Efficient Semi-Automated 3D Modeling of Multi-Level As-is Buildings from Laser Scanning Point Clouds Using a Custom-Built Dynamo Script

Effiziente teilautomatisierte 3D-As-built-Modellierung mehrgeschossiger Gebäude aus Laserscanning-Punktwolken mittels eines benutzerdefinierten Dynamo-Skripts

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Summary
Scan-to-BIM enables the generation of accurate digital models of existing structures, thereby supporting modernization, analysis, and asset management. Whilst automation increases efficiency, accuracy, and saves time, manual steps remain time-consuming, highlighting the need for further automation. This work presents the development of a customized *Dynamo* script to generate semantic-rich 3D models of existing buildings from laser scanning point cloud data. A case study compares the script's performance with a current software solution. Deviation analysis reveals higher accuracy with the *Dynamo* approach. The results demonstrate significant progress in Scan-to-BIM automation and identify areas for improvement and future research.

Keywords: Scan-to-BIM, 3D modeling, automation, Dynamo, laser scanning

Zusammenfassung
Scan-to-BIM ermöglicht die Erstellung präziser digitaler Modelle bestehender Bauwerke und unterstützt damit die Modernisierung, Analyse und das Asset-Management. Während die Automatisierung die Effizienz und Genauigkeit erhöht und auch Zeit spart, bleiben manuelle Schritte zeitaufwändig, was den Bedarf an weiterer Automatisierung deutlich macht. Der vorliegende Fachbeitrag präsentiert die Entwicklung eines maßgeschneiderten Dynamo-*Skripts zur Erstellung von 3D-Modellen bestehender Gebäude aus Laserscanning-Punktwolkendaten. Eine Fallstudie vergleicht die Leistung des Skripts mit einer aktuellen Softwarelösung. Eine Abweichungsanalyse weist nach, dass mit dem* Dynamo-*Ansatz eine höhere Modellierungsgenauigkeit erzielt wird. Die Ergebnisse belegen erhebliche Fortschritte bei der Automatisierung von Scan-to-BIM, und zeigen aber auch Verbesserungsmöglichkeiten und zukünftige Forschungsansätze auf.*

Schlüsselwörter*: Scan-to-BIM, 3D-Modellierung, Automatisierung, Dynamo, Laserscanning*

1 Introduction

Building Information Modeling (BIM) is essential for the digitalization of the AECO (architecture, engineering, construction, operations) industry, covering planning, construction, and asset management. By converting laser scan data into structured digital as-is models, Scan-to-BIM enables, amongst others, efficient structural analysis and renovation and maintenance planning, while supporting sustainability through optimized resource use across the entire asset lifecycle (Borrmann et al. 2018). Automating 3D model generation enhances efficiency, accuracy, and significantly reduces time, but gaps in automated, point cloud-based modeling persist. The current processes in the modeling of parts from architecture, structural engineering and MEP are still largely manual and labor-intensive. Existing tools such as *Revit* or *ArchiCAD* offer only partial automation and face limitations in geometric feature extraction, point cloud interpretation, and model accuracy. Furthermore, high user expertise and point cloud quality are critical for reliable results (Wang et al. 2019, Borrmann et al. 2018, American Surveyor 2024, LIDAR Magazine 2023).

This research introduces a semi-automated *Dynamo* workflow for Scan-to-BIM, aiming to contribute to bridge the gap between raw point cloud data and structured BIM elements. The customized *Dynamo* script generates 3D models from point cloud-derived plans and floor plans, while leveraging recurring structural patterns across multiple levels. The approach accelerates the modeling process and reduces manual effort. Furthermore, it has been demonstrated that this technology is capable of mitigating the performance limitations of *Autodesk Revit* with point clouds by enabling measurements in Autodesk *AutoCAD*, thereby ensuring accurate element placement in the BIM model. This research employs a case study on a laser scanning point cloud of selected parts of a building at TU Darmstadt. The proposed workflow is benchmarked against an existing semi-automated BIM software solution. A deviation analysis assesses the model's accuracy compared to the point cloud. The study demonstrates the advantages of customized scripts for advancing Scan-to-BIM automation and highlights existing challenges, optimization potential, and areas for future research.

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2 Related Work

BIM is a highly relevant research topic in the fields of civil engineering, architecture and geodesy due to its potential to improve efficiency, accuracy, and collaboration across the entire building life cycle. Despite this broad relevance, a persistent challenge is the absence of suitable BIM models. Current scientific investigations and industry applications of BIM cover an extensive range of thematic domains, reflecting its interdisciplinary relevance and practical impact. In the context of engineering and construction processes, Zhao and Taib (2022) provide an extensive review of recent developments in BIM research. In lifecycle management, BIM is recognized as a critical tool for enabling efficient maintenance and preservation strategies for existing structures (Borrmann et al. 2018; Volk et al. 2014). From a geodetic perspective, Jaud et al. (2020) investigate the georeferenced integration of BIM models, demonstrating its relevance for spatial data management on a global scale. Together, these examples illustrate the diversity of BIM-related research and its interdisciplinary significance. In this research, we focus on the generation of 3D models based on building floor plans using *Dynamo*. Accordingly, the following overview of related work focuses on approaches and studies that are closely related to this objective.

For existing structures, *Scan-to-BIM* workflows aim to bridge the gap by converting laser-scanned point clouds into geometric building representations, yet they often lack the semantic information required for comprehensive digital models (Martens and Blankenbach 2023).

Traditional approaches often rely on manual modeling, frequently using architectural floor plans. While floor plan extraction is still largely manual, recent research demonstrates the potential of semantic segmentation to occasionally generate simple floor plans. Tang et al. (2024) propose using 2D density maps with instance segmentation and geometric feature extraction for vertical structures and distance maps to subdivide the building. Fotsing et al. (2024) extract floor plans by projecting multiple horizontal slices onto the ground plane and merging parallel segments in close proximity to define individual walls. Stojanovic et al. (2019) combine concave detection with k-means clustering for boundary representation, and He et al. (2025) integrate AI-generated semantic floor plans with *Dynamo* scripts to produce 3D models. Topological maps of buildings can be generated using a Boundary-Representation approach on pre-classified point clouds, enabling automatic detection of walls, slabs, and multi-level building models (Roman et al. 2024). Similarly, Cloud2BIM provides an open-source, Python-based Scan-to-BIM pipeline for converting point clouds into IFC-compliant 3D models. It uses a volumetric method focused on geometry extraction, allowing automatic detection of floors, ceilings, and building stories, specifically supporting multi-level modeling (Zbirovský and Nežerka 2025).

Revit remains a widely adopted tool for 3D modeling, with *Dynamo* offering a powerful platform to automate Scan-to-BIM processes. Several studies illustrate this potential: Tong et al. (2024) present a *Dynamo*-based workflow for pipeline modeling; Rocha and Mateus (2024) automate BIM creation from point clouds using structured *Dynamo* scripts forming the basis for the subsequent creation of BIM components. Similarly, Chen and Gentes (2021) and Chen (2022) achieve automatic wall, window, and door extraction directly from raw point clouds using gradient-based methods and *Dynamo*, though their approach assumes Manhattan geometry and is limited to low Levels of Detail (LOD), though robust for low-quality scan data. The semi-automatic use of *Dynamo* scripts to generate wall elements from floor plans shows good flexibility for various building types. Necessary improvements were identified regarding the reconstruction of ceilings and floors, as well as developments towards further automation (Volland et al. 2025).

Scan-to-BIM models require thorough dimensional accuracy evaluation. Esfahani et al. (2021) emphasize that manual modeling remains necessary for secondary building elements, while semi-automated methods can enhance accuracy for primary structures (e.g. walls). Consequently, a hybrid approach is recommended to balance dimensional accuracy, modeling efficiency, and time efficiency.

Recent research highlights the growing use of semantic segmentation, automated floor plan generation, and the effectiveness of *Dynamo* scripting to advance Scan-to-BIM workflows. Nevertheless, fully automated BIM creation still faces significant challenges due to the complexity and uniqueness of building geometries.

This research proposes a semi-automated Scan-to-BIM workflow based on manually extracted floor plans from point clouds combined with a customized Dynamo script, aiming to reduce manual modeling effort while improving efficiency and model quality.

3 Methodology

The following section introduces the enhanced Scan-to-BIM workflow, from point cloud acquisition to automated BIM model generation based on manual floor plans, followed by accuracy evaluation via deviation analysis. Fig. 1 illustrates the complete case study workflow.

3.1 Point Cloud Data Acquisition

The point cloud is acquired using a high-resolution terrestrial laser scanner. Multiple scan positions ensure complete coverage of rooms, corridors, and staircases. The scans are conducted without control points or targets, relying on automatic registration. Scan parameters are adjusted to balance resolution, efficiency, and comply with system-specific accuracy standards. All scans are registered into a single dataset for further data processing.

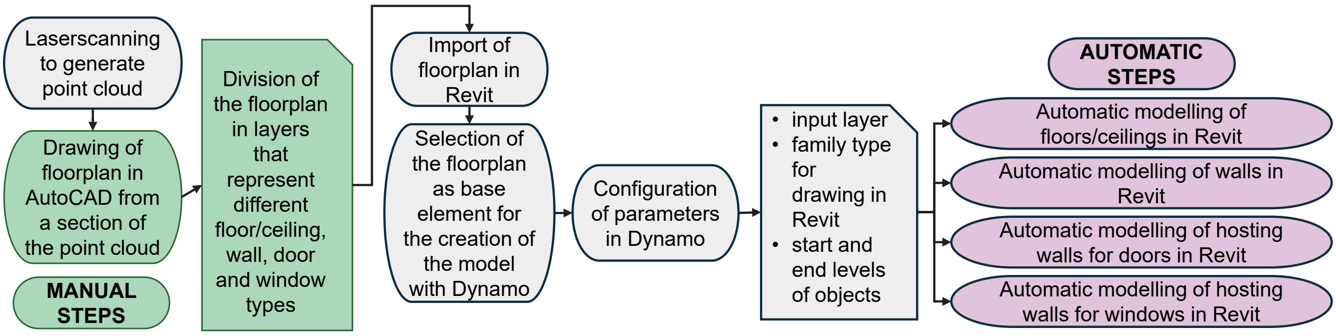

Fig. 1: Workflow of the semi-automated Scan2BIM process of the case study

3.2 Data Pre-processing and Preparation

The laser scans are registered into a unified point cloud, followed by the removal of unwanted data and artifacts. The dataset is exported in E57 format and ".rcp" formats for further processing. Manual segmentation using CAD tools divides the building into distinct parts and components. For each level, 2D floor plans are created, with structural elements such as walls and doors assigned to specific layers. These floor plans reduce computational complexity and align with common *Revit*-based modeling workflows. The prepared floor plans serve as input for the automated 3D model generation via *Dynamo*. Generating accurate floor plans is a non-trivial task. Therefore, the decision was made to initially create the floor plans manually in order to establish a highly accurate baseline. This approach ensures that subsequent steps can be investigated under best-case conditions, allowing the results to be as reliable as possible. In the future, floor plan generation is intended to be automated as well, since it currently constitutes the primary constraint of the workflow.

3.3 Design and Implementation of the *Dynamo* Script

After thorough research, *Revit* is identified as the most widely used 3D authoring software, supporting *Dynamo* to be the preferred tool for automation.

A custom-designed *Dynamo* script generates the 3D as-is model for each building level based on the prepared 2D floor plans. The script follows a defined layer structure and is transferable to similar floors or buildings with recurring patterns. 3D building elements are created according to the pre-defined layers.

3.4 3D Model Generation

The customized *Dynamo* script automatically generates the 3D model using pre-processed 2D floor plans and predefined building elements. The focus lies on reconstructing walls, doors, windows, floors and ceilings. For comparison purposes, the *Revit* plugin *PointCab Origins* is selected as a reference method. *PointCab* is widely applied for point cloud processing and semi-automated *Revit* modeling and serves as a benchmark to evaluate the efficiency and accuracy of the proposed approach.

3.5 Deviation Analyses

Both models, generated with *Dynamo* and *PointCab*, are evaluated through deviation analysis using *Autodesk Point Layout* and *CloudCompare*, following the *Level of Accuracy* (LOA) guidelines established by the U.S. Institute of Building Documentation for evaluating deviations between BIM models and point clouds (USIBD 2016). For this study, a Level of Accuracy (LOA) of 20 is applied, which defines tolerable geometric deviations between 15 mm and 50 mm. The 3D models are compared to the original point cloud to assess modeling accuracy and evaluate the suitability of each method for Scan-to-BIM workflows.

4 Case Study

The case study is conducted on two levels of Building L5|01 at the Technical University of Darmstadt. The complete Scan-to-BIM workflow is applied, as illustrated in Fig. 1. Each process step is described below.

4.1 Point Cloud Data Acquisition

The point cloud data is acquired using the terrestrial laser scanner *Zöller+Fröhlich Imager 5016*. A total of 67 scan positions cover six rooms, corridors, and staircase transitions across two levels (Fig. 2), without the usage of control points or targets. The scan settings are configured to ensure high resolution and meet the recommended quality standards of the laser scanner. The scanner has a field of view of 320° × 360°, capable of capturing 1 million points per second and provides a measurement accuracy of ≤ 1 mm + 10 ppm/m and a maximum range of up to 365 m (Zöller+Fröhlich GmbH 2021).

Fig. 2: Point cloud data of level 0 and level 1

4.2 Data Pre-processing and Preparation

The data processing and preparation for modeling encompass point cloud registration and refinement, as well as the creation of floor plans.

The 67 individual laser scans undergo semi-automated registration through alignment using Z+F LaserControl for cloud-to-cloud registration and Scantra for plane-to-plane adjustment. The registered point cloud is exported in E57 format for further processing. In the next step, unwanted data and artefacts are removed with Autodesk Recap, and a consistent building coordinate system is defined, setting the origin at a reference corner on the lower building level. The cleaned point cloud is then exported in .rcp format to ensure compatibility with *Revit*.

For subsequent floor plan generation, the dataset is segmented into two building levels using *Autodesk AutoCAD*. The segmentation height is selected to ensure all relevant structural details are included. Building elements such as walls, doors, windows, ceilings and floors are assigned to specific layers according to element type. In areas where only one side of a wall is captured, the wall thickness is estimated by the operator derived from the available scanning data. In total, 17 layers are assigned to level 0 and 19 layers to level 1, including duplicates for recurring structural types (Fig. 3). The resulting 2D floor plans are exported in .dwg format (Fig. 3) and serve as input for the automated 3D model generation using *Dynamo*.

4.3 Design and Implementation of the *Dynamo* Script

The custom-developed *Dynamo* script consists of two analogous sections, one for each building level. Its structure is designed to be scalable, allowing replication across multiple levels. For simplification, the following description refers to a single level, as both structure and process are identical.

The script reads the floor plan in *.dwg* format and extracts the geometries based on the predefined layer names for each building element. The exact placement of the floor plans within the *Revit* project is described in Section 4.4. For each building element, specific nodes within the script are connected to nodes defining the start and/or end levels, corresponding to the levels present in the *Revit* model.

The script follows a modular structure divided into four sections: walls, doors, windows and floors and ceilings. For wall generation, the respective layer and associated 3D building element type – referred to as "families" in *Revit* – serve as input. Using the extracted linework as reference, the predefined wall elements are placed directly in the correct position within the *Revit* model. The required 3D families are generated by duplicating existing families in *Revit* and adjusting their geometric dimensions. Measurements for these adjustments are taken using *AutoCAD* or *Recap*, both of which provide superior performance when working with point clouds compared to *Revit*, particularly regarding processing speed and responsiveness.

The generation of doors and windows follows a similar approach. These elements require hosting walls, which correspond to the adjacent walls at the insertion location. The script places doors and windows precisely at the centerline of the corresponding layer geometry, making it essential to verify the center alignment of the families within *Revit*. Windows are additionally placed at a predefined height.

Floors and ceilings are considered equivalent within the *Dynamo* workflow. Similar to walls, a dedicated layer and pre-defined *Revit* element is used as input. Unlike walls, floor placement requires the outer boundary rather than a centerline and only an ending level, as the thickness is

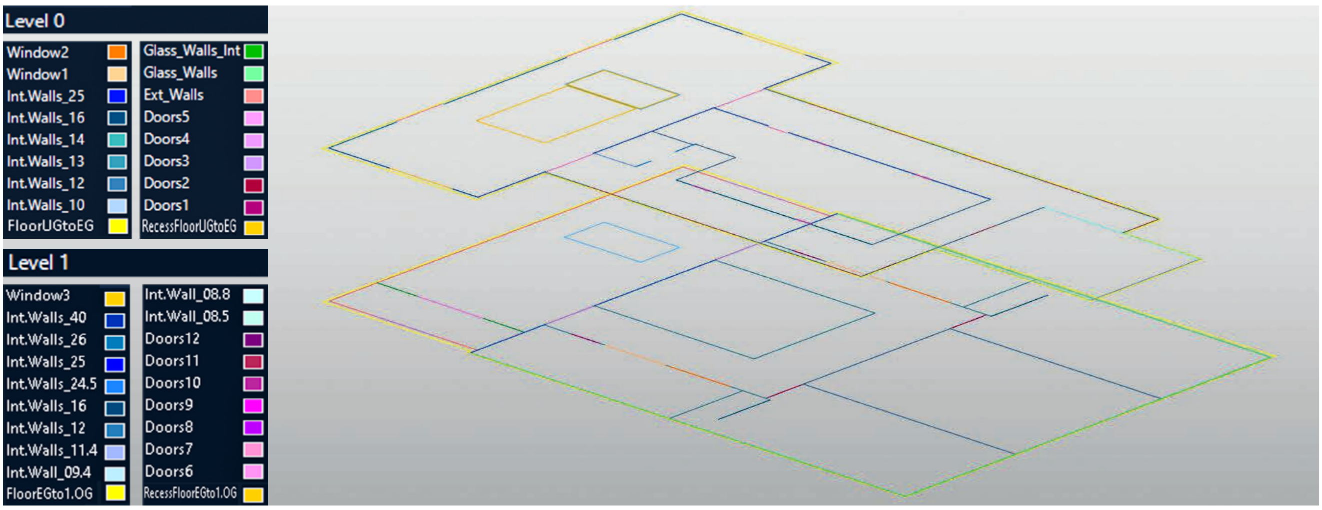

Fig. 3: Layers of the building elements and floor plans for level 0 and level 1

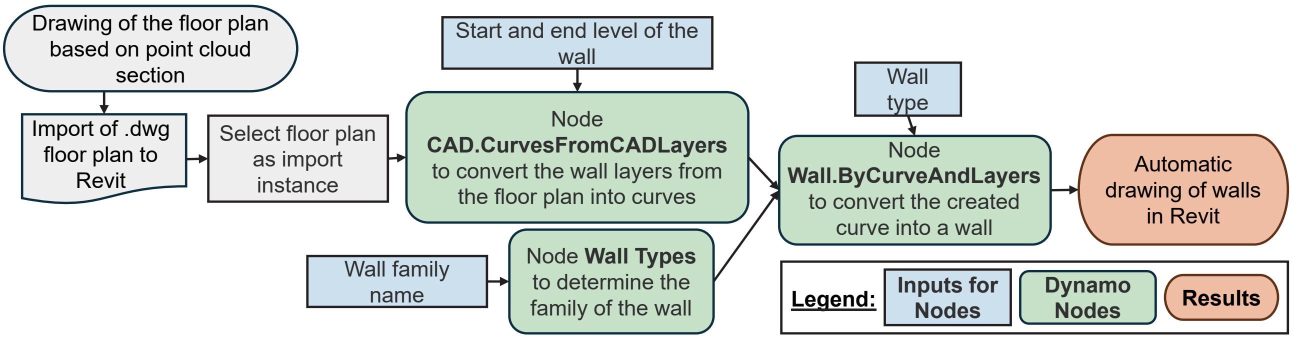

Fig. 4: Dynamo Script – Walls

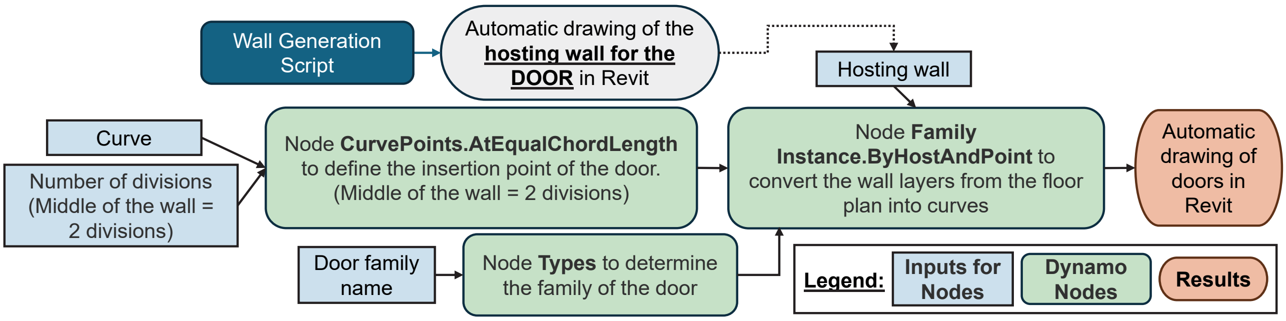

Fig. 5: Dynamo Script – Doors

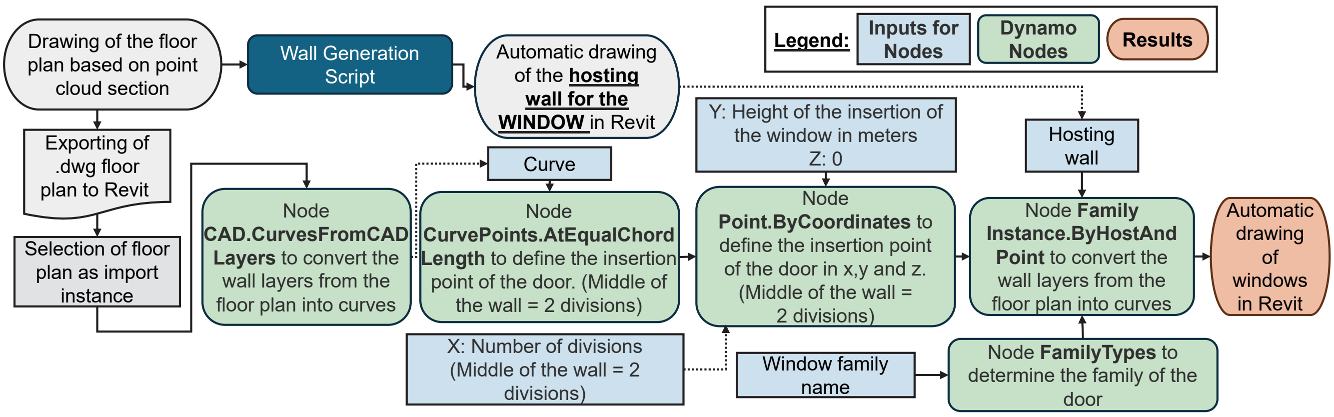

Fig. 6: Dynamo Script – Windows

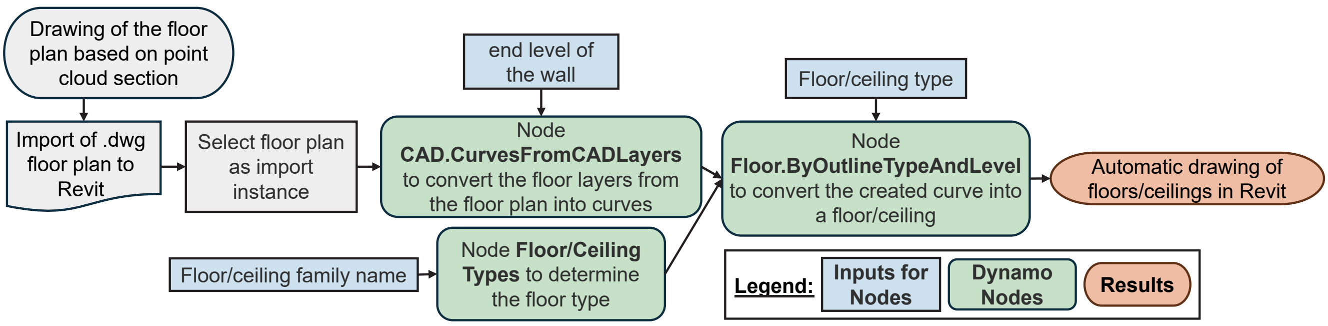

Fig. 7: Dynamo Script – Floors/ceilings

defined by the *Revit* floor type. Floor openings remain a challenge and currently require manual sketch adjustments in *Revit*, which is efficient since the floor plan provides the necessary geometry. Future research will focus on automating floor opening integration.

Fig. 4 to 7 illustrate the implemented workflows for walls, doors, windows, floors and ceilings within the *Dynamo* script.

4.4 3D Model Generation

The 2D floor plans for levels 0 and 1 are imported into *Revit* in *.dwg* format and aligned to the correct reference plans (Fig. 3). Prior to executing the *Dynamo* script, essential parameters such as layer selection from the floor plans and corresponding *Revit* family assignments for walls, doors, windows, floors and ceilings are selected within the script.

Upon execution of the *Dynamo* script, the 3D model is generated within seconds, reconstruction walls, doors, windows, ceilings and floors. Staircases are modeled manually and are not part of the current automated workflow but considered for future work. The resulting model is referred to as Model 1 (Fig. 8 and 9). Fine architectural details and specialized elements fall outside the scope of this study but may be relevant for specific applications (e.g. fire extinguishers for emergency response plans).

For comparative analysis, the *Revit* plugin *PointCab Origins* is applied to create Model 2. Due to the significant time required modeling with *PointCab*, the comparison is limited to level 0, ensuring feasibility within the given research constraints. Consistency is ensured by transferring all relevant properties from Model 1 to Model 2, including identical level definitions and a shared point of origin.

In the *PointCab* workflow, the level 0 point cloud is imported, and a top-view section is generated to guide wall placement in *Revit*. Users manually define wall positions by drawing guidelines within *PointCab*. An automatic connection function is available but requires alignment adjustments to ensure geometric continuity (Fig. 10). *PointCab* lacks advanced tools for precise line centering, which can

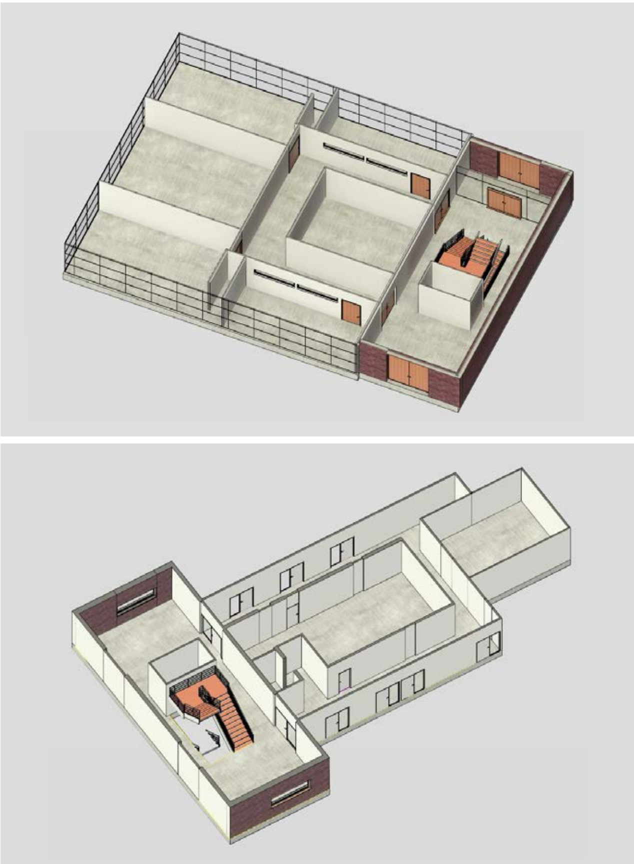

Fig. 8: Model 1 – level 0 (top) and level 1 (bottom)

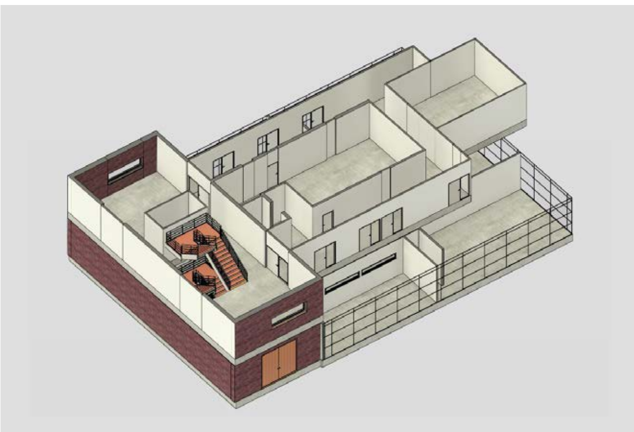

Fig. 9: Model 1 – Both levels

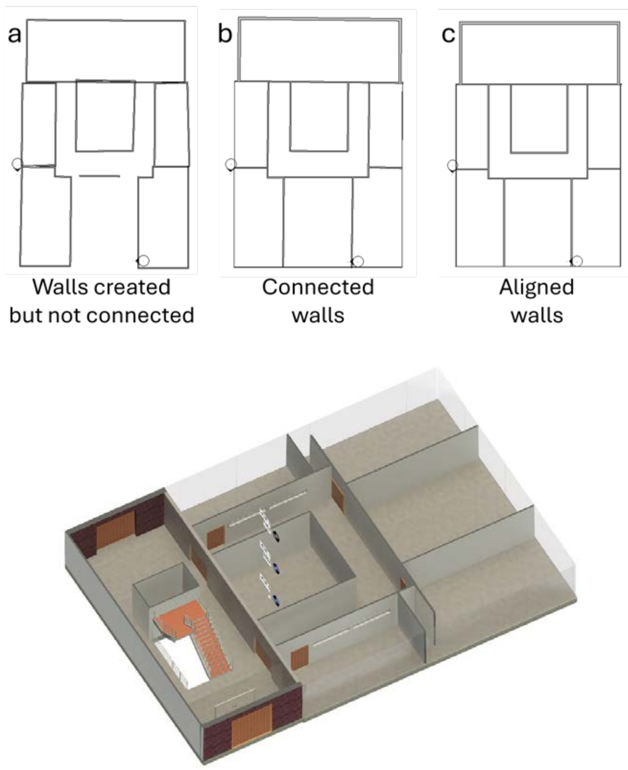

Fig. 10: Wall creation with PointCab Origins (a: Non-connected walls, b: Connected walls, c: Aligned walls) and resulting Model 2 (created with PointCab Origins)

affect placement accuracy. In addition, users must specify the wall type, thickness, and the corresponding levels.

Doors and windows are placed based on manual section layouts. For each element, two diagonal points are selected to define the bounding corners, while the width is specified manually and the height is derived from point positions. The same custom *Revit* families from Model 1 are applied to maintain consistency. Ceilings and floors cannot be generated in *PointCab* and must therefore be created manually. Model 2 for level 0 is shown in Fig. 10.

A time comparison shows that the *Dynamo*-based workflow requires approximately 5 to 10 minutes per level, with most of the time spent selecting layers, levels, and families. While floor plan creation currently requires additional time, this step is expected to be optimized or automated in future research. The *PointCab* workflow exceeds 30 minutes per level, with the manual creation of floors and ceilings adding significant additional time, primarily due to manual floor plan creation, which remains time-intensive but offers potential for future optimization.

4.5 Deviation Analyses

To evaluate both the accuracy and practical suitability of the generated BIM models for Scan-to-BIM applications, a deviation analysis is performed using *Autodesk Point Layout*, a *Revit*-integrated tool for assessing model-to-point-cloud deviations. For this study, a Level of Accuracy (LOA) of 20 is applied, which defines tolerable geometric deviations between 15 mm and 50 mm. The more precise LOA 30 range (5 mm to 15 mm) was deemed unnecessary for this use case, with tolerances adapted from the general framework of DIN 18202 (DIN Deutsches Institut für Normung e. V. 2019).

Point Layout performs the comparison by applying a face-by-face analysis of deviations, comparing each modeled geometry surface to the corresponding area in the point cloud. The maximum point distance from a face was set to 60 mm and a maximum of 500,000 points per selected face were considered. Deviations are visualized using a heatmap with customized color coding. Deviations exceeding ± 50 mm are highlighted in red, while deviations up to ± 30 mm are considered acceptable and shown in green. Intermediate deviations are represented in shades of yellow and orange. For partially scanned walls, only the accessible, captured side is included in the evaluation. The selection of measurement areas is carried out manually to ensure accurate assessment. In addition, deviation histograms were generated using *CloudCompare*, employing the same color scheme as the heatmaps to illustrate the distribution of deviations across all measured points. These histograms

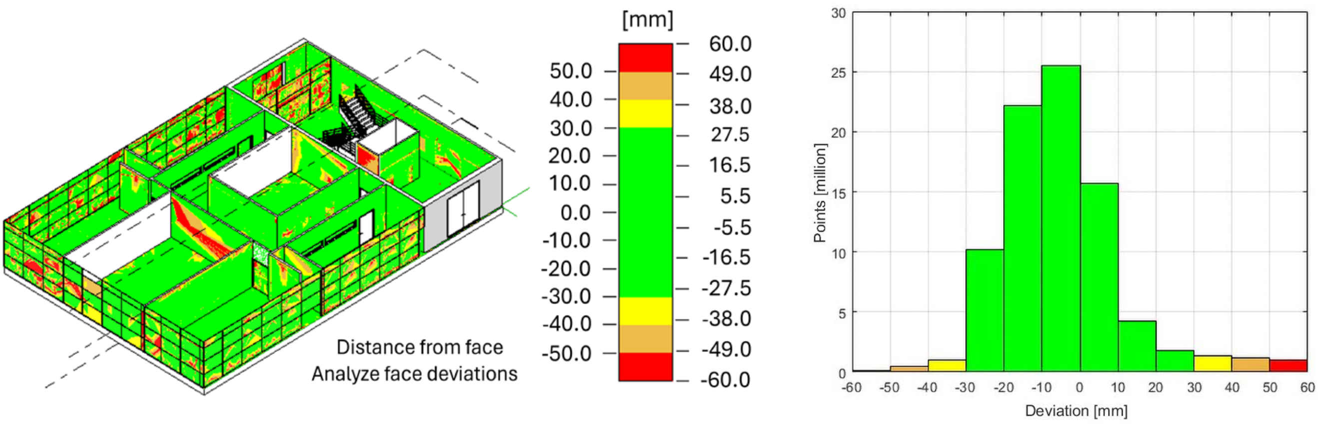

Fig. 11: Model 1 level 0 – Deviation analysis [mm] and histogram of the deviations

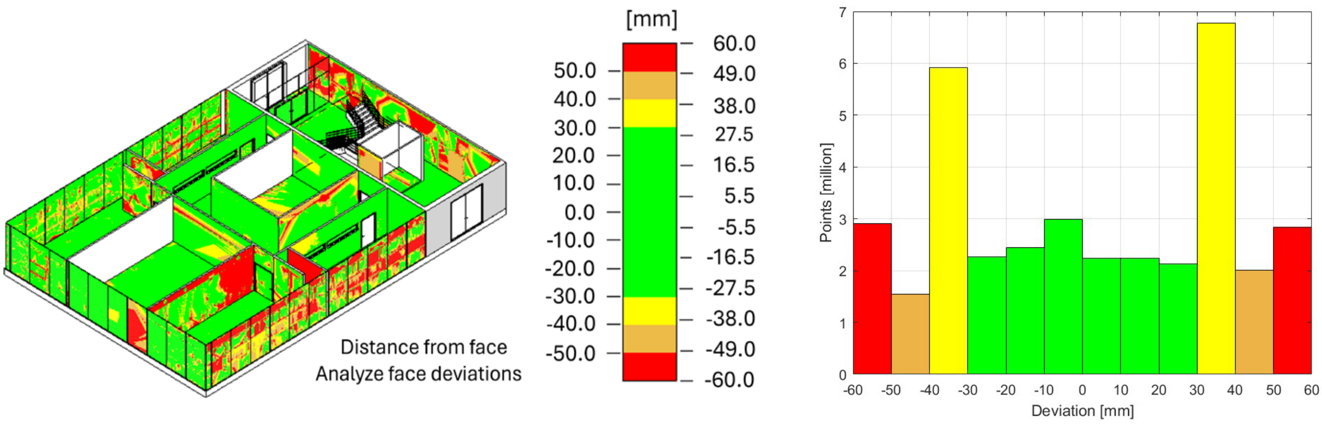

Fig. 12: Model 2, level 0 – Deviation analysis [mm]

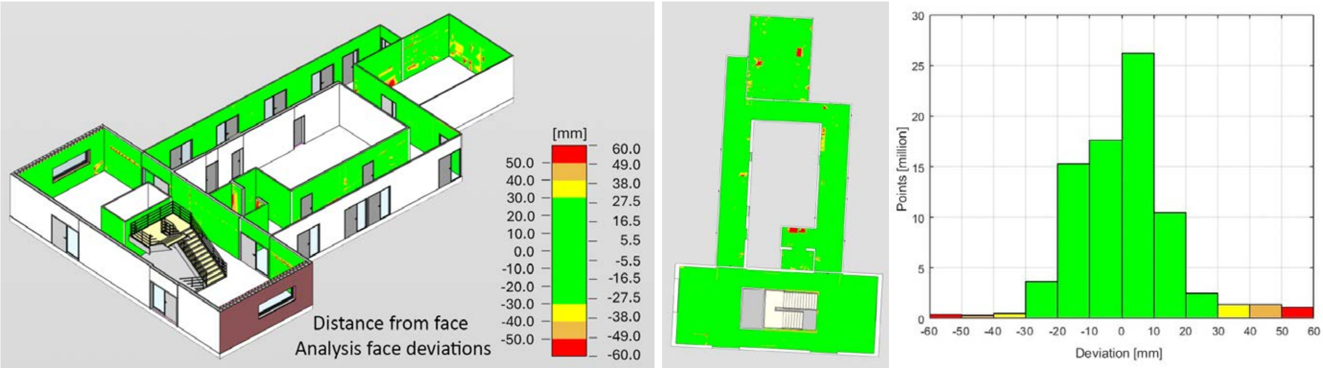

Fig. 13: Model 1, level 1 – deviation analysis and histogram of the deviations [mm]

provide a complementary overview of deviation frequencies; however, they represent deviations across all modeled parts, rather than isolating specific elements as in the *Point Layout* analysis. As a result, a small but negligible difference exists between the two evaluation methods.

Model 1, generated with the *Dynamo* script, shows overall good accuracy for both building levels. The deviations for level 0 of Model 1 largely fall within a high level of accuracy, with only a few isolated higher deviations observed (Fig. 11). However, Model 2 reveals a significantly higher number of areas with larger deviations (Fig. 12).

The deviation analysis is additionally performed for level 1 of Model 1 to validate the approach on a second floor. The heatmap and the histogram show good overall accuracy with few local deviations (Fig. 13). No comparative evaluation is conducted for level 1, as the *PointCab* model was only generated for the lower floor.

5 Key Contributions, Findings and Results

To evaluate the deviation results, the heatmaps of each model section are assessed individually. Model 1 is evaluated both independently and in direct comparison with Model 2 on level 0. The results demonstrate significantly higher geometric accuracy for Model 1 compared to Model 2, as exemplified in Fig. 14. Larger deviations within Model 1 primarily result from non-modeled elements such as fire hose cabinets and wall-mounted lighting fixtures (Fig. 14). Glass surfaces present a challenge, as reflections hinder accurate laser detection. Deviations in these areas typically result from point cloud inaccuracies rather than modeling errors.

Further analyses include maximum deviation measurements and percentage-based accuracy assessments for both models, using varying deviation thresholds. Across all evaluations, Model 2 consistently shows a higher number and magnitude of deviations compared to Model 1. Deviations did not exceed 1000 mm and primarily affected non-modeled elements. For level 1 of Model 1, the higher deviations are likewise caused by non-modeled objects and additionally by point cloud limitations in confined areas, as it was the case on level 0.

The overall accuracy of all models, including both levels of Model 1, is determined by evaluating each modeled geometry surface for which corresponding point cloud data is available. For every such surface, deviations exceeding ± 50 mm are identified and manually delineated, due to technical limitations in *Point Layout*. To achieve this, true-to-scale heatmap exports are imported into *AutoCAD*, where the areas above the deviation threshold (± 50 mm) are traced with polylines. The sum of these delineated areas is then related to the total modeled surface geometry to calculate the proportion of significant deviations. Glass surfaces are excluded from the analysis to avoid distortions caused by known measurement limitations in reflective regions. Tab. 1 presents the accuracy values for Model 1 (Level 0 and Level 1) and Model 2 (Level 0). The accuracy for the floors and ceilings is shown separately, as no

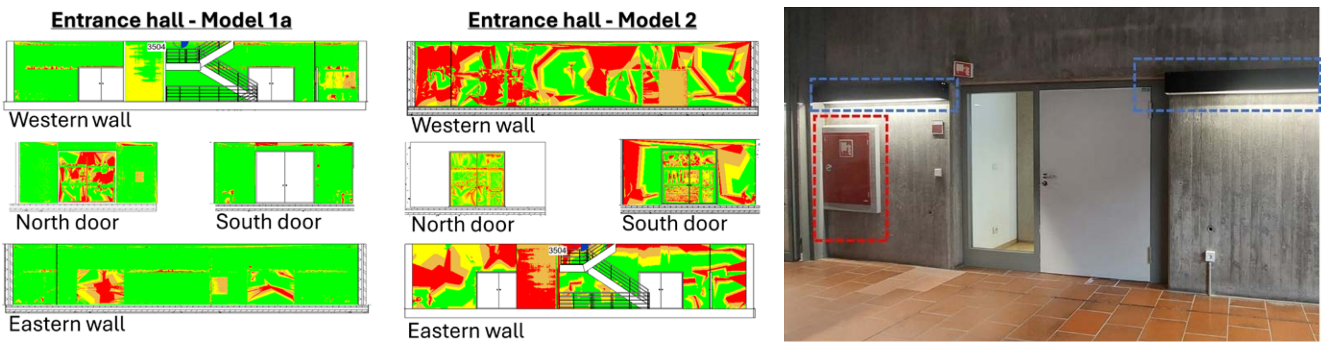

Fig. 14: Left: Comparison of the heatmaps of the deviation analysis – Model 1 vs. Model 2. Right: Examples for non-modeled elements leading to higher deviations

Tab. 1: Accuracy levels of all models [%]

Model 1	Model 1	Model 2	Model 1	Model 1
Level 1 (without floors)	Level 0 (without floors)	Level 0 (without floors)	Level 1 Floor	Level 0 Floor
98,73 %	96,86 %	87,23 %	99,73 %	99,95 %

comparison with Model 2 is possible in this region. Model 1 shows similar accuracy results on both levels, with 98.73 % (with deviations lower than ± 50 mm) on level 1 and 96.86 % on level 0 for the automatically modeled regions without the floor, and even 99.73 % on level 1 and 99.95 % on level 0 for the floor regions. In contrast, Model 2 demonstrates an accuracy of 87,23 % on level 0, representing a difference of 10 % compared to Model 1.

While deviation analysis could also be performed using *CloudCompare*, *Autodesk Point Layout* was initially chosen as it allows for targeted selection of individual elements and surfaces. *CloudCompare* was additionally used to generate histograms, with glass surfaces excluded beforehand. Minor deviations between the results of both tools occur, as *CloudCompare* evaluates walls from both sides, while point cloud data is available for only one side. This difference is limited but will be addressed in future research.

The results further confirm that the proposed approach delivers reliable outcomes and exceeds the accuracy of existing software solutions. Under the premise that a floor plan is already available, the method already enables faster reconstruction, particularly for buildings with recurring structural elements across multiple levels. Currently, floor plan creation remains the primary limiting factor; however, its automatic generation is part of planned future research using AI-based methods. It is expected that, once this step is automated, the overall workflow will become significantly more efficient compared to existing software solutions.

Using 2D floor plans may reduce the 3D accuracy of the point cloud, especially for vertical or irregular geometries, potentially requiring manual corrections. However, the case study showed that this was not a significant issue in the present scenario. This finding applies primarily to buildings with simple and repetitive geometries, frequently based on a modular construction principle, as commonly observed in administrative or university facilities. It is unlikely to be applicable to complex structures, such as historical buildings, or to applications requiring true-to-deformation analysis, where higher geometric variability and irregularities may render manual adjustments unavoidable.

Furthermore, the utilization of point clouds in *Revit* was found to be less efficient, thereby rendering crucial modeling tasks such as precise measurements or the alignment of elements more time-consuming, especially for large datasets. The proposed workflow addresses this by performing measurements in *AutoCAD*, which, in this specific context, demonstrated more effective point cloud handling. It is acknowledged that other software solutions may offer comparable or even superior performance depending on the application scenario. Combined with generated floor plans, the *Dynamo* script enables accurate element placement in *Revit*, mitigating performance limitations when working directly with point clouds. The proposed workflow is currently implemented within *Revit*, which serves as a demonstrator for the method. Although this setup relies on *Revit*, the workflow itself is fundamentally transferable to other modeling environments, provided that methodological adaptations are made. The use of *Dynamo* Sandbox as a standalone application is theoretically possible for geometry processing, and an additional export function, such as .obj, could enhance compatibility with other software (Dynamo 2018, 2023a, 2023b). However, creating a full BIM model still requires suitable BIM authoring software beyond *Dynamo* Sandbox.

6 Conclusion and Outlook

This study presents an approach that contributes to the automation of the Scan-to-BIM process by using a custom-developed *Dynamo* script for efficient, rule-based modeling in *Revit*. The method builds on pre-extracted plans and 2D floor plans derived from laser-scanned point clouds and is particularly effective for buildings with recurring structural patterns across levels.

The case study has been conducted on a university building, examining two levels. Compared to conventional, predominantly manual, modeling techniques, the approach achieves higher accuracy, surpasses existing semi-automated solutions in accuracy and reliability, and significantly reduces modeling time when floor plans are available. It should be noted that an experienced modeler could achieve higher precision through manual reconstruction. However, in a time-equivalent comparison the proposed approach achieves higher accuracy while maintaining a favorable balance between processing time and achievable accuracy. A key advantage lies in its high degree of transferability to other building levels and structurally similar environments, supporting its applicability, making it suitable for large-scale projects with repetitive layouts.

Challenges such as point cloud inaccuracies, especially at glass surfaces, remain unavoidable due to fundamental laser scanning limitations. The study also identifies key challenges, notably *Revit*'s limited performance when processing point clouds, which can hinder efficient modeling. This is mitigated by integrating CAD software for faster measurements while predefined floor plans ensure precise element placement in *Revit*.

Future research aims to focus on automating floor plan extraction through semantic segmentation and expanding the *Dynamo* script to include staircase transitions. Moreover, upcoming investigations will explore the automated generation of *Revit* families. Further refinement of the workflow allows for reduced manual effort, while maintaining high accuracy in building reconstruction.

This study makes a significant contribution to the field of Scan-to-BIM automation by offering a structured and adaptable methodology. This methodology has been proven to enhance efficiency, precision, and usability, thereby providing a valuable and robust foundation for future advancements in the realm of digital building reconstruction.

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