Development of Online Course for Open Infra Built Environment Information Model

Annika Kemppainen[1], Tanja Kolli[1] and Rauno Heikkilä[1]

[1] Civil Engineering Research Unit, Department of Technology, University of Oulu, Finland
Annika.kemppainen@student.oulu.fi, tanja.kolli@oulu.fi, rauno.heikkila@oulut.fi

Abstract –

Infra Built Environment Information Modeling (infraBIM) enables efficient and accurate planning, construction, and maintenance of complex infrastructure systems. InfraBIM has spread worldwide and is used in various countries for infrastructure projects. InfraBIM experts are essential to take full advantage of the benefits of digital information modeling.

The goal of the article is to find the structure of the infraBIM online course. For this reason, a total of 19 online courses related to building information modeling (BIM) were explored based on their available title level structuality. The online courses were then analyzed and tracked with 17 subject occurrences in the courses. The use of artificial intelligence (AI) was tested to get information and its correctness as well as to prepare the test task material for the course. International interviews were done to study the current situation of InfraBIM. The course module was piloted during summer 2023 and the feedback was collected and analyzed. As a result, the open InfraBIM online module course was developed to promote international utilization and the learning process.

Finally, the general structure of the developed online module course serves as a good starting point for the further development of an open and multilingual website for learning more about open InfraBIM.

Keywords –

Open InfraBIM; online course; marketing; e-learning; AI

1 Introduction

The level of use of building information modeling (BIM) varies from country to country on an enormous scale [1]. In 2010, the implementation rate of information modeling in the Western European construction sector was only slightly more than a third (36%) [2]. In Europe, the implementation of BIM in construction companies was only 29 % in 2016 [3]. However, the estimation of BIM implementation is exceedingly difficult due to the fact each country has a different BIM maturity Level [4]. One reason could be the variety of technologies, which makes open infrastructure BIM complex and challenging. According to Salzano et al. (2023), one solution is to develop and increase the know-how of technological aspects when solving case study problems [5].

Increasing the use of the BIM in industry also requires that students and professionals develop the necessary skills and competencies to succeed in the modern infrastructure industry. Therefore, multiple construction and consulting companies are offering paid education. According to the NATSPEC Report (2023), 22 countries have BIM education in higher education and technical training institutions (vocational education) with a focus on Architecture, Engineering, and Construction (AEC) students. However, only 10 countries, such as Finland, Sweden, and Germany, have also BIM education both physical and/or virtual courses, and training for civil engineering. In addition, road construction-related projects have also been conducted between different countries, for example ERASMUS+ project inROAD. [6] The knowledge of educator's base and skills in information technology tools and software, constantly changing or lacking instructions or requirements, students of different levels, availability of both financial and physical resources, and resistance to change among educational institutions and their staff are the main reasons why for example the education of infraBIM is not spread worldwide. [6]

The introduction of infrastructure modeling has been promoted in countries by many parties when the benefits of its use have come to the attention of governments. At the European level, the use of infrastructure modeling is a requirement in public sector projects, in addition to Finland, for example in Sweden, Norway, and Great Britain. The Nordic countries have been at the forefront of introducing open infrastructure modeling. In Finland, a lot of work has been done since 2010 [7] to develop an open infra built environment model (infraBIM) to present information about infrastructure objects (such as roads) that is suitable for digital communication, interpretation, and processing by people and computer applications. The

concept of open InfraBIM includes Common InfraBIM Requirements (YIV2021), classification, and open format. YIV2021 supplies general requirements and guidelines for model-based projects as well as more detailed model technical requirements [8]. Classification presents the numbering and naming conventions covering the life cycle of infrastructures and models. InfraModel (IM), which is based on the international LandXML standard, is recommended for use as an open format to transfer infrastructure data.

Globally, there are still a limited number of countries that are pioneers in infrastructure modeling [9,10]. In Central Europe, in several countries, the public sector has recommended the use of infrastructure modeling and has taken development steps to promote its use by creating standards, implementing programs, and conducting pilot projects [9,10]. Germany is a potential export country for InfraBIM technologies due to the ongoing development of infra modeling there, which is why the country was selected as one of the examples countries for a closer examination. Germany has already seen potential savings with the "selective use" of infrastructure modeling in small, medium, and large operations [11].

However, the need to harmonize and update the requirements has already been found in Germany, and the vision of the Standardization of Data Modelling of the Built Environment project program launched in 2022 is to unify the data modeling requirements of the built environment, which includes, for example, the standardization of guidelines, formats, and nomenclature by 2025 [8].

In this article, the online pilot course for InfraBIM was developed and tested. For this purpose, the study of other online courses related to the topic was done and analyzed. The material was selected based on the interview of experts and using modern tools, such as artificial intelligence.

2 Development of the online course

2.1 Study of BIM-related online courses

A total of 19 online courses [12-30] were selected in this paper. The following criteria were to choose 1) must be online courses that are openly available, 2) can be completed independently online, 3) are at the basics level, 4) course materials must be available in English, and finally 5) the course must be found on the Google search. Search phrases that were used were BIM for the infrastructure course, InfraBIM, and course free. BIM for infrastructure course, InfraBIM course free, InfraBIM course EU (European Union), InfraBIM e-learning, and variations of those. The phrases were selected based on what regular information seekers would be expected to use to find information about the topic.

2.2 Determination of the content of the course

A methodical analysis was utilized to examine the content frameworks of the identified Building Information Modeling (BIM) courses. The evaluation was based on the criteria outlined in section 2.1. Initially, each course was scrutinized based on the available information, without any payment or login constraints. The table of contents or main headings were reviewed because of their accessibility and functioning as a decision-making tool for undergoing the course. Subsequently, data was systematically collected in Excel from the table of contents, outlining the inclusion of construction information modeling topics within these BIM courses at a fundamental level, along with their sequence. A color-coded system was used to identify similarities among topics across different courses. Finally, 17 topics were chosen based on shared themes and the required content.

2.3 Interview study of the experts

In the interview study, the point of view of experts about infrastructure modeling in Finland, Germany, and Denmark was investigated, and ideas about the content and structure of the website were mapped. The interviews were done by Teams meetings during spring 2023.

Table 1. Profile of BIM experts from Finland, Germany, and Denmark.

Country	Profile of expert
Finland	Software industry
Finland	Development Manager in Bridge and Concrete Structures, Product and Equipment Development for a Contractor
Finland	Development Manager for BIM
Germany	BIM Coordinator and Consultant
Germany	Software Industry
Denmark	Senior BIM Specialist and Project Manager

2.4 Use of artificial intelligence

ChatGPT is a chatbot developed by OpenAI based on artificial intelligence (AI) technology, which is trained using a large language model. ChatGPT in dialogue format can produce human-like text and communicate interactively, as well as learn from earlier conversations. The browser-based ChatGPT was released to the public in November 2022 and is currently freely available in a research phase gathering feedback. [31]. In this paper, the use of ChatGPT was briefly investigated for creating multiple-choice tests and summarizing entities. The free version of ChatGPT was presented with natural language

tasks and questions in Finnish and English, and its ability to translate a multiple-choice survey into German was tested. ChatGPT's summarizing skills were tested with three questions presented in different ways: "How to summarize BIM or Building Information modeling in the infrastructure industry", "What is InfraBIM" and "What does Open InfraBIM mean" to see how ChatGPT's answers differ according to the layout of the questions and how it interprets the concepts of BIM in the infrastructure industry, InfraBIM, and Open InfraBIM.

2.5 Pilot course

The pilot course aimed to test the idea of online InfraBIM. The focus of the pilot course was decided to be a summary of the basics of the world of InfraBIM, model-based construction, and benefits. The Microsoft Sway application was used as a tool in the course publication to implement the course. The content of the course included text, pictures, a text-to-speech video, Teams-interview video, a case study, and a quiz. The language of the course was decided to be English, since one of the target groups is Germany.

The link to the pilot course can be found on the Ouluzone+ web pages. [32] The link to the course was distributed by e-mail to the persons involved in the topic, selected experts, and contacts from Germany. Permission was granted to share the link freely. A total of seven-question survey was done by Microsoft Forms to receive feedback. The answers were analyzed and used to develop the general structure for an InfraBIM online course.

3 Results

3.1 The availability of infraBIM courses

When doing some background research with the Google search engine, it soon became clear that despite several standard search terms such as BIM for infrastructure course, BIM for infrastructure online course, InfraBIM course, InfraBIM course free, InfraBIM course EU, etc., no website or online course dealing with the basics of infrastructure modeling could be found freely online at hand. With the selected criteria like free access, independent online, basic level, in English, finding online courses was challenging even for construction information modeling, as even most free courses require the creation of credentials to view the content. After expanding the criteria, the lists of 19 BIM courses were collected. Some of the founded courses were online courses offered by universities such as Coventry University [13], National Taiwan University [15], Purdue University [16] using for example edX.org or Coursera.org platforms which may have included lecture teaching, too. Many of the BIM courses are produced by industry-specific company such as TÜVSÜD and HOCHTIEF ViCon [17, 26]. Si!BIM course is the ERASMUS+ project which is focused on vocational training [30]. In addition, many of the courses can be found on LinkedIn Learning (formally known as Lynda.com) [12], Udemy online learning platform [14, 18-24] as well as Alison.com [25] or Reed.co.uk [27-29]. The names of the 19 studied BIM-related online courses are listed in Figure 1, and the number of subjects is presented.

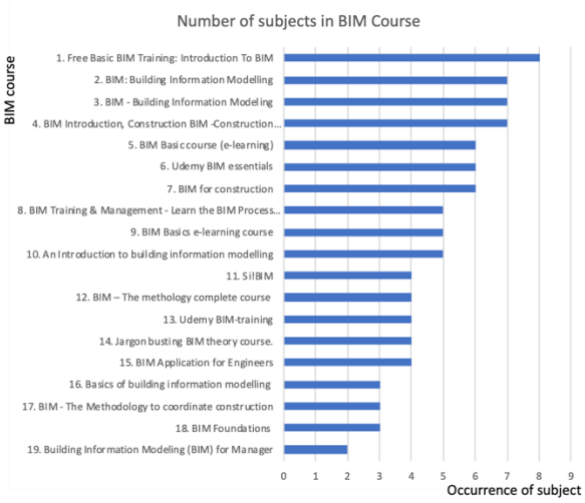

Figure 1. A total of 19 BIM online courses [12-30] were analyzed related to specific 17 subjects.

3.2 Content of the studied BIM courses

Since one of the criteria was free access to the course, only the available material, e.g. the titles, were analyzed. A total of 17 BIM-related subjects was selected to study in more detail and the occurrence in the course was calculated (see Figure 2). The studied subject had to come out clearly from the title. The lengths of the courses varied so a more precise location of the subjects' determinations was not made.

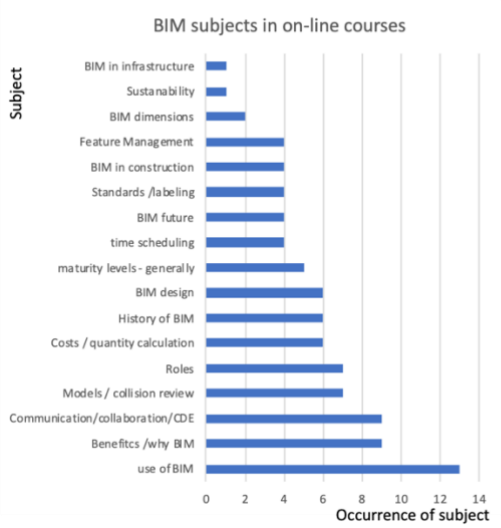

Figure 2. The occurrence of BIM subjects in 19 online courses [12-30].

What the courses had in common was to get started by somehow defining BIM, what BIM is, or why it is needed in the construction industry. The benefit aspect was therefore placed at the top in several courses, but it also appeared at the very end of the courses. The category that appeared the most in the courses was "implementation/use of BIM" in a total of 13 courses. Other most popular topics were "Benefits/why BIM" and "Communication/Collaboration", which appeared in the bodies of nine (9) courses, and "Models/Crash Analysis" and "Tools/technology/software" which were in the bodies of seven (7) courses. Not a single course had those topics appearing at the same time. The clearest positions can be seen with the categories "Future of BIM", which without exception came last in the course, if it was included in it, and "BIM's dimensions", which was the second first topic in both of its courses. For several topics, it is possible to find whether they are most often found before or after the middle of the course. Titles related to sustainable development, or the infrastructure sector appeared in only one course. BIM in design was included in the courses a little more often than BIM in construction. The terms model-based construction, machine control, machine automation, open BIM, or open data did not appear in the title of any course.

3.3 The result of expert interviews

The first query revolved around the current state of BIM implementation in the interviewee's respective country. In the Finnish interviews, significant attention was drawn to the term "infrastructure information modeling." Interviewees expressed concerns over its lack of a clear or universally understood definition within the infrastructure sector, complicating its application. While it was acknowledged that the adoption of information modeling in the infrastructure sector lagged behind that of the construction industry, there was optimism about its potential to surpass the latter in development.

In contrast, in Germany, the discussions dealt with varying degrees of maturity of the infrastructure sectors, ranging from 0 to 3, depending on the sector. In particular, engineering firms demonstrated a more comprehensive understanding and use of infrastructure modeling compared to other sectors. The design sector appeared as the primary focal point around 2014–2015 when discourse on infrastructure modeling started. Larger design firms swiftly embraced infrastructure modeling, reaching a commendable maturity level between 2 and 3. Medium-sized firms fell within levels 1 and 2, with smaller entities typically at level 1. Interest among contractors in infrastructure modeling burgeoned around 2020, possibly catalyzed by pressure from the design sector. Larger contracting companies approached a maturity level nearing 1, while smaller contractors largely refrained from model-based construction due to perceived redundancy. The spectrum of maturity levels among infrastructure owners appeared notably broad, spanning from 0 to 3. For major infrastructure stakeholders, such as Germany's railways, early endeavors related to infrastructure modeling signify considerable potential for digitalization advancement.

According to a Danish BIM expert, Denmark occupies an intermediate position, akin to Sweden, rather than being at the forefront of infrastructure modeling use. Although infrastructure modeling is still relatively uncommon, there is a gradual ascent in maturity within the sector. The adoption of certain Finnish open infrastructure modeling practices underscores this evolution. However, Denmark faces challenges, particularly in aligning with the pace of the construction industry. The longitudinal nature of infrastructure objects poses a distinct hurdle, complicating their portrayal as 3D entities. Insufficient object requirements impede progress, with the existing two-part Industry Foundation Classes (IFC) geometry proving inadequate. Consequently, there exists a palpable necessity for an IFC 4.3 infrastructure extension update to ease seamless data exchange, potentially spurring software companies to adapt to open infrastructure modeling standards.

Subsequently, discussions centered on the essential components of a learning environment. Experts encapsulated the concept of InfraBIM, emphasizing the use of 3D models enriched with metadata and information for each structural element. Standardized data and information structures were considered imperative for streamlining the modeling process. Central to the narrative was the critical role of

standardization in enhancing information flow and collaborative functionality. Furthermore, deliberations touched upon data transfer formats, advocating for the predominance of open standards. However, recognition was given to the practicality of native formats for internal modeling purposes. The inclusion of IFC or Inframodel in online courses was deliberated, considering the varying subscriber preferences for open formats across different countries. Significantly, the potential future standardization of IFC's infra extension as an ISO standard was highlighted as a significant development, with the potential to catalyze international adoption and compel software platforms to incorporate IFC support.

3.4 AI as a tool to supply course material

Based on the response produced by ChatGPT, the general concept of BIM is recognized, as well as the benefit perspective and life cycle management, in the consolidation experiments of the entities, but the response to the definition of "BIM in infrastructure" did not take a position on the perspective of the infrastructure sector and ChatGPT did not know how to connect the InfraBIM concept to the response. When asked about InfraBIM, ChatGPT was able to distinguish the term InfraBIM from BIM, which is the application of BIM for infrastructure projects. The answer brought up the same benefits as in the case of the first compaction, and no other differences in infra modelling compared to information modelling of building construction have been brought up, other than the target's infra projects. Linguistic problems were noticeable in the form of repetition, the answer listed "collaboration, efficiency, accuracy, and sustainability" twice, and a water treatment plant is included in the infrastructure items. Regarding Open InfraBIM, ChatGPT produced the longest answer and found that the use of open standards and data transfer formats should be encouraged and listed mostly achievable benefits. There is no mention of the use of nomenclature or common modelling requirements in the answer.

For the course material testing, ChatGPT produced multiple-choice surveys when handed the topics. There were some errors in the questions and answers, but after a human inspection, they could be used if there is a need for efficient material production. What ChatGPT could be more usable for is in terms of translating the course materials for different languages, which it did successfully from English to German.

Text-to-speech video sound recording for the pilot course was made with the free version of Amazon Polly according to the text materials.

3.5 The results of the pilot course

For the pilot module, the most important topics had to be defined as the basics of infra modeling, for which expert interviews, and observations from existing BIM courses´ were used. Based on the analyses of the other BIM online courses, the learning goals in this tested module were decided to have three goals (Figure 3).

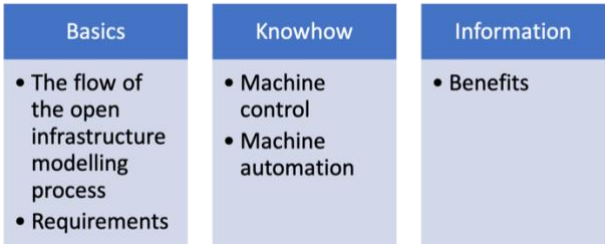

Figure 3. The learning outcomes for the tested pilot course.

The material of the course was BIM vocabulary, statistics, text-to-speech video, summary after the video, Teams-interview, case study, and quiz. An example of the material presented in the pilot course is among other things the difference between information exchange using a Common Data Environment (CDE) and traditional information exchange is explained in the text, but also in the picture (Figure 4.).

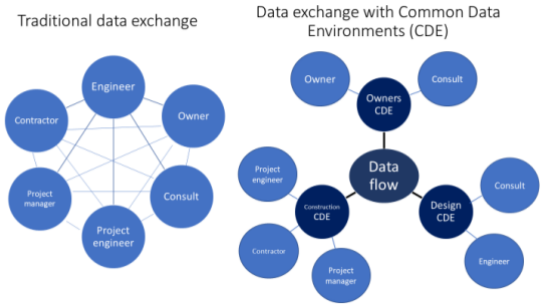

Figure 4. Comparison of data exchange between traditional and Common Data Environment (CDE).

The table of the pilot course had decided to have the following 11 topics:

1. Why BIM in the infrastructure industry?
2. Vocabulary
3. What are the benefits of using InfraBIM?
4. 3D modelling vs. BIM
5. Roles and new responsibilities
6. Digital processes change the way we work
7. Why so many different models?
8. What are the requirements for InfraBIM?
9. Case study
10. Quiz
11. Learning more and references.

Even though the course link had been opened more than 200 times, only nine participants gave feedback to the survey at the end of the course. Users were allowed to select their top 3 favorite topics from the list mentioned above. A total of 18 votes were cast. According to feedback the most useful topic in the course was the part where the benefits of using infraBIM (28% of the answers) were described. The roles and new responsibilities (22% of the answers) were the second useful topic. The other topics were evaluated between 5 to 11 %, as can be seen in Figure 5.

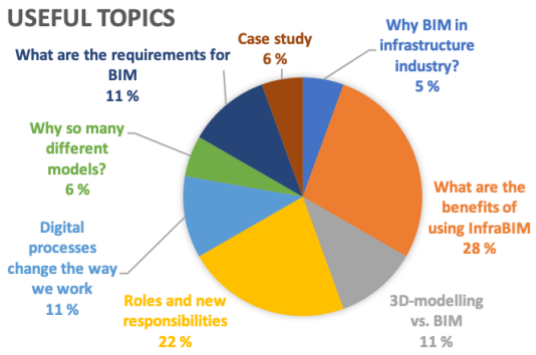

Figure 5. Topics in the course that were considered the most useful for learning based on the feedback.

In the feedback survey, we were also asked to evaluate what materials were useful for the learning aspect. Users were allowed to select their five most interesting materials. A total of 36 votes were given. The results can be seen in Figure 6.

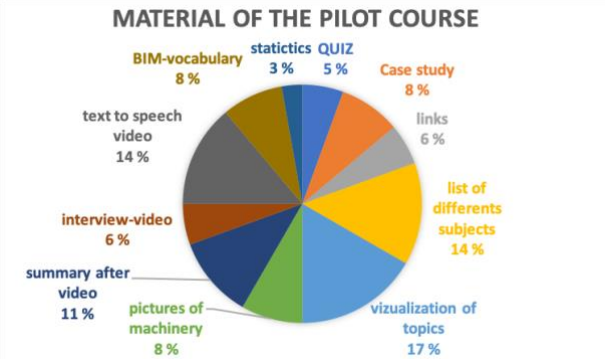

Figure 6. What types of material on the course were considered most useful for learning based on the feedback of the final survey.

The materials of the pilot course ended up emphasizing a practical solution, whereby customers, designers, and contractors can all have their databases, and the most important thing is how to ensure a functioning open data transfer between the databases. The challenge of the pilot module was finding a suitable level of accuracy in summarizing the topics, with the goal being as concise a presentation as possible, for example, summarizing the role of machine control in model-based construction and whether breakdown into 2D and 3D machine control systems is carried out. In the pilot, no breakdown was made, but the processing of machine control was carried out on a more general level, and the section included a link to Novatron Oy's website for other information. It was decided to use three examples of open data transfer formats in the materials throughout the module, IFC, LandXML, and InfraModel, the first two because of their international recognition and the last one from the perspective of Finnish infrastructure modelling and its international growth potential.

During the preparation and translation of the teaching materials, it was discovered that the terms translated directly from Finnish to English are not necessarily as well understood or in the same way. Based on the correction suggestions received, the English version of the YIV instructions could not be used straightforwardly.

As a result of the pilot course and feedback, a general structure for an InfraBIM online course module was developed (Figure 7). The general structure aims to perfect the conveyance of the fundamentals of the ideology of open infrastructure modeling using different teaching resources in the most efficient order.

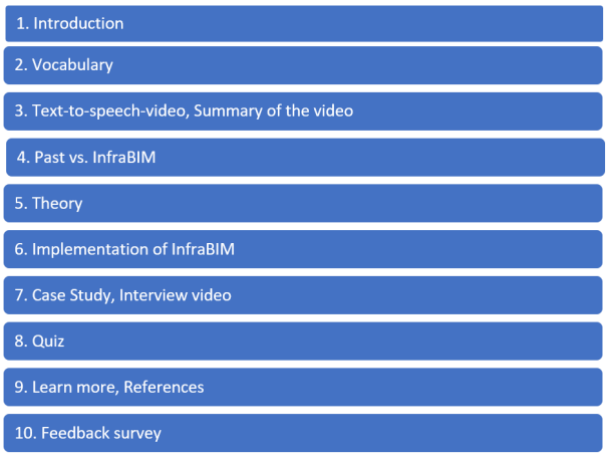

Figure 7. The general structure of the basic level InfraBIM online course module.

4 Conclusion

Based on observations, Open InfraBIM still needs more international visibility and recognition as a term and a process. Infrastructure modeling has been overshadowed within the existing BIM online course

offerings and content, focusing primarily on building information modeling (BIM) in construction. This supports the need for an independent website dedicated to infrastructure modeling. In addition, it is justified to cover the fundamental principles of open infrastructure modeling in its education and marketing efforts because the expansion of its adoption is freshly beginning in several countries.

Considering the feedback received, the general structural model of the InfraBIM online course is a good starting point for the further development of an open and multilingual website. An open infrastructure modeling website would be beneficial both internationally and domestically because the accessibility of easily available information within infrastructure modeling is a common issue.

There is a need for educational materials to start from the very basics, distinguishing infrastructure modeling from mere 3D modeling. 3D modeling is already a familiar topic within the infrastructure sector and has been in use for quite some time. Therefore, the emphasis on materials should shift from generating information to consuming and managing information using an open model-based process and infrastructure models. Open infrastructure modeling is a vast domain, but it is possible to narrow down the model-based process by focusing on a particularly essential aspect: the renewed information consumption within infrastructure modeling.

Acknowledgments

The authors would like to acknowledge all the participants who tested the module. Authors are grateful to the experts from the construction industry, Destia Oy, Infrakit Oy, Pointscene Oy, Sandvik Oy, and Novatron Oy for supplying feedback on their experiences and for bringing their technology. This Open Ecosystems2 project was financed by Business Finland (2021-2023).

References

[1] Mwila, L., Rautiainen, J. & Lehtoviita, T., 2022. Benchmarking BIM maturity level in various European countries to develop BIM competence in Finland. LAB RDI Journal. Online: https://www.labopen.fi/en/lab-rdi-journal/benchmarking-bim-maturity-level-in-various-european-countries-to-develop-bim-competence-in-finland/, Accessed: 13.12.2023.

[2] Bradley, A., Li, H., Lark, R., Dunn, S. BIM for infrastructure: An overall review and constructor perspective, *Automation in Construction*, 71(2): 139-152, 2016.

[3] European Construction Sector Observatory - Trend Paper - Building Information Modelling in the EU construction sector – March 2019. Online: https://ec.europa.eu/docsroom/documents/34518. Accessed: 7.12.2023.

[4] Luomala, P. The different phases of BIM adoption in Europe. Online: The different phases of BIM adoption in Europe. Available: https://www.magicad.com/en/blog/2020/03/bim-adoption-europe/, Accessed: 8.12.2023.

[5] Salzano, A., Intignano, M., Mottola, C., Biancardo, S.A., Nicolella, M., Dell'Acqua, G. Systematic Literature Review of Open Infrastructure BIM. Buildings 2023, 13, 1593. Online: https://doi.org/10.3390/buildings13071593, Accessed: 13.12.2023.

[6] NATSPEC: BIM education – Global – 2023 update report. International Construction Information Society. 2023 Online: https://www.icis.org/wp-content/uploads/2023/05/BIM-Education-Global-2023-Update-Report-V10.0.pdf. Accessed: 16.2.2024.

[7] Heikkilä R., Kolli T., and Rauhala T. Benefits of Open InfraBIM – Finland Experience. 39th *International Symposium on Automation and Robotics in Construction* (ISARC 2022). Pages 253-260, Bogota, Columbia, 2022.

[8] BuildingSMART Finland. Common InfraBIM Requirements 2021. Online: https://wiki.buildingsmart.fi/fi/04_Julkaisut_ja_Standardit/YIV, Accessed: 23.11.2023.

[9] Noeskoski J., 2021. Tietomallintamisella ja integroidulla rakentamisella kohti infra-alan yhteistoiminnallisuutta. Tampereen yliopiston väitöskirjat 446. Online: https://urn.fi/URN:ISBN:978-952-03-2043-0, Accessed: 13.12.2023.

[10] Alsina-Saltarén S., Ponz-Tienda J.L., Gutiérrez-Bucheli L. & Sierra-Aparicio M. *Implementation of BIM in infrastructure: the need to address it from the public sector*. Building & Management, vol. 2(3), pp. 62-72, 2018. Online: http://dx.doi.org/10.20868/bma.2018.3.3843, Accessed: 13.12.2023.

[11] Meister A., Scholz F. & Banemann S., 2022. Federal Trunk Roads BIM Masterplan. Federal Ministry for Digital Transport. Germany, Berlin. Online: https://bmdv.bund.de/SharedDocs/DE/Artikel/StB/masterplan-bim-bundesfernstrassen.html, Accessed: 13.12.2023.

[12] 1. Free Basic BIM Training: Introduction To BIM, National Institute of Building Technology (NIBT) E-Learning. Online: https://www.udemy.com/course/introduction-to-bim/, Accessed: 20.4.2023.

[13] 2. BIM: Building Information Modelling. Online:

https://www.reed.co.uk/courses/bim-building-information-modelling/383084#/courses/bim, Accessed: 20.4.2023.
[14] 3. BIM - Building Information Modelling. Online: https://www.reed.co.uk/courses/bim-building-information-modelling/428573#/courses/bim, Accessed: 20.4.2023.
[15] 4. BIM Introduction, Construction BIM - Construction process. Online: https://www.udemy.com/course/bim-introconstruction-bim-construction-process-part-1of-6/, Accessed: 20.4.2023.
[16] 5. BIM Basic course (e-learning). Online: https://www.hochtief-vicon.com/vicon_en/7.jhtml, Accessed: 20.4.2023.
[17] 6. Udemy BIM essentials. Online: https://www.udemy.com/course/certificate-in-building-information-modelling-bim-level-2/, Accessed: 20.4.2023.
[18] 7. Purdue University, BIM for construction. Online: https://www.classcentral.com/course/bim-for-construction-52892, Accessed: 20.4.2023.
[19] 8. BIM Training & Management - Learn the BIM Process today! Online: https://www.udemy.com/course/bim-management-process-planning-implementation-part-1/, Accessed: 20.4.2023.
[20] 9.TÜVSÜD, BIM Basics e-learning course. Online: https://www.tuvsud.com/en-ae/services/training/e-learning-courses/building-information-modelling-bim-basics, Accessed: 20.4.2023.
[21] 10. Coventry University, An Introduction to building information modelling. Online: https://www.classcentral.com/course/building-information-modelling-10604, Accessed: 21.4.2023.
[22] 11. Si!BIM. Online: https://www.sibim.eu/course-material, Accessed: 21.4.2023.
[23] 12. BIM - The Methodology to coordinate construction. Online: https://www.udemy.com/course/bim-the-methodology-to-coordinate-construction/, Accessed: 21.4.2023.
[24] 13. Udemy BIM training. Online: https://www.udemy.com/course/bim-training/, Accessed: 21.4.2023.
[25] 14. Jargon busting BIM theory course, Udemy BIM made Easy. Online: https://www.udemy.com/course/bim-made-easy/, Accessed: 21.4.2023.
[26] 15. BIM Application for Engineers, National Taiwan University. Online: https://www.classcentral.com/course/bim-application-12117, Accessed: 21.4.2023.
[27] 16. Basics of building information modelling. Online: https://alison.com/course/basics-of-building-information-modelling-bim, Accessed: 22.4.2023.
[28] 17. BIM – The methodology complete course. Online: https://www.udemy.com/course/the-complete-course-of-the-bim-methodology/, Accessed: 22.4.2023.
[29] 18. LinkedIn Learning, BIM Foundations. Online: https://www.linkedin.com/learning/bim-foundations-2, Accessed: 22.4.2023.
[30] 19. Building Information Modelling (BIM) for Manager. Online: https://www.reed.co.uk/courses/building-information-modelling-bim-for-manager/360383#/courses/bim, Accessed: 22.4.2023.
[31] Rahman, M., and Watanobe Y. ChatGPT for Education and Research: Opportunities, Threats, and Strategies. *Applied Sciences* 13(9):5783, 2023.
[32] Kemppainen A. InfraBIM e-learning website. Online: https://www.ouluzoneplus.com/infrabim, Accessed: 9.4.2024.