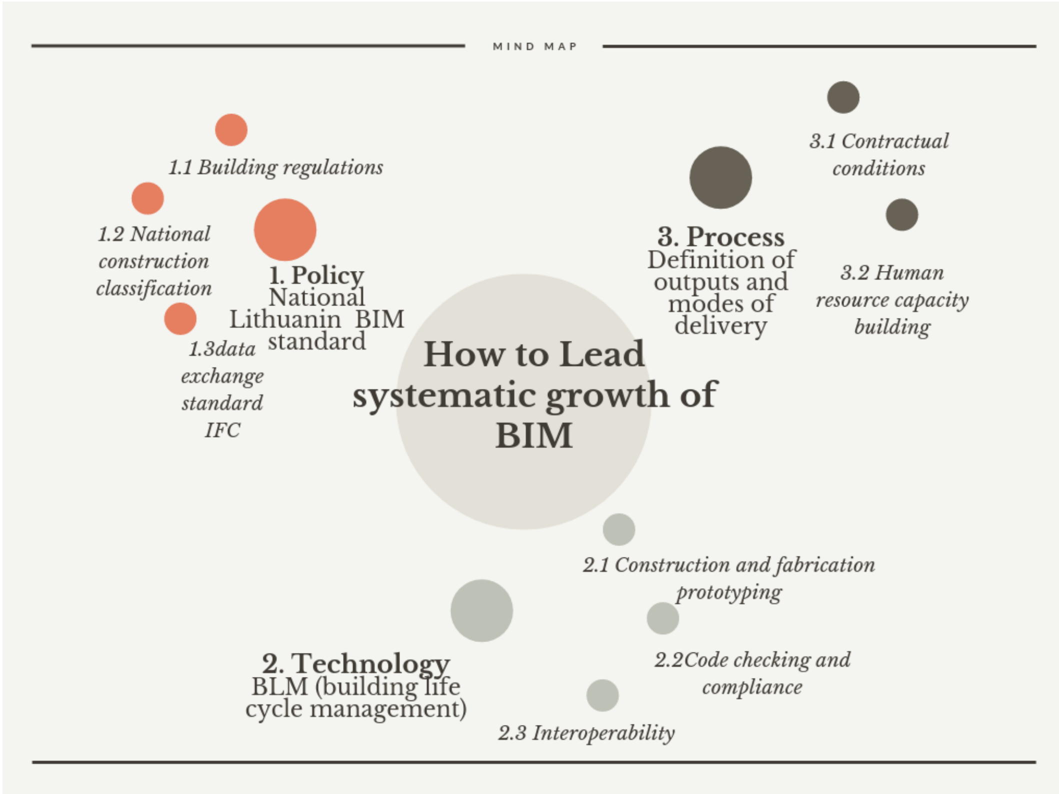

Figure 2. Needed next steps at the developed strategic and operational methodology. (Authors, 2019)

4. Conclusion

The authors of the article presented the BIM approach and analysis of BIM implementation maturity of construction projects in Lithuania. Evaluation analysis of maturity of BIM implementation was conducted based on the theoretical model of (Succar, B., 2009). In order to assess the maturity of BIM implementation in Lithuania empirical research was done to survey the implemented steps of 18 projects to check the maturity stage at all of the technology, processes, and policy fields of BIM implementation. It can be said that the level of implementation of the BIM is more than good in a country such as Lithuania; the BIM has not been officially adopted until the date of this paper. The authors found that 15 of the best 18 projects in Lithuania were implemented in accordance with the second level of BIM according to the evaluation tool used in this paper BIMM. In addition, at least one project was implemented according to the third level. This gives an optimistic view of the reality of the BIM in Lithuania in the next few years. Anyway, the result of comparative analysis using BIM maturity model and best international practices results were used to suggest a systematic approach for BIM implementation in Lithuania that enhances the recent practices and guides the main players at construction projects. The researchers made several recommendations for each of the fields assessed - including, but not limited to, in the field of technology. The building companies need to move to a general state of automation and use international standards within all construction entities. In the field of operations, a better understanding of delivery methods is required. In the field of policy, which is the least mature among the three areas, the authors believe that the Government should begin to develop standards

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for BIM, develop a national implementation policy that includes capacity building and best practice, and support the systematic improvement of BIM implementation.

Authors couldn't assess steps about infrastructure and human resources, and some technology types due to data limitation.

Furthermore, no systematic steps were found in the scope of building regulations as codes and standards, moreover, on project guidelines, no steps were founded regarding projects benchmarks and best practices and classification in Lithuania.

The future studies may be dealing with a framework to enhance the BIM implementation in Lithuania.

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