ESTONIAN UNIVERSITY OF LIFE SCIENCES
Institute of Agricultural and Environmental Sciences

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# Overcoming Barriers to the Implementation of Building Information Modeling (BIM) in Landscape Architecture: *A Case Study of Estonia*

# Ehitusinformatsiooni Modelleerimise (BIM) juurutamisraskuste ületamine maastikuarhitektuuris: Eesti juhtumiuuring

Master's thesis
Curriculum in Landscape Architecture

Supervisor: Peeter Vassiljev, MSc.

Tartu 2023

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Käesolev uuring keskendub takistustele, mis pärsivad ehitusinformatsiooni modelleerimise (BIM) laialdast kasutuselevõttu maastikuarhitektuuri valdkonnas Eestis. Vaatamata BIM-i paljudele eelistele on selle kasutamine maastikuarhitektuuris piiratud. Uuringus kasutati kvalitatiivset uurimismeetodit, mis hõlmab poolstruktureeritud intervjuusid valdkonna professionaalidega ja põhjalikku kirjanduse ülevaadet. Esmaste andmete saamiseks küsitleti maastikuarhitekte, BIM-spetsialiste ja BIM-i juurutamisega seotud poliitikakujundajaid. Eesmärgiks oli saada uuritud rühmadest põhjalikud teadmised ja arusaamine. Uurimistulemused tuvastasid takistused BIM-i rakendamisel maastikuarhitektuuris. Nende takistuste hulka kuulusid BIM-teadlikkuse ja -mõistmise puudumine, maastikuettevõtete väiksus, standardite puudumine, puudulik teadlikkus saadaolevast rahalisest abist ja toetusest, esialgse töökoormuse suurenemine, rahulolu praeguse tehnoloogiaga ja BIM-i puudumine, konkreetsete erialaseltside või huvigrupide puudumine. Tuginedes intervjuude tulemustele ja kirjanduse ülevaatele, pakub uuring soovitusi ja strateegiaid BIM-i juurutamise takistuste ületamiseks maastikuarhitektuuris. Eesmärk on soodustada BIM-i integratsiooni ja võimaldada spetsialistidel selle võimekust Eesti maastikuarhitektuuri sektoris ära kasutada. Lõppkokkuvõttes tuvastab see uuring takistused BIM-i laialdasele rakendamisele maastikul.

Märksõnad: BIM, Ehitusinformatsiooni modelleerimine, projekteerimine, ehitus, maastikuarhitektuur

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This study focuses on the barriers to widespread adoption of Building Information Modelling (BIM) in the field of landscape architecture in Estonia. Despite the many benefits of BIM, its use in landscape architecture has been restricted. A qualitative research approach was used in the study, which includes semi-structured interviews with industry professionals and a thorough literature review. Landscape architects, BIM professionals, and policy makers involved in BIM implementation were interviewed for primary data. Aimed to gain in-depth knowledge and understanding of the studied groups.The research findings identified barriers to BIM implementation in landscape architecture. These barriers included a lack of BIM awareness and understanding, small size of landscape firms, a lack of standards, a lack of awareness of available financial aid and support, an increase in initial workload, complacency with current technology, and a lack of BIM-specific professional societies or interest groups. Based on the outcomes of the interviews and a review of the literature, the study offers recommendations and strategies for overcoming the barriers to BIM implementation in landscape architecture. The goal is to foster BIM integration and enable professionals to leverage its capabilities in the Estonian landscape architecture sector. Ultimately, this study identifies the barriers to widespread BIM implementation in the landscape.

Keywords: BIM, Building Information Modeling, project documentation, building activity, landscape architecture

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## LIST OF ABBREVIATIONS

BIM – Building Information Modelling

LA – Landscape Architect

RKAS - Riigi Kinnisvara AS (Estonian State Real Estate Ltd.)

CCI-EE – Ehituse ühtne klassifitseerimissüsteem

MKM – Ministry of Economic Affairs and Communications, MKM

LOD – Level of detail

# 1. INTRODUCTION

## 1.1 Abstract

The development of Building Information Modeling (BIM) as a workflow has fundamentally altered how construction industry professionals work. Nevertheless, there are a number of obstacles that prevent the widespread adoption of BIM in landscape architecture, in this case, in the nation of Estonia. The purpose of this thesis is to try to understand why BIM in landscape architecture has not gained widespread acceptance by focusing on these barriers and addressing them.

As it is already known, BIM methodologies have gained wide acclaim for their ability to improve productivity, teamwork, and decision-making throughout the lifecycle of a project. BIM enables stakeholders to collaborate in a virtual setting while creating a digital representation of a building or infrastructure's physical and functional characteristics, enhancing communication and coordination.

My aim is to generate awareness and comprehension of the challenges that Estonian landscape architects encounter when employing BIM methodologies through this research.

The significance of BIM in the construction industry and the benefits it offers have been well-documented for quite some time. Yet, landscape architects still don't seem to be impacted by its appeal. I want to understand why professionals have not embraced this technology and discoverd its immense potential. I'll dive into detail regarding the specific difficulties faced in the Estonian context and provide practical suggestions to overcome them.

The ultimate goal of my thesis is to open up possibilities for the broad acceptance of BIM in Estonian landscape architecture.Researching this We could equip landscape architects with the knowledge, tools, and strategies necessary to take advantage of the potential of BIM and improve their design procedures, collaborative efforts, and project results by understanding and tackling the barriers that inhibit its adoption.

## 1.2 Research problem and its significance

The research problem at hand revolves around the barriers that hinder the widespread implementation of Building Information Modeling (BIM) in the field of landscape architecture in Estonia. Despite the numerous benefits offered by BIM, its adoption in

landscape architecture has been relatively limited, posing challenges for professionals in the industry. This thesis aims to identify and address these barriers, providing insights and recommendations for overcoming them and promoting the effective integration of BIM in the Estonian landscape architecture sector.

The significance of this research lies in its potential to bridge the gap between BIM and landscape architecture, unlocking the transformative power of digital technologies in designing and managing outdoor spaces. By exploring the barriers that hinder the implementation of BIM in Estonia, we can gain a deeper understanding of the challenges faced by landscape architects and devise strategies to overcome them.

First and foremost, this research is significant for landscape architects in Estonia. By addressing the barriers to BIM adoption, professionals in the field can gain insights into how BIM can improve their design processes, enhance collaboration with other stakeholders, and streamline project management. Through practical recommendations and case studies, this research can empower landscape architects with the knowledge and tools necessary to embrace BIM and leverage its benefits.

Furthermore, this research holds value for the Estonian design industry as a whole. By promoting the widespread adoption of BIM in landscape architecture, we contribute to the overall advancement and innovation within the sector. This, in turn, can lead to the creation of more sustainable, visually appealing, and functional outdoor spaces that meet the evolving needs of communities and the environment.

Additionally, this research has broader implications for the architectural and engineering industries. As BIM becomes increasingly prevalent in these fields, understanding its integration within landscape architecture can foster better collaboration and coordination between professionals from different disciplines. This interdisciplinary approach to BIM implementation can result in more holistic and integrated design solutions that consider both the built and natural environments.

In conclusion, the research problem of identifying and addressing barriers to implementing BIM in landscape architecture in Estonia holds significant importance for professionals, the design industry, and academic communities. By overcoming these barriers, we can unlock the potential of BIM, foster innovation and sustainability in outdoor space design, and

contribute to the advancement of the landscape architecture profession in Estonia and beyond.

## 1.3 Research question and objectives

Going into the thesis I had three main research questions that I wanted to address by the end of this study:

- What are the key challenges that hinder the adoption of BIM in landscape architecture projects in Estonia, and how can they be overcome?
- What are the potential benefits of using BIM in landscape architecture projects in Estonia, and how can they be realized?
- What are the best practices for implementing BIM in landscape architecture projects?

These research questions will guide the investigation and analysis of the barriers, challenges, and strategies related to the implementation of BIM in landscape architecture in Estonia. Through addressing these questions, the research aims to provide valuable insights and recommendations for landscape architects and the industry as a whole.

The research objectives of this thesis are as follows:

- To identify the barriers that hinder the widespread implementation of Building Information Modeling (BIM) in the field of landscape architecture in Estonia.
- To examine the specific challenges faced by landscape architects in adopting BIM workflows.
- To explore the impact of a lack of awareness and understanding of BIM among professionals in landscape architecture.
- To understand the resistance to change within the landscape architecture industry and its effect on the implementation of BIM.
- To examine the regulatory & standardsation challenges specific to the integration of BIM in landscape architecture in Estonia.
- To propose strategies and recommendations for overcoming the identified barriers and promoting the effective implementation of BIM in landscape architecture.
- To discuss the potential benefits and impact of integrating BIM in landscape architecture

By addressing these research objectives, this thesis aims to provide a comprehensive understanding of the barriers to BIM implementation in landscape architecture in Estonia and offer practical solutions to overcome them.Ultimately, this research seeks to contribute to the broader adoption of BIM in the Estonian landscape architecture sector, fostering innovation, sustainability, and collaboration within the industry.

## 1.4 Thesis Structure

The general framework of this thesis (Figure 1) shows the steps undertaken to conduct this research, The thesis began with literature review which is compiled in chapter 2, to understand the general trend in BIM as whole, in Europe and then finally in estonia, research gaps were addressed. The third chapter contains data collection methodology for the research , the interviews and their processing. In chapter 4. the results from the said interview were discussed and categorised in nodes. The chapter 5 will identify the barriers to BIM in LA derived from results. Finally in the chapter 6recommendations are provided to mitigate these barriers. In the bibliography, references are cited and the appendices contain questions and other themes for interviews and other information.

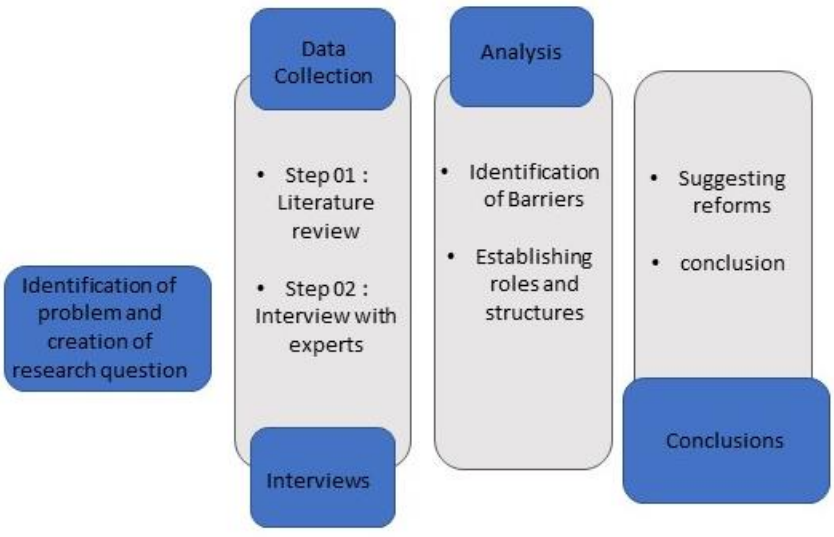


**Figure 1**: An abstract of the steps followed to derive different chapters of this thesis

## 2. LITERATURE REVIEW

As BIM is rapidly adopted by the construction industry for its ability to enhance project coordination, facilitate effective communication between team members and optimize overall efficiency. Landscape architects are no exception; they too must get on board the latest industry trends. This literature review will delve into the elements of BIM, Its evolution, Its various stakeholders and how it affects landscape architects & and the challenges they face in the current era.

## 2.1 What is BIM?

It is hard to find one adequate definition of what Building Information Modelling (BIM) is. Rather, it can be described as a multi-dimensional, continously evolving, complex phenomenon. BIM can be defined initially as a digital representation of a building, an object-oriented three-dimensional model, or a repository of project information to facilitate interoperability and information exchange with related software applications (Miettinen & Paavola 2014).

BIM Tools support parametric modelling and enable new levels of spatial visualisation, simulation of building behaviour and more efficient project management. BIM is also explicitly a collaboration tool. When BIM is extended from design to construction, facility management and building maintenance, new levels of interoperability and collaboration can be achieved. The collaborative use of BIM workflows reduces planning errors and increases the productivity of the construction industry. BIM therefore offers a new paradigm for construction management or "an emerging technological and procedural shift in the Architecture, Engineering and Construction industry"(Succar 2009).

Fundamentally BIM is a collaborative workflow that amalgamates various aspects of a construction project, architectural design, structural engineering, electrical & mechanical systems, and construction management. It goes beyond traditional 2D drawings to include 3D models, data-rich objects, and intelligent information. (Charef *et al.* 2019).

The main principle of BIM is to create a centralized and shared information model that serves as a single source of Information for all project stakeholders. This model contains detailed and interrelated information about the objects geometry, spatial relationships, materials, quantities, costs, schedules, and more. By using this comprehensive model, architects,

engineers, contractors and owners can collaborate more effectively, identify and resolve conflicts, and make more informed decisions throughout the project lifecycle.

BIM offers numerous benefits. First, it improves visualization and communication of designs by providing realistic 3D models, simulations and visualizations. It also enables better coordination and clash detection between different construction systems, reducing errors and rework during construction. BIM facilitates accurate quantity takeoff, cost estimating and project scheduling, resulting in better cost control and project management. (Arunkumar *et al.* 2018). In addition, BIM enables analysis of energy performance, structural integrity and other key parameters, resulting in more sustainable and efficient design. It also supports building management by providing valuable information for maintenance, renovation and operation throughout the life of the building.(Arunkumar *et al.* 2018)

Overall, BIM has compleltely transformed the architecture, engineering, and construction industry by streamlining workflows, improving collaboration, and increasing project outcomes. It has become an indispensable tool for achieving higher quality, efficiency and sustainability in the built environment. As technology develops further, BIM processes and workflows will grow even further and become essential in determining how construction and infrastructure projects will be carried out in the future.

## 2.2 Why adopt BIM?

Digital activity within construction sector has been platauded since the advent of CAD, And over the year use of advanced digital activity has been one of the lowest. (Figure 2)

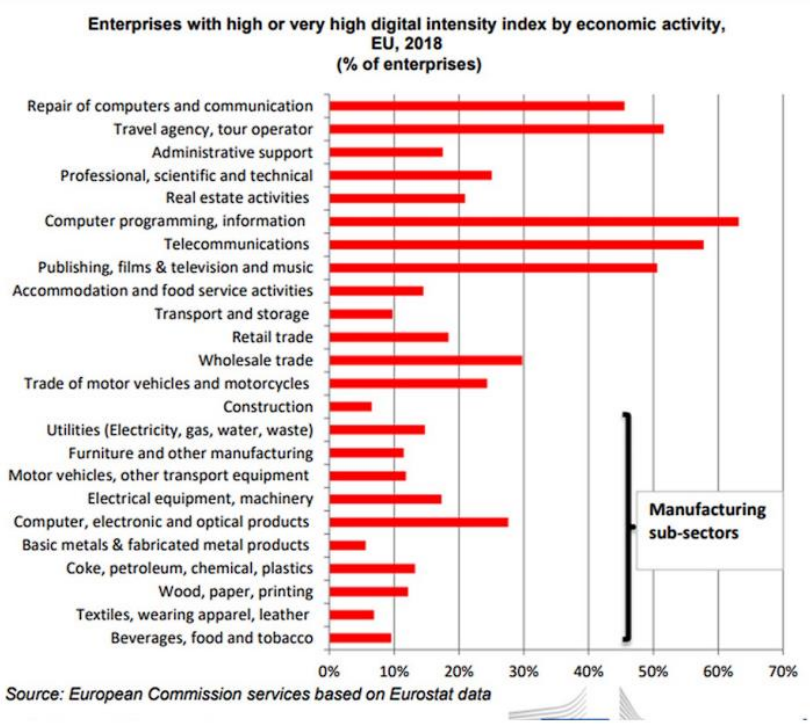


**Figure 2**: Categories of different sectors with digital economic activity in the EU 2019

**Figure 2:** Categories of different sectors with digital economic activity in the EU 2019 Report, notice how construction sector lags and has low productivity. This is one of the reasons why white spread implementation and adoption of them is essential in construction industry. (Source: European Commission services based on Eurostat data)

## 2.3 BIM adoption in EU Zone

In recent years, Building Information Modeling (BIM) has gained acceptance in the European Union (EU) as a revolutionary approach to building and infrastructure design. This has been mostly due to European policymakers who encouraged BIM adoption and understand its potential to improve collaboration, increase efficiency, and reduce costs throughout the lifecycle of a project.

The current BIM standardisation & Policy has its roots in the Construction 2020 initiative, which is a plan developed by the European Union to promote the construction industry's and its businesses' long-term competitiveness. The initiative was launched in 2012 with the aim of improving innovation, regulatory framework, internationalization, skills, and resource efficiency in the construction industry. The Construction 2020 initiatives Main focal points was in the arena of Digitalization i.e BIM

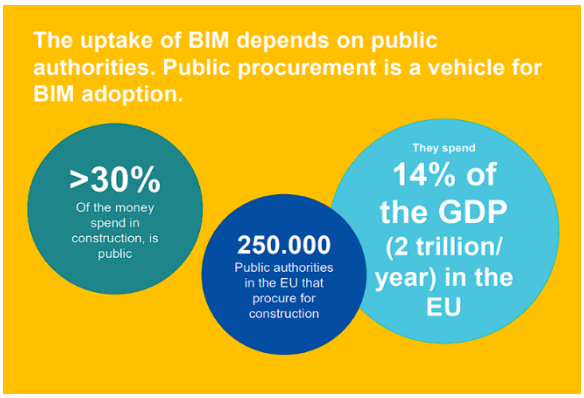


**Figure 3:** Public procurement data and financial figures (Source: Ilektra Papadaki, European Commission)

The adoption of BIM in EU has been centred around and focused on public sector works. Public procurement acts as a vehicle for BIM adoption. By explicitly stating BIM requirements in the public procurement process government can use this as an opportunity to act as a catalyst for wider BIM implementation. The BIM market in EU is predicted to grow by 13% and reach €2.1 billion by 2023, with support from the public sector. (Figure 3) The EU has recognized the transformative benefits of BIM and taken steps to encourage widespread adoption. The European Commission has encouraged member states to implement BIM strategies and has emphasized the importance of BIM in achieving the goals of the EU's Digital Single Market. The commitment to the adoption of BIM is reflected in various initiatives and policies across the EU. (Ilektra Papadaki, , Entrepreneurship and SMEs, European Commission)

Legislations like “EU Directive for Public Procurement 2014” which recommend BIM, while not making it mandatory, is an example of BIM centred policymaking. Since Public assets, such as infrastructure and buildings, remain with the same owner for longer periods, and the investment made by the public returns to the public. Thus, wider adoption of BIM can lead to long-term benefits for the members of public, as it improves the management of public assets and lead to cost savings. (DIRECTIVE 2014/24/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL)

There have also been suggestions such as public competitions being used to push job creation, innovation, and efficiency, which in turn means that public authorities would use competitions to encourage the adoption of BIM and other innovative technologies in the construction industry, which can lead to improved efficiency.

Several EU member states have made significant progress in implementing BIM strategies. The United Kingdom, a former EU member state, has led the way in the adoption of BIM because the government has required its usage on all public projects since 2016. in phases. ("Government-Construction-Strategy_0.pdf" n.d.)

Northern European Countries such as Finland, Norway, and the Netherlands have also developed national BIM standards and the development of BIM Public procurement programs, While other regions have had varying levels of success. (Figure 4)

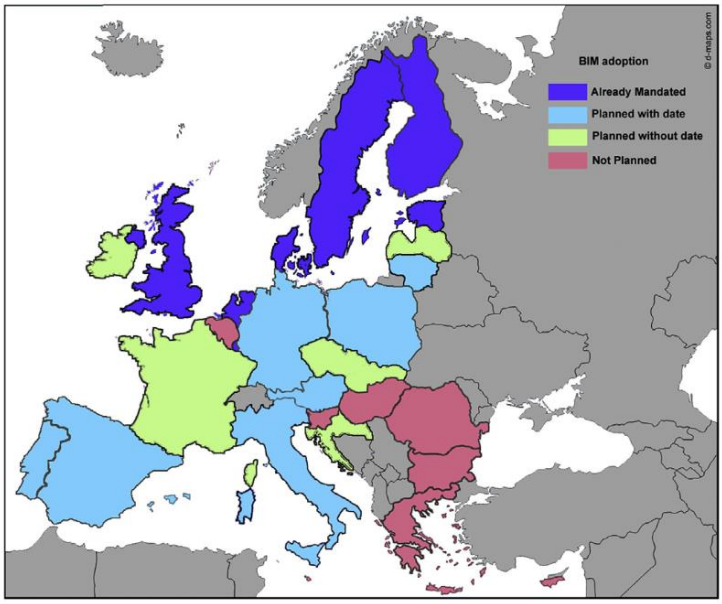


**Figure 4**: BIM implementation is quite varied across Europe (Source : Charef et al. 2019)

Even within the EU, adoption of BIM has been sporadic, with some countries decades ahead in implementing BIM processes and standardization in the public sector.

The figure 4 showcases how European countries have been divided into 4 categories based on questionnaire which assessed the respondents confidence in their countries BIM readiness/Adoption (Charef *et al.* 2019)

Several major Infrastructure firms have started using BIM technology in In the context of landscape design on a large infrastructure project. This integration of BIM and realistic rendering of the planting design can be quite useful to landscape architects since its provides the twofold benefit of having BIM data as well as visualisation benefits. (Figure 5)

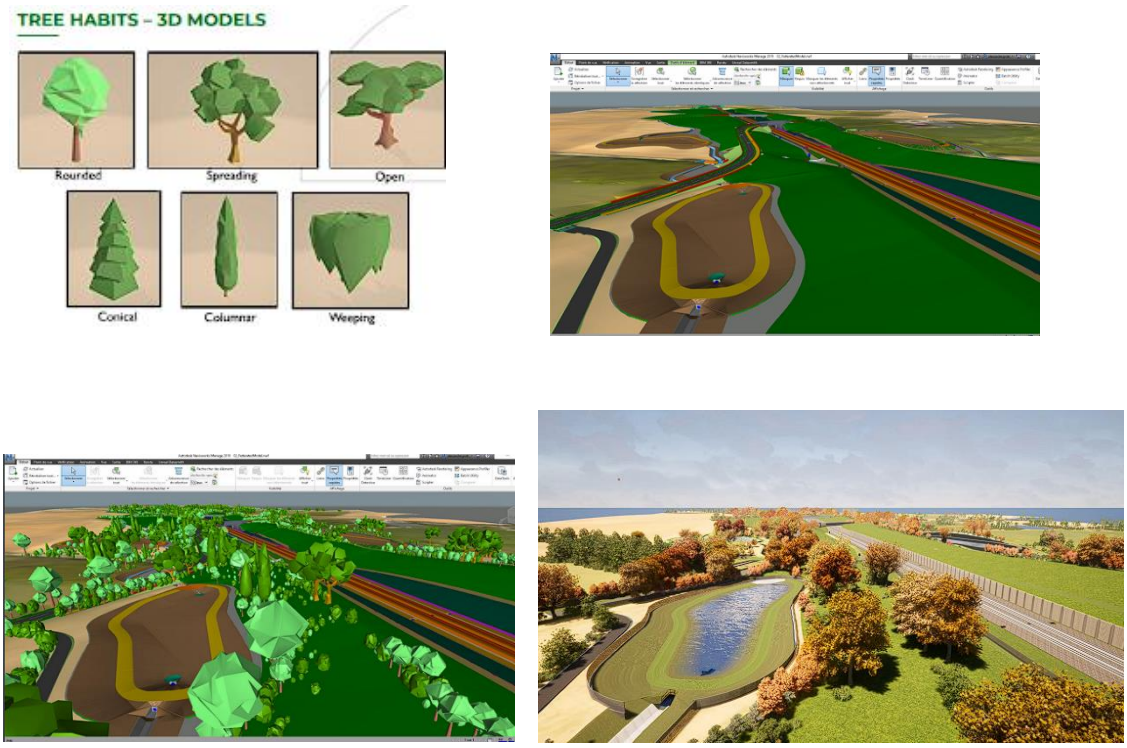


**Figure 5:** Integration of BIM and Visualisation plugins (Source : Killian ROLLAND, Alexandre PRATS)

## 2.4 Why adopt BIM? Lessons from architecture field

Being early adopters of BIM workflows, architecture and infrastructure companies across the world have reaped great benefits. BIM Implementation provided benefits such as cost estimation accuracy, reduction in time and project cost, and improvement in design documents to architects. The following benefits associated with BIM were reported by Stanford University's Center for Integrated Facilities Engineering (quoted in CRC Construction Innovation 2007) after research and data collection on 32 significant projects:

• Up to 40% elimination of unbudgeted change.

• Cost estimation accuracy within 3% as compared to traditional estimates.

• Up to 80% reduction in time taken to generate a cost estimate.

• Up to 7% reduction in project time.

(Azhar 2011)

Over the course of years adoption of BIM technology by architects has increased exponentially in a short period of time (Figure 6)

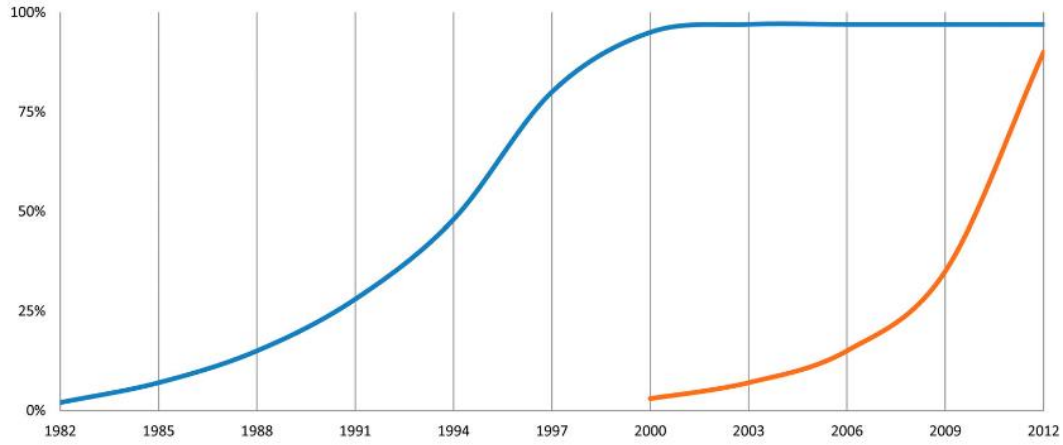


**Figure 6:** Adoption of CAD versus BIM graph (Deutsch, 2011, p. 4)

## 2.5 BIM adoption in Estonia

Estonia has always been forntrunner in advanced digital infrastructure and e-governance initiatives. So the concept of BIM based public procurement was deemed appropriate widely used in the construction sector, with Estonia emerging as a pioneer in this area.(Figure 7) Recognising the potential of BIM in the construction industry through the execution of numerous programs and policies, the Estonian government has aggressively pushed the adoption of BIM.

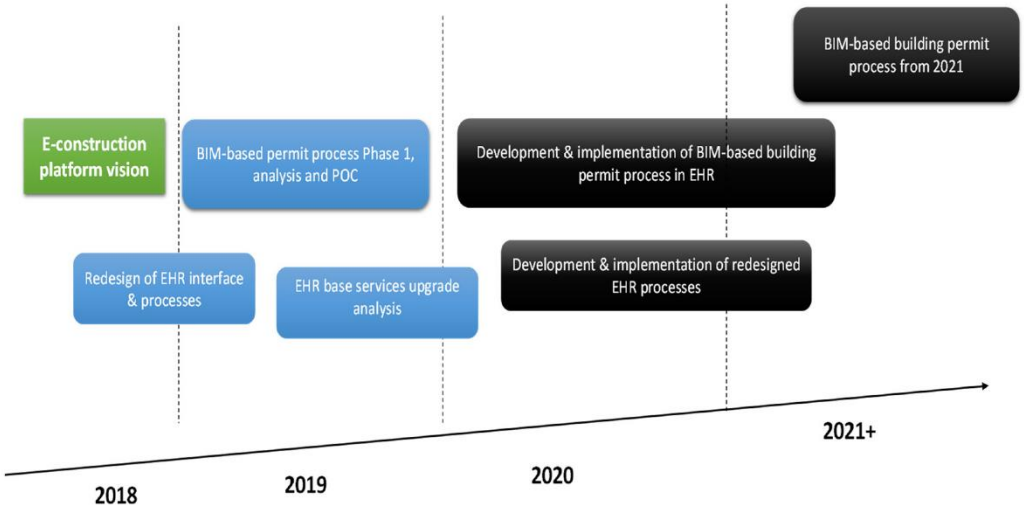


**Figure 7:** Timeline for BIM-based building permit process (source: Estonian Ministry of Economic Affairs and Communication).

Estonia Ministry of Economic Affairs & Communications overlooks the standardization of the so-called Public Sector BIM requirements through the development of the Estonian BIM-based building permit process, which uses the CCI-EE classification system and requires the input of an additional data set where the data content of BIM models is expressed in IFC format. (Noardo *et al.* 2022)

### 2.5.1 Estonian Building Registry (EHR)

The Ministry of Economic Affairs and Communications of Estonia had started the development of BIM-based building permit processes in the Estonian Building Registry (EHR). This enabled the user a thorough analysis of BIM models in IFC format based on BIM practices and be able carry out automated building code checks.

The "Digital Construction Cluster" program, which intends to promote the collaborative use of digital technologies, including BIM, in the construction sector, was introduced by the Ministry of Economy and Communications in 2018. The initiative promotes information exchange, research and development, and the creation of BIM standards and guidelines. (Puusaag & Palmi 2021)

Estonia has created a thorough digital infrastructure to manage information pertaining to construction, including building registry services. Information regarding buildings, building projects, permits, and inspections can be found on the Estonian Electronic Building Register, a centralized database.(figure 8) With the use of this digital register, stakeholders, such as architects, contractors, builders, and regulators, may share information more easily, transparently, and more efficiently.


**Figure 8:** Model uploaded in IFC format can be checked for all codes (source: Estonian Ministry of Economic Affairs and Communication).

Building registry services and BIM integration in Estonia create an ecosystem that enriches the building operations by providing a data rich model of the project and its surrounding its mechanical electrical and plumbing systems, this workflow helps building design, construction, and maintenance.(Figure 8). This integrated strategy makes it possible to manage buildings effectively, enhance maintenance planning, and optimize energy usage.

By incorporating data from BIM into the building registry, accurate and up-to-date information about buildings is accessible to all stakeholders. The platform also enables seamless exchange of information between the models from BIM and the building register, enabling better decision making in urban planning, infrastructure development and building management.

In addition, the integration of BIM and Building Registry services improves the efficiency and transparency of construction projects. The digital platform streamlines administrative procedures, reduces paperwork, and ensures that relevant information about building permits, inspections, and certifications is immediately available.

### 2.5.2 Financial assistance: Ehituse e-hüpe

Ministry of Economic Affairs and Communications, MKM, had launched a funding program in 2022 for the development of digital construction, during the EHITUSE E-HÜPE , around 4.5 million euros was distributed to those operating in the construction field in the years 2022-2025 for the development and implementation of digital solutions. Funding could be solicited for software development or acquisition, research and training under this program. A total of 62 projects receiving support totaling 2.6 million euros in funding. The content of the projects differed considerably. A wide range of product development, organizational innovation, and training initiatives obtained support. The next round of applications is expected to open in the coming near future. (“E-Ehitus kui e-riigi uus edulugu” 2023)

### 2.5.3 Unified Classification System for Construction (CCI)

Standards are essential in the field of digital construction because they create a common language and improve collaboration between both the private and public sectors. (“E-Ehitus kui e-riigi uus edulugu” 2023). This commissioned project aims to develop a unified classification system for construction that takes into account contemporary BIM technology and digital construction trends. From initial planning to environmentally responsible

demolition, this system will offer a standardized and understandable language for managing construction information throughout the entire lifecycle of buildings and infrastructure facilities.

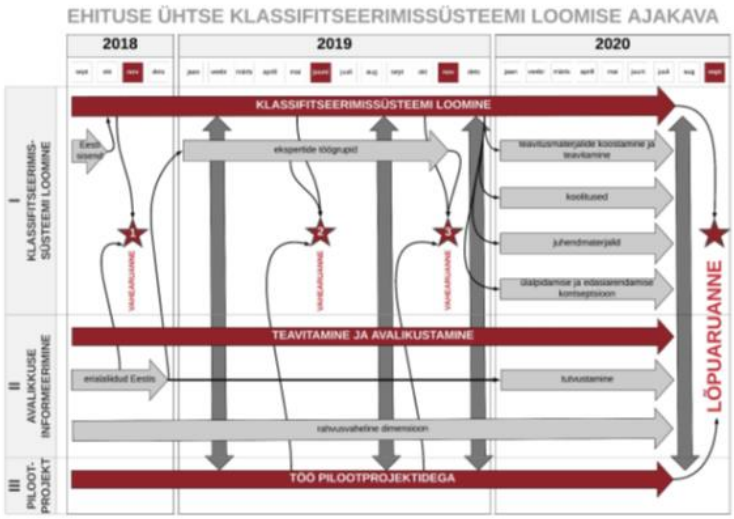


**Figure 9:** Common Construction Classification System (CCI-EE), Contract schedule ("UKS-Lopparuanne_CCI_EE.)

The project involved three main activities: ("Ehituse ühtne klassifitseerimissüsteem (CCI-EE)" n.d.)

- Developing a classification system based on ISO 12006-2:2015. (Figure 9)
- Engaging the public and collaborating with the international community to ensure broad participation and input.(Figure 10)
- Identifying a suitable pilot project to test and monitor the newly created classification system.

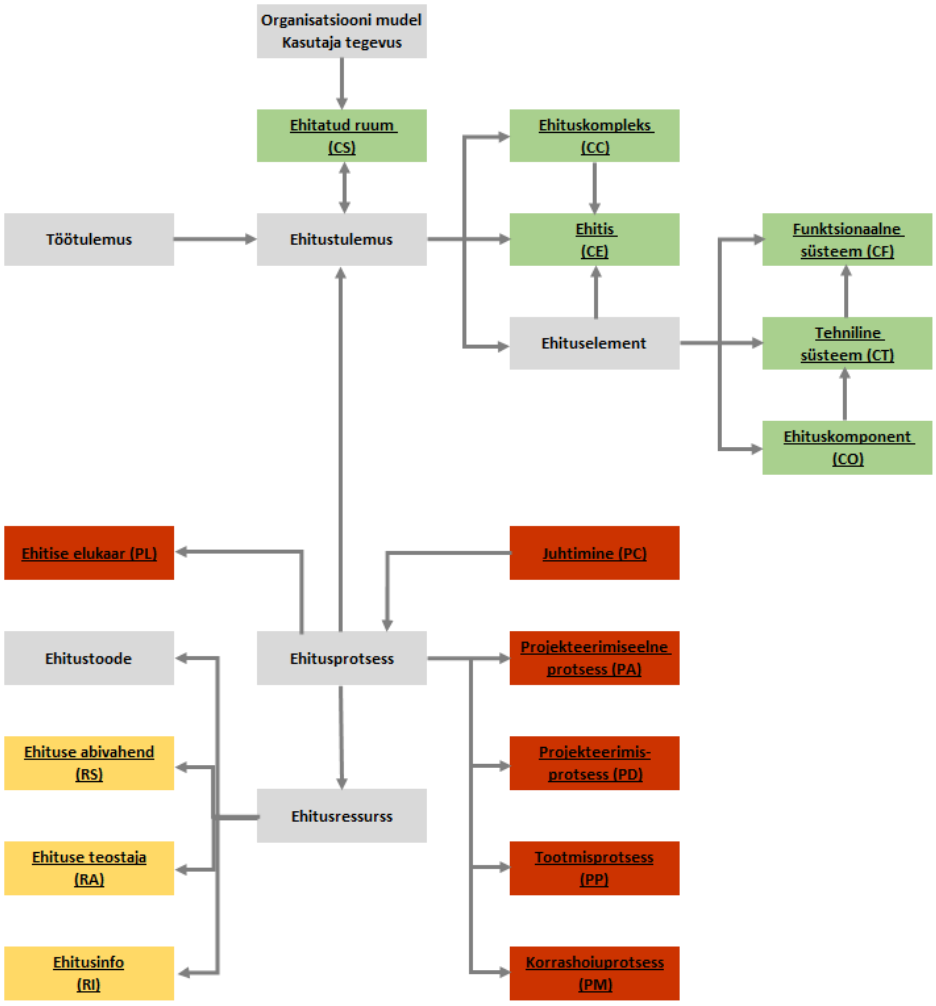


**Figure 10:** CCI-EE classifiers (Source : Ehituse ühtne klassifitseerimissüsteem (CCI-EE)

### 2.5.4 Unified BIM Requirements (ÜBN)

These are a set of requirements which have been developed with the aim to provide a framework for clients to effectively implement BIM technology and best practices in order to achieve their short and long-term goals. These requirements have been developed to harmonize the model design process and its outcomes, promoting consistency and efficiency. This lists down all the BIM data to be provided before an online submission of the model.(Figure 11) The ÜBN can be exploited to ensure adherence to these uniform BIM requirements. (“E-Ehitus kui e-riigi uus edulugu” 2023)

| Maanteeamet - Mulded | | | | |
|---|---|---|---|---|
| Atribuut | ES | EP | PP | TP |
| Tähis | | X | X | X |
| Kihi tüüp* | | | X | X |
| Kihi paksus* | | | X | X |
| Kihi ehitamise aasta* | | | X | X |
| Tootja | | | X | X |
| Mulde materjali omadused | | | X | X |
| Nõutav tihendus ja kandevõime | | | X | X |
| Elastsusmoodul (MPa) | | | X | X |
| Kihi paksus - tulemus | | | | |
| Peenosiste sisaldus | | | | |
| Filtratsioonimoodul EVS-EN 901-20 | | | | |
| Kandevõime | | | | |
| Tihendustegur | | | | |

**Figure 11:** Tables depicting different LODs(level of detail) and the different requirements for submittal, HD III Lisa 7 – Atribuudid, (Souce : eehitus.ee)

## 2.6 Gaps in literature review

Diminished role of landscape architects: The existing literature tends to focus more on infrastructure and architecture and even policy making as a whole and landscape architect seem to be missing from the picture. This gap highlights that the landscape architecture community has been lagging in adopting BIM methodoly

### 2.6.1 Lack of empirical research

There is an acute dearth of imperative studies of landscape architects and their interaction with softwares especially BIM softwares and workflows in my time trying to find literature I could not come across many search articles. I did come across many landscape information model articles but there was less emphasis on the prevalence of their use throughout the community of professionals.

Since the role of landscape architect is quite way read and responsibilities carried out are quite different depending on the region and the locality there is limited availability of search data in English language.

### 2.6.2 Relevance of this research:

This research directly addresses the gaps identified in the literature review by focusing on the barriers that the landscape architects face in implementation of BIM in their workflows and what can be done to address that, particularly in Estonia.

The findings of this thesis can have practical implications for landscape architects, urban designers, and policymakers. By gaining insights into the experiences and perspectives of landscape architects and BIM Professionals in Estonia, this research can also help formulate best practices, guide future decision-making of BIM in LA policies.

Another Direct impact that this research hopes to accomplish is to put landscape architects in the spotlight and bringing them out of the shadow of architects and infrastructure professionals in terms of BIM usage.

In summary, this research addresses specific gaps in the literature regarding the role of BIM in Landscape architecture, the obscacles that this guild faces in the complete Implementation of BIM, and the opinion of Policy makers have in such a transitional professinal paradigm.

## 3. METHODOLOGY

### 3.1 Data collection

For the purpose of this qualitative research, primary data was gathered through Semi-structured interviews with industry professionals Landscape architects & BIM professionals to understand the overall scenario. Secondary data was gathered from scholarly publications, magazines, local government and institution studies, public statistical databases, and through collaboration with researchers looking at related fields.(Figure 12). The study uses qualitative research, the main aim of this qualitative research is to gather an in depth and profound knowledge of the groups that are being studied the qualitative method researches the behaviors and understanding, the logical thinking of the groups, It analyses the What, where, when etc, which is the reason why smaller specifically targeted samples are prefereed over larger samples. (Patton 1987). The qualitative approach was chosen works better when trying to explain complex human behavior and attitudes towards certain trends. Additionally, qualitative analysis is preferable when examining phenomena that are difficult to measure and necessitate a more thorough understanding. BIM implementation in Estonia is in its early stages, even more so in landscape architecture, than in other construction sectors therefore performing a statistical and a large extensive survey would not be feasible.

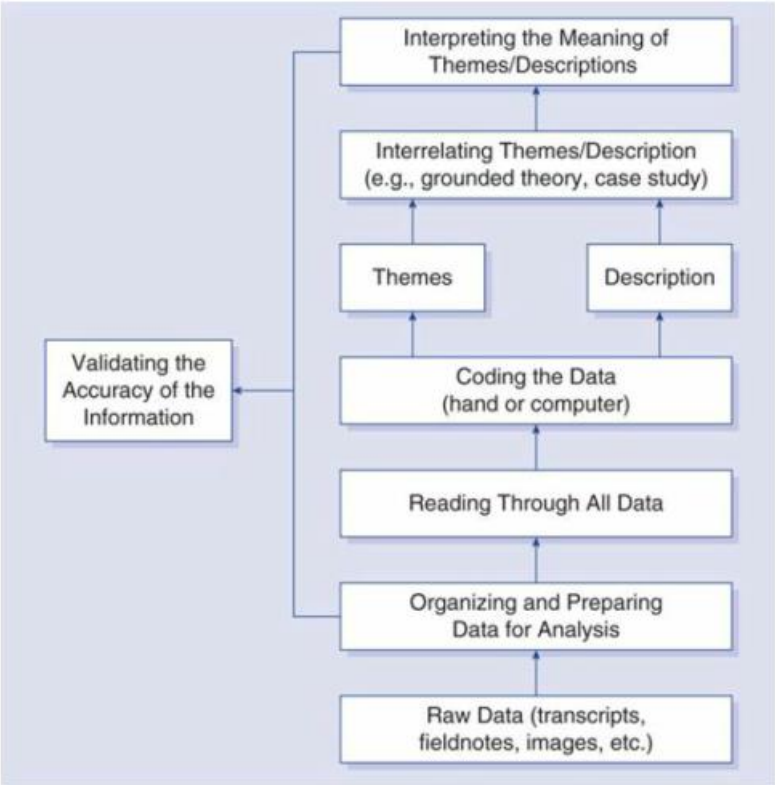


**Figure 12:** The steps involved in data analysis ("John W. Creswell - Research Design_ Qualitative, Quantitative, and Mixed Method Approaches-SAGE Publications (2013)

For this research data was processed through four major steps.(Figure 13) two different types of data collection methods were implemented first was the details interviews with focus groups, divided into BIM professionals and landscape architect, the second was literature study of relevant data, current trends of BIM in Estonia, Government policies and such. However precedence was given to semi structured interviews. The research begin with an comprehensive study of policies implemented recently in Estonia that encouraged BIM workflows, this helped me design informed & detailed interview questions that I could ask the industry professionals.

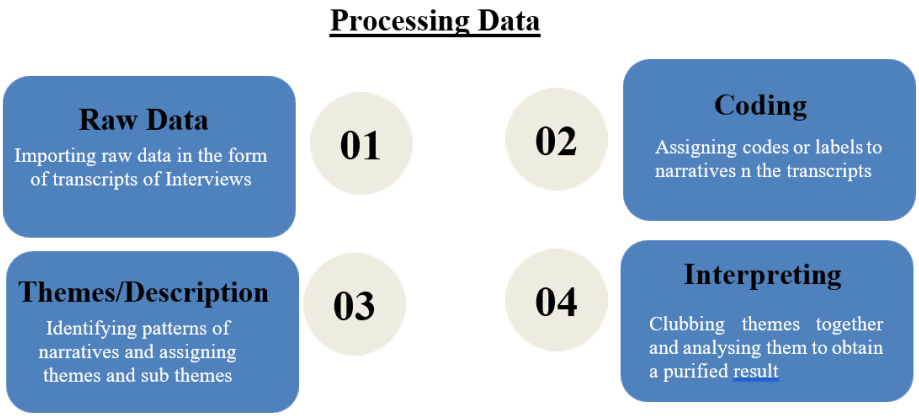


**Figure 13**: Steps undertaken to showcase processing of data

### 3.1.1 Interviews

Semi-structured Interviews were conducted in order to collect the data. For the purpose of a better understanding of Bim and to categorise the interviewees were divided into two groups, first was the landscape architects and the second was industry experts in BIM in Estonia.The interview questions are open ended and formed in such a way that the participant could talk about their experiences in without me having to interject them again and again.

The questions that I had prepared were different for both focus groups, adapted to each groups abilities and requirement for BIM. I conducted most of the interviews in person while some of them were conducted via online platforms. The interviews stretched over a period of 2 months, depending upon the availability of each professional. In total there were 11 interviewees.

I was also fortunate enough to interview two government officials who were directly involved with implementation of them in Estonia their input and analysis help me in understanding and validating my literature review. Their input helped me understand and formulate the conclusions for this research.

All the professionals I interviewed already had interaction with BIM in some way or another. The group of BIM professionals, who are mostly infrastructure professionals, were not directly involved in landscape architecture however their input help me understand and find relevant context to the problems faced by landscape architects.

| Interview Participant | | Length of Interview |
|---|---|---|
| Landscape Architects | 1 | 00:56:55 |
| | 2 | 00:35:36 |
| | 3 | 00:36:11 |
| | 4 | 01:28:04 |
| | 5 | 00:48:41 |
| BIM experts (Infrastructure and Government officials felicitating the move to BIM) | 6 | 00:27:08 |
| | 7 | 00:34:47 |
| | 8 | 00:41:21 |
| | 9 | 00:38:13 |
| | 10 | 00:47:18 |
| | 11 | 00:34:25 |

**Table 1**: The two categories and the time for which interview went on.

## 3.2 Data Coding

All the interviews were recorded on an electronic device and after collecting them on my computer, I eventually uploaded them on a transcription website which I used for transcribing the interviews into scripts that I could later analyse. The audio files were converted into a suitable format and then uploaded on online to be transcribed, the process of online transcription was fairly easy compared to manual one.Although there were some

errors in text they were fairly easy to identify and were rectified. These files were categorised by speaker 1 and speaker 2 with speaker one being me and the speaker 2 being the interviewee. These files also contained time stamps for better understanding the chronology of the topics being discussed and for me to come back to them in case I wanted to review them, I downloaded these script files in word format onto my computer for the next steps.

### 3.2.1 Nodes

For the purposes of this research coding was done using nvivo software. Firstly the transcripts with all the details were uploaded on the software, then I started marking ideas or words that kept repeating across different participants and marked them down as “Nodes”.For example, in the landscape architects interview, one idea that kept reccuring was "difficult to adapt”, So I marked it down as a Node. I did not try to get too specific with the nodes since I wanted specific ideas later on in the form of themes.

### 3.2.2 Themes

For the purpose of creating themes, I bunched together nodes that expressed similar ideas and were repeated across the lines by different interviews. The purpose of creating themes is to categorise these nodes into a larger section that can be later explored.
These themes were later branched off into further sub themes so that they can be explored.
The process of creating themes works really well, when the aim is to concentrate the ideas expressed by participants into tangible topics that can be studied. Without the creation of these things the entire research interview results would be too scattered and it would be hard to focus on the topics dicussed by participants, hence, creating a hierarchy of ideas and topics that were discussed by participants was essentials so that they could be explored in a systematic manner.

As a part of my methodology of conducting this research, I tried to discuss the themes and sub themes and try to provide recommendations and solutions to the problems discussed in those themes, that have trickle down from nodes. In this research it was necessary for me to understand the context and the true meaning of the idea of the feelings that were expressed by the participants since inter relating nodes of different interviews could get jumbled or confused together if the context in which they were analysed was not ascribed properly

## 4. RESULTS

This chapter presents the results of the two focus groups of interviewees, with a detailed representation of the results and analysis separated by each group. Since the categorization of groups is different, the themes and the resulting nodes of each category cannot be compared or interlinked with each other. This chapter deals with the creation of nodes (Table 2,4) and Themes(Table 3 ,5) and their subsequent processing.

## 4.1 Nodes based on Landscape architects interviews

These are interviews conducted with landscape architects these are landscape architects who are using BIM for some time and are interested in advancing digital construction methods.

| No. | NODES |
|---|---|
| 1 | Non-existent BIM standards for LA |
| 2 | BIM in LA is mostly self-Implemented |
| 3 | Client attitudes towards BIM in LA |
| 4 | Contractor attitudes towards BIM in LA |
| 5 | Lack of awareness of BIM in LA |
| 6 | BIM software licences are quite expensive |
| 7 | Integration of BIM with other landscape design tools |
| 8 | Data management with IFC is tricky |
| 9 | Lack of training and education for BIM in LA |
| 10 | Its hard acclimating senior designers to BIM workflows |
| 11 | Preliminary design phase in BIM takes a lot of time |
| 12 | Improving accuracy and efficiency with BIM in LA |
| 13 | Challenges of using BIM for complex LA projects |
| 14 | BIM and 3D visualization in LA |
| 15 | Errors are discovered when modelling in BIM |
| 16 | Increased Workload since BIM has been implemented. |
| 17 | Potential for BIM to enhance the design process in LA |

**Table 2**: Nodes based on Landcsape architects interviews

| No. | Themes | Sub - Themes |
|---|---|---|
| 1 | Challenges in adopting BIM in LA | · Complex nature of landscape architecture projects<br>· Apprehension to learning new softwares<br>· Lack of regulations/standards<br>· Training senior members of the staff for BIM software's<br>· Cost of Purchasing software license, High performance Computers<br>· Initial investment of time and manpower |
| 2 | Benefits of using BIM in landscape architecture | · Collaboration and efficiency gains;<br>· Not having to jump between 2-3 software's<br>· Reduction of potential errors.<br>· Easy adjustments of elements, such as tree spacing, to avoid root conflicts with drains |
| 3 | Collaborative processes between landscape architects and BIM experts | · Collaboration between multiple stakeholders |
| 4 | Training and education for BIM adoption in landscape architecture | · Workshops/ Seminars<br>· Lack of Estonian language support<br>· Bi-Annual meetups regarding BIM Issues |
| 5 | Future prospects of BIM in landscape architecture | · Future of BIM in Estonia<br>· Current technology in Landscape Architecture is enough Career prospects |

**Table 3**: Themes and sub-themes based on Landcsape architects interviews**.**

### 4.1.1. Lack of regulation

While discussing challenges faced by landscape architecture in its implementation, lack of regulation was mentioned multiple times hence this was created as a separate theme. Interviewed Landcsape architects complained that they don't have BIM regulation in Estonia officially from the government body, but it relies heavily on the RKAS standards. RKAS which is basically an organisation which takes care of government real estate, RKAS has certain BIM standards, however for landscape architects these standards are quite insignificant so they end up leaning more on best practices and broad knowledge of the BIM.

"*Its just a filler space"*

While RKAS standard has this list that is like mandatory in many projects, the level of the detail in these projects for landscape architects really loose. So basically if you have you have to model a bench in the project, then it doesn't have to look like a detailed bench, it can appear just as a basic box square, kind of like a placeholder, that holds the construction information, and it can be named as a bench in the project and thats it. Even vegetation is depicted by proxy models But as you move forward they need to get more and more details however relatively speaking they are still quite loose standards. Hence to avoid any last minute detailing at later stages and to save time, landscape architects tend to create detailed models according to their office standards in the beginning of the project this creation of individual personal libraries helps them at later stages and is quite convenient.

" *Usually we are now modeling everything just to well understand the space for ourselves. But at the current stage 80% of the projects have BIM, however, If the client is RKAS then the BIM is 100% mandatory*"

So as a general trend Landscape architects have switched to BIM completely with no scope for 2D drawing event for smaller projects since it can be laborious twitching to and fro between programs, Ultimately, the adoption of BIM by landscape architects is driven by the desire to improve efficiency, collaboration, and design outcomes, this is inspired by RKAS adopting BIM for its projects.

To conclude in BIM adoption for landscape architecture is the absence of comprehensive regulations and standards specific to this field. While the architecture sector, which has well-established BIM protocols, landscape architecture lacks clear guidelines and standardized practices for BIM implementation. The lack of such regulations cause landscape architects

to have their own office standards which can be your worrying trend the long term it may result in quite diverse and divergent best practices.

### 4.1.2 Complex nature of Landscape Architecture projects:

Many landscape architects complain about the fact that landscape architecture projects by designing are quite varied and require different approaches to execute. Unlike architecture or like civil engineering, landscape architects have to deal with organic design elements like terrain, planting which changes over course of many years, and many other dynamic elements, for creating digital representation of these elements in BIM the landscape architects need to be quite skilled with the software, hey this scan be quite demanding in terms of both soft skills on part of the landscape architects and on pure graphical computational requirements to accurately model these elements. Architects complain about the shear graphical requirements in order to model terrains in softwares which makes the availability of hi performance computers an absolute requirement.

### 4.1.3 Training senior members of the staff for BIM software:

*"As of now, BIM modelling tasks are done almost exclusively by a typically usually a young tech-savy designer or consultant working in the firm, We dont have any BIM specific hirings"*

It is known that a skilled professionals with the know-how to employ BIM software tools and methodologies are necessary for adoption of BIM. Training senior staff members who have extensive experience in conventional designing but may not be familiar with BIM workflows is one of the issues faced by landscape architecture firms. Upskilling senior staff members in BIM technologies may take a lot of time and effort due to the steep learning curve associated with BIM software. However, there were also success stories in many offices. *"Well, the beginning was hard of course, but now they see, it as a part of the job. So it's it's fine, In the beginning there were one or two people who were really struggling with even mundane tasks like just generating models general but, they have shown great improvement, it's a work in progress."*

Three of the participants mentioned that converting to BIM had actually increased their workload in the initial phases by a lot especially when working on smaller projects

### 4.1.4 Software's Involved in BIM in Landscape architecture:

Most of the architecture offices report Vectorworks as they are most preferred software when it comes to BIM tools, they describe it as an easy tool, that is not too punishing on their computers. "*Rhino has also developed a really good BIM capability for landscape architects, But we haven't really deeply looked into it"* They mentioned that most of the drafting is done in AutoCAD since it's really easy and appropriate for the preliminary design phase. "*Early phase of Design is best done in AutoCAD because its a lot simpler and more flexible,but we are trying to move over to Vectorworks for that as well".* On being asked as to why vector works was their choice of software, they mention the fact that it has a really big library of BIM vegetation, so it has all the information in there to be used, sometimes it may need minor altering, but it's considered pretty complete and holistic. Many landscape architects mention that they generate some sort of library as they work on increasingly extensive BIM projects. The problems that landscape architects face in regard to Vectoworks, is generally with the terrain and exporting the terrain to land XML format. *"Biggest problem arises when you try to export the model in IFC, you have to do some sketchy things to get it out."* They also mention that other majore issue they face in this software is is hardscaping. *"In vectorworks if you want the hardscape to have also multiple lower layers, so as to not have Vectorworks automatically cut out the site model,In that case, you will always end up doing it manually*".

Site model is really like sketchy if it's not done in Vectorworks , mentions one Landscape architect, saying that when well, the Terrain model is received from Road Engineer and/or Civil Engineers, it's basically impossible to put anything on the ground. So, they almost always end up creating a terrain model for them to work on. Collaborating with architects, the landscape architects mentioned that building coordinates are showing up at random places instead of where they should be on the coordinate system.

### 4.1.5 Cost strain to Small size companies :

One of the major concerns is that Estonia doesn't have a lot of suitably large companies for implementing BIM Almost around 90% of landscape architecture companies are small, Having just one or two Landscape architects, the type of work that they execute is also quite small compared to other fields, Implementing BIM can be quite an uphill task for them since acquiring BIM software licenses can be a significant financial investment for landscape

architects, especially for small to medium-sized practices, Since BIM software's are typically priced based on subscription models or high upfront costs, making it a considerable expense for firms. This cost factor does pose where BIM adoption in landscape architecture is still in its early stages.

*"Unless you're already quite good with software's, it doesn't make sense to purchase a license because licenses are quite costly"*

Upon being asked about financial support provided by the state for implementation of BIM all the participants had given a negative answer.

### 4.1.6 Language support:

Another issue that was raised by participants was the fact that these software providers do not have Estonian language support, most of them are either in English or German or some other foreign language. So having direct one-on-one support as a customer is a benefit that they don't receive when purchasing popular BIM software subscription.

"*The first person to introduce Vectorworks in Estonia was someone who had an Internship in Germany and upon coming back started using Vectorworks at this own firm"*. There isn't a lot to lean on when it comes to training support and online lectures, because there has historically never been any Estonian lectures or study materials at all. Even the English material were not sufficient for participants since all that was in for a North American audience, Vectorworks being an American program.

### 4.1.7 Collaboration and Efficiency Gains:

Participants noted that they were able to work on the same level platform as road engineers and civil engineers since the advent of BIM, Landscape architects, architects, engineers, and contractors can collaborate, share information, and make real-time updates on a shared platform made available by BIM. They noted that this enhances project outcomes and improves efficiency by streamlining communication and lowering errors caused on by misinterpretation or miscommunication. BIM allows for simultaneous design development, reducing the time spent waiting for sequential design submissions. The ability to visualise the design in 3D, with various stakeholders contributing their expertise, fosters better-informed decision-making and leads to more integrated and sustainable design solutions.

One participant mentioned that switching and working on BIM software was a more pleasant experience in general.

*"It more fun to model things, going from 2D to 3D is a lot more exciting".*

### 4.1.8 Software Integration:

*"We no longer have to jump between like 3-4 different programs, just to illustrate or render something, we can now do everything in one software. This may even replace illustrators and InDesign, so I think the workflow has gotten better".*

Almost all participants noted that using BIM eliminates the need to jump between multiple software applications, as it provides a comprehensive platform for landscape architects to carry out various tasks. They pointed out that BIM software specifically designed for landscape architecture integrates multiple functionalities into a single interface, allowing seamless coordination between design, modelling, analysis, and documentation.

### 4.1.9 Reduction of Potential Errors:

*"When you are able to see your design in 3D, then you see for yourself that you have placed this manhole into the ditch and the cable is under the ditch, maybe I should place it 2 meters away. I don't need to do this on another clash detection software, but just visually I can make out that I potentially made a mistake".*

The interviewees noted that errors and conflicts that can and often do occur during the design and construction phases. By creating a digital model that incorporates various design elements, BIM enables us to do clash. Participants noted that without the need for time-consuming manual calculations, BIM tools give landscape architects the flexibility to make quick changes to design elements, such as tree spacing. Designers can change one element using the parametric features of BIM software, and the related elements will automatically adjust as a result. Landscape architects can explore a variety of design options and make wise decisions based on visualizations and data thanks to this feature, which makes efficient design iterations possible.

### 4.1.10 Training and education:

During the in-depth interview, several participants expressed stuation of Training and education scenario surrounding BIM in LA, They mentioned the lack of BIM in landscape architecture courses in Estonian language, and mentioned that several landscape architects even can't make the switch to BIM because they do not have the means and the tools required to become equipped in BIM methodologies.

*"There are no BIM courses available that professionals who are not initaited into BIM can undertake to become certified BIM professionals"*

One participant mentions that *"BIM courses should be an integral part of formal landscape architecture education in order to expose young individuals to dynamic tools & workflows like BIM"*

While such courses exist for infrastructure students & professionals in universities in Tallinn, they are not available for rest of the wider landscape architecture guild, since it is often brushed aside as an afterthought.

Three of the participants felt that conducting workshops and seminars provide professionals with practical training on BIM software tools and workflows based on the peculiarities of the problems they face in Landscape architecture. Having a platform where such individuals could come together and exchange ideas with each other can also lead to future career prospect growth.

#### 4.1.11 Enhanced design visualization and virtual reality:

Participants of the interview conveyed that, they wholeheartedly believe in the future of Virtual reality (VR) and that improved design visualization are huge potential benefits of BIM in landscape architecture.

*"I appreciate the fact that visualization softwares have such a good real time integration with BIM softwares, It will be great help when presenting it to clients, especially City-representatives"*

VR technologies can be integrated with BIM models to give client access to lifelike virtual environments. With VR, landscape architects can offer virtual tours that show how the landscape will appear and feel in the present to their clients. The presentation and interaction with landscape designs will be transformed by this experience, imprving client satisfaction and encouraging better design decisions.

#### 4.1.12 Photgammetry and drone mapping :

*"Drones are the future",* Two of the Participants have mentioned that site analysis stage could be better excecuted & implemented, in the coming years by generating a cloud model of site and existing site conditions by using drones and photogrammetry tools, however they have never used these tools yet.

## 4.2 Nodes based on BIM professionals' interviews

These are interviews conducted with the BIM professionals and the government officials who are invested in promoting BIM technologies in Estonia, none of the participants were Landscape architects or involved with landscape architecture directly.

| No. | NODES |
|---|---|
| 1 | BIM Awareness |
| 2 | Training and education |
| 3 | Implementation process |
| 4 | Benefits in Public procurement process |
| 5 | Lack of BIM experts in Estonia |
| 6 | Collaborative stage |
| 7 | Estonian Digital Construction Cluster |
| 8 | Democratisation of Public procurement |
| 9 | BIM requirements put a huge strain on small offices, since BIM implementation is expensive. |
| 10 | Project documentation and delivery |
| 11 | Project cost estimation and control |
| 12 | BIM project performance evaluation and improvement |

**Table 4**: Nodes based on BIM professionals Interviews.

**Themes based on BIM professionals' Interviews**

| No. | Themes | Sub - Themes |
|---|---|---|
| 1 | Impact on the Industry | · BIM Awareness<br>· Difficulties in integrating BIM into existing processes<br>· Issues with the IFC<br>· Challenges in creating accurate models for complex infrastructure elements |
| 2 | Collaboration and Integration | · Standardisation of templates<br>· Estonian Digital Construction Cluster<br>· Democratisation of Public procurement<br>· Project Documentation and Delivery |
| 3 | BIM Implementation and Training | · Ehituse e-hüpe<br>· Training and Education<br>· Lack of BIM experts in Estonia<br>· BIM requirements put a strain on small offices |

**Table 5:** Themes and sub-themes based on BIM Professionals interviews

Most of the professionals interviewed in this section were mostly of civil engineering background and were employed in the infrastructure industry.

### 4.2.1 BIM awareness:

*"I have been hearing about BIM for the last 10 years and I'm tired of waiting for it to become the next big thing"*. This remark from one Participant emphasised on the fact that BIM has been around for long time in other industries as compared to landscape architecture. It has been much spoken on and quite well researched.

All participants held this acronym in a very high esteem and view it as a panacea to all the problems plaguing the current Estonia construction industry. The participants felt that there

was a certain hype around the word BIM and while people in general were aware about the importance of this, no one bothers enough to get into the specifics of what it entails.

### 4.2.2 Difficulties in integrating BIM into existing processes:

Participants express their displeasure at the fact that that they were working in are already used to certain workflows and methodologies with the recent implementation of them in public procurement processes companies whose clients are b public sector have to implement 100% BIM. *"We had already been using civil 3D so taking out a model of IFC from that was not very hard, the hardest part was inserting information in the model with existing tools, we are still learning".* In case of architects, they already had a long-standing workflow. Upon adapting to BIM software's like REVIT and ArchiCAD, the transition was almost ideal. However, In case of Infrastructure professionals, most participants agreed that the software of their choice, in infrastructure projects, AutoCAD civil 3D, which is built on top of a legacy software of AutoCAD, is very limited in its BIM capabilities compared.

### 4.2.3 Issues with the IFC :

Many of the participants expressed that they had at some point faced some kind of issue with IFC file format while creating submittals for their projects. *"IFC is sometimes inconsistent, and the information stored in it can be hard to view, also it's not the best file format while working with real time projects in on site".*

For the purpose of standardisation and having seamless IFC output, there are several Templates created by Ministry of Economic Affairs and Communications, that ensure that relevant information is attached to the model while submitting.

### 4.2.4 Challenges for infrastructure elements:

In large scale infrastructure projects, you have several details planted in them creating a digital BIM model of this requires seamless integration of GIS data, Piping & other civil data into the BIM methodology. This can be quite challenging since it is necessary to make sure the coordinates match, and there is no awkward clash when compiling the different elements. The complexity of such project increases exponentially.

### 4.2.5 Policy:

"We know exactly the data we need to feed into the model so as to make sure that it is compliant with the Ministry of Economic Affairs and Communication's BIM requirements before uploading the model" The general mood regarding the BIM requirements, was that they were well conveyed, and the stance was quite clear (as mentioned in the Common BIM Requirements).

However, several participants mentioned that there was no dedicated website for such BIM related developments and It was something they wished to see. I was fortunate enough to interview government policy makers who were implementing digital cluster programs, that is supposed to bring together several different fields on to single platform and revolutionising how BIM & digital processes are carried out in Estonia. As he quoted "In the near future, we will be able to test and work on construction projects in virtual platform before putting them into action in real life thanks to technology developed in collaboration between the public and private sector".

During the interview with industry expert, they mentioned about a program that was called Ehituse e-hüpe, which provided funds for implementing BIM at their workplace. The funding is intended to encourage construction industry entrepreneurs to develop and implement digital solutions that will broaden the scope of services available on the e-construction platform, projects for the development, prototyping, or application of BIM solutions independent of the construction industry. They mentioned about a range of activities that Ehituse e-hüpe supported. As was with the case of landscape architects, participants felt that, it was the small and medium sized companies that were facing hurdles in terms of complete BIM adoption since the associated cost with starting BIM methodologies is quite high, interestingly none of the professionals mentioned about the programme Ehituse e-hüpe which subsidises BIM adoption.

### 4.2.6 Public procurement:

*"I remember clearly that 10 years ago,there was no public procurement through computer or Internet. I remember at the time when I prepared the tenders on paper, put them into envelopes and drove to the clients site and there used to be around 10 or so men waiting*

*around a table. The client would come in with bunch of envelopes and they started to open and write on the wall, old school style. It was very common, I remember that time very clearly because I have been there, then the state created the possibility to do this through the website of public procurements and instructed local municipalities and clients that they should do atleast 50% of their tenders in electronic format"*

This participant who had vivid memories of how Estonia and its e-governance had transformed over the years, gave an insightful view of what the future beholds for us. 2 of the participants mentioned that in recent years since the BIM procurement was implemented, bidding on tenders was shifted to the lowest bidder winning the procurement. This had left some of the professionals with a bitter taste, since they felt that this could take a bad turn where it would become unsustainable for companies to have large number of employees, if they won't be able to provide the lowest and the winning bid.

# 5. DISCUSSION

## 5.1 Barriers identified

It is evident from the interviews, that the landscape architects feel that the industry is on the cusp of a change, while benefits of implementing BIM has trickled down to other sectors, Landscape architects are cautious in their approach and many feel that their adoption of BIM personal and on an individual level, rather than on a across the board. This cautiousness is is primarily brought together by the fact that BIM is still seen as an tool that is an 'Outsider' which is was & is used by architects and engineers.

### 5.1.1 Small size of Landscape firms

The Landcsape architecture sector in Estonia is relatively small, which presents another unique challenge. There isn't a pressing need for widespread adoption of BIM because most projects executed by landscape architects aren't significant and complex enough to necessitate BIM. There can possibly be significant apprehensions in acceptance and implementation unless a solution directly addresses the unique needs of small scale landscape architects and provides immediate benefits to them. As was noted in the interviews & literature review, BIM implementation was the result of government policies aggressively promoting BIM and public sector clients commissioning the projects in BIM.

However smaller sized landscape architecture offices tend to work with private clients who are not aware of the advantages/importance of BIM and do not require as a priority. Projects. The cost of BIM software is a significant barrier to BIM adoption in landscape architecture. The initial investment and ongoing costs for licenses, updates, and maintenance can be prohibitively expensive, especially for smaller firms and solo practitioners. Budget constraints and slim profit margins make allocating funds solely for BIM software difficult.

### 5.1.2 Lack of standards

In the absence of specific regulations, meant exclusively for landscape architects it is paramount that organizations like RKAS does not club landscape architects with other wider fields like infrastructure or architecture, It is also pertinent that concerns of landscape architects like LOD requirements are separately documented for landscape projects, it has been observed and the interviews that Landscape architects frequently produce their own

detailed models in accordance with their office standards at the beginning of a project to get around this difficulty and prevent last-minute detailing. However, this may lead to divergent best practices among different landscape architecture firms, which is not good in the long run. Working towards the establishment of Landscape architecture BIM standards and regulations to ensure consistency and interoperability across projects is essential. This will facilitate the seamless exchange of information and enhance collaboration among stakeholders.

### 5.1.3 Awareness about financial aid available

During the course of the interview it was found that when asked about financial support provided by the government they replied in negative, and none of the participants were aware of the program launched by in government called Ehituse e-hüpe. This lack of awareness of government initiated support programs is concerning as it indicates a disconnect between the construction industryand the government policy support made available to them. It hints to the fact that valuable resources and opportunities for financial assistance may be going unnoticed and unused.

### 5.1.4 Training and Support

Training and education is esstential in order to operate effectively using BIM tools and techniques. It was observed that BIM tools were all self learnt by participants in the landscape architecture group of interviewees rather than through a proper channel or accreditation. However in the case of BIM, experts they mentioned that they often attended seminars and skill development classes. But, since most experiences are recent, it is still uncertain on how BIM should be taught. Several participants were of the view that educational institutions should incorporate BIM-related courses into their curricula, preparing students to navigate and use BIM technology. Continuing education programs and professional development opportunities can also assist industry experts in staying current on the newest BIM breakthroughs. Collaboration between educational institutions, industry groups, and BIM software suppliers can help to establish comprehensive training programs that answer the sector's unique demands. However it must be kept in mind that organising training sessions for employees can be a burden on companies that are small sized.

### 5.1.5 Increased Workload

As mentioned by participants and supported by studies, the increased workload during the early stages of projects is a legitimate concern. Higher expectations and demands are placed

on professionals, especially in fields like landscape architecture where BIM technology is still pretty recent. New tools and procedures frequently require a learning curve and adjustment period, adding extra work to the project start-up process as a whole.

When advanced design software or building information modeling (BIM) are used, it takes more time and effort to enter and organize project data, build precise terrain models, and communicate with relevant stakeholders. As professionals adjust to these methodologies, workload may increase, however after a certain time the trend reverses and increased productivity is seen.

### 5.1.6 Current technology in Landscape Architecture is enough

Many interviewees claimed that other Non BIM user professionals in landscape architecture say they are happy with the technology as it is and have no plans to change unless government mandates it. Their complacency frequently results from the absence of explicit requests for complex modelling and detailing solutions from private sector clients.

While some Landscape architects might feel that the available technology is adequate for their needs, it is important to recognize the potential benefits that new technology could offer the industry. The ability to increase efficiency, accuracy, and design capabilities is made possible by the ongoing development of technology. Private clients might not actively seek out advanced BIM tools, but in order for professionals to stay competitive, they must explore and adopt new and upcoming workflows. Using new technologies can result in better project outcomes, more productive workforce, and happier customers.

Additionally, sticking with current technology and not actively seeking out advancements can impede career advancement and reduce available opportunities. As the field of landscape architecture develops, staying current with new technologies enables professionals to stay ahead of the curve.

### 5.1.7 Lack of BIM for LA professional society or an interest group

The absence of a professional society or interest groups devoted to BIM can have a detrimental effect on adoption of BIM in landscape architecture These organizations can potentially host workshops, seminars, and conferences that provide information on the most recent BIM case studies, tools, and techniques and how to tackle problems and pecularities of Landscape architecture. Interest groups foster cooperation among colleagues in the industry, building a network of like-minded individuals. Landscape architects might lose out on important contacts, alliances, and collaborative opportunities that could improve their

BIM projects. Collaboration is essential for creating ideal strategies and exchanging professional experiences that advance BIM. A united professional association may lobby for the use and integration of BIM in landscape architecture. Landscape architects can often struggle to persuade decision-makers, regulatory organizations, and educational institutions to acknowledge and encourage BIM deployment in their sector without a unified voice, this can also lead to them getting favourable outcomes when standardization policies are undertaken by government.

### 5.1.8 Focus on procurement

BIM procurement sets the documentation stage in motion by listing all the minimum BIM requirements for the project. This can perhaps be described as result of top down approach of Estonia's BIM implementation While BIM-based procurement is critical for embedding BIM processes throughout project delivery, the adoption and use of BIM-based technology itself should not be overlooked. During the interviews, it was felt that a lot of times BIM experts,who are in senior position conflate BIM based procurement with the use of BIM software technologies and workflows.

# 6. RECOMMENDATIONS & CONCLUSIONS

The results from interviews with Landscape architects and BIM proffesionals revealed significant hindrances to BIM implementation in the field of landscape architecture. These hindrances arise from the unique characteristics and dynamics of the LA industry, which have not been adequately addressed by existing BIM Policies and mandates. Consequently, this study argues that recognizing and addressing these hindrances present an opportunity for landscape architects to adopt BIM strategies more robusty.

## 6.1 Recommendations

Below is the list of recommendations for mitigating core hindrances and minimizing other identified issues.

### 6.1.1 Government financial assistance:

- Increase awareness of government assistance programs, such as Ehituse e-hüpe, among landscape architects by actively promoting and disseminating information through social media & other channels.
- Create a dedicated website or platform to make landscape architects aware about available financial aid and resources for BIM implementation.
- Creating specific funding programs or grants for small scale landscape firms to help with the financial burden of implementing BIM software.

### 6.1.2 Regulations and standards:

- Develop specific BIM standards and regulations for landscape architecture in collaboration with relevant stakeholders such as landscape architects, professional associations, and government agencies.
- Ensure that landscape architects are not lumped in with other professions such as infrastructure or architecture, but rather have their own set of standards and requirements.
- To promote consistency and interoperability across projects, landscape architecture firms should document and share best practices amongst themselves.

### 6.1.3 Training and assistance:

- Encourage educational institutions to include BIM-related courses in their landscape architecture curricula to ensure graduates have BIM skills.
- Encourage collaboration among educational institutions, industry groups, and BIM software providers in order to develop comprehensive training programs tailored to the specific needs of landscape architects.
- To decrease the burden of organizing training sessions, provide accessible and affordable training opportunities, such as online courses or workshops, specifically designed for small-sized landscape firms.

### 6.1.4 Addressing workload issues:

- Recognize the initial increased workload associated with BIM projects and assist landscape architects in mitigating this challenge.
- Create tools and plugins that streamline processes, automate repetitive tasks, and boost productivity for landscape architects who use BIM software.
- To motivate landscape architects, share success stories and case studies demonstrating the long-term benefits and increased efficiency achieved through BIM implementation.

### 6.1.5 Promoting the Advantages of BIM Technology:

- Increase landscape architects' awareness of the potential benefits of new technology, such as increased efficiency, accuracy, and design capabilities.
- Communicate how staying current with new technologies can lead to career advancement and expanded opportunities.
- Encourage cooperation and exchange of information among landscape architects that shows the value and impact of BIM implementation.

### 6.1.6 Creating a Professional Society or an Interest Group:

- Encourage the establishment of a professional society or interest group devoted to BIM in landscape architecture.

- Organize workshops, seminars, and conferences centered on BIM case studies, tools, and techniques tailored specifically to landscape architects.
- Encourage networking and collaboration among landscape architects in order to share experiences, exchange knowledge, and create a unified voice advocating for BIM adoption.

## 6.2 Conclusion

The barriers identified in this study pose significant challenges to BIM implementation in the field of landscape architecture. Landscape architects are often constrained by tight limited resources and project schedules.

The results of this study can serve as a valuable guideline to analyse the barriers to BIM adoption for landscape architecture. However, it is important to acknowledge the limitations of the study, as BIM in Estonia is fairly new and even more so in landscape architecture. Future research could delve deeper into the experiences of BIM using Landscape architects in overcoming these barriers and developing successful BIM workflows for landscape architecture. This would provide a more comprehensive understanding of the challenges and opportunities involved. By building upon the findings of this study and conducting further research, Landscape architects can gain valuable insights into the dynamics, user requirements, and effective strategies for BIM implementation in landscape architecture.

## SUMMARY

BIM is a digital technology & methodology that allows for the creation, management, and exchange of information throughout a project's lifecycle. It provides numerous advantages, including improved collaboration, improved visualization, and increased efficiency. However, when compared to other sectors of the construction industry, its adoption has been found to be lagging in Landscape architecture.

The research problem at hand revolves around the barriers that hinder the widespread implementation of Building Information Modelling (BIM) in the field of landscape architecture in Estonia. Despite the numerous benefits offered by BIM, its adoption in landscape architecture has been relatively limited, posing challenges for professionals in the industry. In this study the following research questions are addressed- (a) What are the key challenges that hinder the adoption of BIM in landscape architecture projects in Estonia, and how can they be overcome? (b)What are the potential benefits of using BIM in landscape architecture projects in Estonia, and how can they be realized? (C)What are the best practices for implementing BIM in landscape architecture projects? This thesis aims to identify and address these barriers, providing insights and recommendations for overcoming them and promoting the effective integration of BIM in the Estonian landscape architecture sector.

A qualitative research approach was used to gather primary and secondary data. Primary data was collected through semi-structured interviews with industry professionals, including landscape architects and BIM professionals. Secondary data was gathered from scholarly publications, magazines, local government websites and institution studies, public statistical databases, and through collaboration with researchers looking at related fields. The qualitative research approach was chosen as it works better when trying to explain complex human behaviour and attitudes towards certain trends. The main aim of this qualitative research was to gather an in-depth and profound knowledge of the groups that were being studied.

Face-to-face interviews were conducted, and the questions were open-ended, allowing participants to freely voice their opinions. The interviews were taped and transcribed in order to be analysed. Among the Interviewees were two government officials who were directly

involved in BIM implementation in Estonia. Their contributions and analyses aided in comprehending and validating my literature review.

The secondary data was collected through a comprehensive literature review, that was conducted to investigate the challenges and potential solutions for implementing BIM in landscape architecture. Literature review also analysed how policy making helped spur the implementation of BIM in the construction sector. The review sought to identify the barriers to widespread BIM adoption and to propose effective strategies for overcoming them. This study also served as the foundation for the creation of Interview questions to collect insights from Landscape architects & BIM professionals.

The findings of the survey revealed several barriers to BIM implementation in landscape architecture. These barriers encompassed factors such as limited awareness and understanding of BIM, small size of Landscape firms, lack of Standards, lack of awareness about financial aid available, training and support, increased initial workload, complacency with current technology in Landscape Architecture, lack of professional society or an interest group etc despite these challenges, the survey participants recognized the potential benefits of BIM methodologies.

Based on the interview results, combined with insights from the literature review, a set of recommendations and strategies were formulated to overcome the barriers to BIM implementation in landscape architecture.

Finally, the study identified existing barriers to widespread BIM implementation in landscape architecture and offered approaches to overcome them. Overcoming these obstacles will contribute to the advancement and integration of BIM in landscape architecture practices, allowing professionals to take advantages of its capabilities.

## KOKKUVÕTE

BIM on digitaalne tehnoloogia ja metoodika, mis võimaldab luua, hallata ja vahetada teavet kogu projekti elutsükli jooksul. Sellel on palju eeliseid, sealhulgas parem koostöö, parem visualiseerimine ja suurem tõhusus. Kuid võrreldes teiste ehitussektoritega on selle kasutuselevõtt maastikuarhitektuuri valdkonnas maha jäänud.

Käsitletav uurimisprobleem keerleb tõkete ümber, mis takistavad ehitusinformatsiooni modelleerimise (BIM) laialdast kasutuselevõttu maastikuarhitektuuri valdkonnas Eestis. Vaatamata BIM-i pakutavatele arvukatele eelistele on selle kasutuselevõtt maastikuarhitektuuris olnud suhteliselt piiratud, mis seab valdkonna professionaalidele väljakutseid. Selles uuringus käsitletakse järgmisi uurimisküsimusi: a) Millised on peamised väljakutsed, mis takistavad BIM-i kasutuselevõttu maastikuarhitektuuri projektides Eestis ja kuidas neid ületada? b) Millised on BIM-i kasutamise võimalikud eelised maastikuarhitektuuri projektides Eestis ja kuidas seda realiseerida? c) Millised on parimad tavad BIM-i rakendamiseks maastikuarhitektuuri projektides?

Käesoleva lõputöö eesmärk on tuvastada ja kõrvaldada need takistused, anda teadmisi ja soovitusi nende ületamiseks ning edendada BIM-i tõhusat integreerimist Eesti maastikuarhitektuuri sektorisse.

Primaarsete ja sekundaarsete andmete kogumiseks kasutati kvalitatiivset uurimismeetodit. Esmased andmed koguti poolstruktureeritud intervjuude kaudu valdkonna professionaalidega, sealhulgas maastikuarhitektide ja BIM-spetsialistidega. Sekundaarseid andmeid koguti teadusväljaannetest, ajakirjadest, kohalike omavalitsuste veebisaitidelt ja institutsioonide uuringutest, avalikest statistikaandmebaasidest ning koostöös seotud valdkondi uurivate teadlastega. Kvalitatiivse uurimistöö lähenemisviis valiti, kuna see toimib paremini, kui püütakse selgitada inimeste keerulist käitumist ja suhtumist teatud suundumustesse. Selle kvalitatiivse uurimistöö peamine eesmärk oli koguda põhjalikud teadmised uuritavatest rühmadest.

Viidi läbi näost näkku pool-struktureeritud intervjuusid, kus küsimused olid avatud laadi, võimaldades osalejatel vabalt oma arvamust avaldada. Intervjuud lindistati ja transkribeeriti, et neid analüüsida. Intervjueeritavate hulgas olid kaks riigiametnikku, kes olid otseselt seotud BIM-i juurutamisega Eestis. Nende panused ja analüüsid aitasid kirjanduse ülevaadet mõista ja kinnitada. Sekundaarsed andmed koguti põhjaliku kirjanduse ülevaatega, et uurida

väljakutseid ja võimalikke lahendusi BIM-i rakendamisel maastikuarhitektuuris. Kirjanduse ülevaates analüüsiti ka seda, kuidas poliitika kujundamine aitas innustada BIM-i rakendamist ehitussektoris. Kirjanduse ülevaate eesmärk oli tuvastada BIM-i laialdast kasutuselevõttu takistavad tõkked ja pakkuda välja tõhusad strateegiad nende ületamiseks. See uuring oli ka aluseks intervjuuküsimuste loomisele, et koguda maastikuarhitektide ja BIM-spetsialistide teadmisi.

Uuringu tulemused näitasid mitmeid takistusi BIM-i rakendamisel maastikuarhitektuuris. Need tõkked hõlmasid selliseid tegureid nagu piiratud teadlikkus ja arusaamine BIM-ist, maastikuarhitektuuri firmade väiksus, standardite puudumine, teadmatus saadaolevast rahalisest abist, koolitusest ja toest, suurenenud esialgne töökoormus, rahulolu maastikuarhitektuuri praeguse tehnoloogiaga, maastikuarhitektuuri spetsiifilise BIM-i puudumine, professionaalse seltsi või huvigrupi puudumine jne., Vaatamata nendele väljakutsetele, mõistsid küsitluses osalejad BIM-metoodikate võimalikke eeliseid.

Intervjuu tulemuste ja kirjanduse ülevaatest saadud arusaamade põhjal koostati soovituste ja strateegiate kogum, et ületada maastikuarhitektuuris BIM-i juurutamise takistused.

Lõpuks tuvastati uuringus olemasolevad takistused BIM-i laialdasele juurutamisele maastikuarhitektuuris ja pakuti välja lähenemisviise nende ületamiseks. Nende takistuste ületamine aitab kaasa BIM-i edendamisele ja integreerimisele maastikuarhitektuuri praktikas, võimaldades spetsialistidel selle võimalusi ära kasutada.

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**APPENDICES**

# Appendix 1

Interview question structure,followed for landscape architects

## Introduction :

- Briefly introduction and the purpose of the interview
- Why I am interested in learning about the challenges of implementing BIM in landscape architecture in Estonia
- Asking the participant to provide their background and experience with BIM in landscape architecture

## Section 1: Understanding of BIM in landscape architecture in Estonia

- Asking the participant about their level of familiarity with BIM in landscape architecture in Estonia
- Asking about their use of BIM in their landscape architecture projects in Estonia

## Section 2: Identifying the major challenges to BIM implementation

- Asking the participant to provide their perspective on the extent of challenges in implementing BIM in landscape architecture in Estonia
- Asking the participant to describe the biggest challenges they have encountered while implementing BIM in their landscape architecture projects in Estonia
- Asking the participant to rate the impact of factors such as lack of standardization and interoperability,

1. Lack of standardization and interoperability between different BIM tools
2. Limited support and expertise from software vendors
3. Complexity of BIM software and technology
4. Inadequate collaboration and communication between different stakeholders
- Lack of awareness and understanding of the benefits of BIM

Asking the participant to rate the level of support and resources available for BIM in landscape architecture in Estonia

Very low
- Low
- Neutral
- High
- Very high

## Section 3: Benefits of BIM in landscape architecture in Estonia

- Asking the participant to discuss their perspective on the extent to which BIM could improve the quality and accuracy of landscape architecture projects in Estonia
- Asking the participant about their level of confidence in using BIM for designing and managing landscape architecture projects in Estonia

## Section 4: Recommendations and suggestions

- Asking the participant to discuss any additional support and resources they think would help to overcome the challenges of implementing BIM in landscape architecture in Estonia
- Asking the participant to provide any additional comments or suggestions on the implementation of BIM in landscape architecture in Estonia

# Appendix 2

(a) Interview question structure, for different Policy makers for BIM

1. What is the current status of BIM adoption in the transportation department in Estonia, and what challenges are currently being faced in this regard?

2. How is the transportation department addressing the issue of data sharing and collaboration between different stakeholders, such as architects, engineers, and contractors, to enable effective BIM implementation?

3. What kind of training and education programs are being offered to transportation department staff to enhance their skills and knowledge of BIM technology?

4. How can the transportation department ensure that the BIM models used in construction projects are accurate and reliable, and comply with international standards?

5. What are some of the potential benefits of implementing BIM in the transportation sector, such as improved project delivery times and reduced costs, and how can these benefits be maximized?

6. How can the transportation department work with industry stakeholders to promote the adoption of BIM across the sector, and what kind of incentives or support can be provided to encourage this?

7. What kind of investment is needed to support the implementation of BIM in the transportation sector, and how can this be secured?

8. What is the timeline for full implementation of BIM in the transportation department, and how will progress be monitored and measured?

9. How can BIM be used to improve asset management and maintenance practices in the transportation sector, and what steps are being taken to integrate BIM with other systems such as GIS?

1. Lastly, how can the transportation department work with other government agencies, such as the Ministry of Economic Affairs and Communications, to promote a collaborative approach to BIM adoption in Estonia?

# Appendix 3

(b) Interview question structure, for Policy makers for BIM

1. What is the government's current stance on BIM adoption in Estonia, and what steps are being taken to promote its implementation across the country?
2. What are the biggest challenges faced by the government in implementing BIM, and how can these be addressed?
3. What are some successful case studies of BIM implementation in other countries that the government could learn from and replicate in Estonia?
4. How is the government addressing the issue of BIM skills shortage and lack of expertise in the country?
5. What are some of the potential benefits of implementing BIM, such as increased efficiency and cost savings, and how are these being communicated to stakeholders and decision-makers?
6. What kind of support is being provided to small and medium-sized businesses in adopting BIM, and how can they be encouraged to use this technology?
7. How does the government plan to ensure that the BIM systems used in Estonia are interoperable with those used in other countries and comply with international standards?
8. What role can the government play in incentivizing the adoption of BIM, such as providing funding or tax breaks to companies that implement it?
9. What is the timeline for full implementation of BIM across the country, and how will progress be monitored and measured?
10. Lastly, how can the government work with industry stakeholders to ensure that BIM implementation is collaborative, inclusive, and meets the needs of all stakeholders involved?

**Appendix 4. Non-exclusive licence for depositing the final thesis and opening it for the public and the supervisor's (supervisors') confirmation for allowing the thesis for the defence**

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**(19/01/1994).**

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