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Institut für
Bau- und Infrastruktur-
management
Circular Engineering for
Architecture

Bachelor Thesis

Automating Scan-to-BIM for Telecom Site Planning

A Comparative Analysis and Case Study

Autumn Term 2025

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Declaration of Originality

I hereby declare that the written work I have submitted entitled

Automating Scan-to-BIM for Telecom Site Planning

is original work which I alone have authored and which is written in my own words.[1]

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With the signature I declare that I have been informed regarding normal academic citation rules and that I have read and understood the information on 'Citation etiquette' (`https://www.ethz.ch/content/dam/ethz/main/education/rechtliches-abschluesse/leistungskontrollen/plagiarism-citationetiquette.pdf`). The citation conventions usual to the discipline in question here have been respected.

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[1] Co-authored work: The signatures of all authors are required. Each signature attests to the originality of the entire piece of written work in its final form.

Preface

This thesis was developed as part of my bachelor's degree in geospatial engineering. Since I enjoy translating scientific findings into practical applications, I sought an industry-related project for my research.
Before my studies, I worked for several years in mobile network planning, where I had the opportunity to accompany dozens of telecommunications sites from the initial site survey to the building permit application. By chance, on a cold winter day, I found my bachelor's thesis topic over a lunch meeting with my former colleague, Jean-Charles Schaeggi. He supervised me on behalf of Axians, for which I am very grateful.
Furthermore, I would like to extend my special thanks to Helena Laasch from the Institute for Geosensors and Engineering Geodesy. She was my first point of contact at ETH. Because the institute did not have much practical BIM expertise, she connected me with the Institute of Construction and Infrastructure Management, where I found my two supervisors, Océane Durand Maniclas and Kasimir Forth...
TODO: Finish this paragraph

Jeffrey Leisi
Zurich, 2025

Abstract

- **Introduction to the Topic**
- **Research Objective**
- **Methodology**
- **Results**
- **Conclusion and Impact**

Keywords

BIM, Scan-to-BIM, telecommunications, automation, point cloud processing

Contents

Symbols

Symbols

ϕ, θ, ψ	roll, pitch and yaw angle
b	gyroscope bias
Ω_m	3-axis gyroscope measurement

Indices

x	x axis
y	y axis

Acronyms and Abbreviations

ETH	Eidgenössische Technische Hochschule
D-BAUG	Departement Bau, Umwelt und Geomatik (depatement of ETH)
IBI	Institut für Bau- und Infrastrukturmanagement (institute of D-BAUG)
CEA	Circular Engineering for Architecture (research group at IBI)
BIM	Building Information Modeling

Chapter 1

Introduction

"Global construction has a productivity problem" [1]. The construction industry is one of the largest economic sectors, yet its productivity has stagnated for decades. In the two decades from 1995 to 2015, its productivity grew by only 1%, far below the global economy's average of 2.8%.
Als einer der Gründe gilt die geringe Automatisierung der Planung. Um die jahrtausendwende wurden flächendeckend Computer aided design (CAD) eingeführt. Es handelte sich um eine evolutionäre innovation, bei der die konventionelle planung digitalisiert wurde. Das manuelle Zeichnen am reissbrett wurde durch manuelles zeichnen am computer ersetzt, die einzelnen arbeitsschritte blieben weitgehnd dieselben. Bei der konventionelle planung wird ein reales objekt induktiv durch einzelne, zweidimensionale zeichnungen (z.B. grundriss, schnitt, detail) abgebildet. Die zeichnungen werden oft als seperate datei (z.B. dwg, dxf) gespeichert und sind weder geometrisch noch semantisch miteinander verbunden. änderungen am realen objekt müssen in allen zeichnungen manuell vorgenommen werden.
Um eine disruptive innovation handelte es sich hingegegen bei BIM.
BIM-Planung: rachte eine disruptive digitalisierung. Es wird ein einheitliches, digitales Modell als Grundlage erstellt. Gebäudeteile (Geometrie) wird mit Information (Semantik) verknüpft.

1.1 Background and Motivation

TODO: Explain the problem and why it is important. [2]

1.2 Research Objectives and Questions

TODO: Clearly define the purpose of the research. [3]

1.3 Scope and Limitations

TODO: Define the boundaries of the study. [4]

1.4 Methodology Overview

TODO: Briefly outline the research approach. [5]

1.5 Thesis Structure

TODO: Provide a brief overview of the chapters.

Chapter 2

Literature Review

2.1 Introduction

TODO: Introduce the purpose of the literature review.

2.2 Overview of Scan-to-BIM

TODO: Provide background on Scan-to-BIM.

2.3 Existing Approaches for BIM Generation

TODO: Summarize previous research and approaches.

2.4 Point Cloud Processing Techniques

TODO: Review literature on point cloud data processing.

2.5 Automation in BIM: State of the Art

TODO: Analyze how automation is being integrated into BIM workflows.

2.6 Gap Analysis and Research Justification

TODO: Identify gaps in the existing literature.

2.7 Summary and Conclusion

TODO: Summarize key takeaways from the literature review.

Chapter 3

Methodology

3.1 Introduction

TODO: Provide an overview of the methodology.

3.2 Research Approach

TODO: Define the overall research strategy.

3.3 Data Collection

TODO: Describe the data sources and acquisition methods.

3.4 Point Cloud Processing and Preprocessing

TODO: Explain the techniques used to process raw data.

3.5 Algorithm Selection and Implementation

TODO: Describe the algorithms and techniques used for BIM generation.

3.6 Evaluation Criteria and Validation

TODO: Define how the performance of the methodology is assessed.

3.7 Tools and Software

TODO: List and explain the tools used in the research.

3.8 Limitations and Challenges

TODO: Identify potential limitations of the methodology.

3.9 Summary

TODO: Summarize the methodology.

Chapter 4

Problem Description

What comes here? Only relevant if problems occur?

Chapter 5

Results

5.1 Introduction

TODO: Provide a brief introduction to the results chapter.

5.2 Overview of Experiments and Data Collection

TODO: Summarize how data was collected and processed.

5.3 Quantitative Results

TODO: Present numerical results obtained from experiments or simulations.

5.4 Qualitative Results

TODO: Describe observations that are not purely numerical.

5.5 Comparison with Manual Workflow

TODO: Compare the automated approach with the traditional manual approach.

5.6 Case Study (if applicable)

TODO: Present case study results (if a real-world test site was used).

5.7 Summary of Key Findings

TODO: Summarize the main results.

Chapter 6

Discussion

6.1 Introduction

TODO: Provide a brief introduction to the discussion chapter.

6.2 Interpretation of Key Findings

TODO: Explain the meaning of the results.

6.3 Comparison with Existing Literature

TODO: Relate findings to prior research.

6.4 Implications for Telecom Site Planning and BIM Automation

TODO: Discuss the practical relevance of the findings.

6.5 Limitations of the Study

TODO: Identify and explain the limitations.

6.6 Future Research Directions

TODO: Suggest areas for further investigation.

6.7 Summary

TODO: Summarize the key discussion points.

Chapter 7

Conclusion

7.1 Introduction

TODO: Briefly introduce the purpose of the conclusion.

7.2 Summary of Key Findings

TODO: Recap the most important results of the study.

7.3 Contributions of the Research

TODO: Explain the impact of the research.

7.4 Limitations and Challenges

TODO: Recap the main limitations of the study.

7.5 Recommendations for Future Work

TODO: Suggest directions for further research.

7.6 Final Remarks

TODO: End with a strong closing statement.

Bibliography

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