BUILDING PASSPORTIZATION AND INFORMATION MODEL OF THE FACULTY OF CIVIL ENGINEERING IN BRNO

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Abstract
This article describes the process of building passportization and the subsequent application of an information model for the Faculty of Civil Engineering in Brno. Given the high probability that the building documentation for these structures is outdated, updating the information becomes essential for future maintenance, renovation, and grant applications. The purpose of the article is to provide a description of the procedure for building passportization based on laser scanning technology and showcase the results of the scanning process of Building Z.

Keywords
Building passportization, BIM, information model, point clouds

1 INTRODUCTION

The obligation for property owners to maintain up-to-date building documentation is based on act §125 183/2006 Sb. of the Czech Republic. The law mandates the possession of appropriate documentation for the actual construction or, alternatively, simplified documentation, commonly known as building passport. Beyond the legal obligation, owning updated documentation offers several practical benefits. First of all, it is essential to have documentation reflecting the actual current state in the event of any changes such as structural modifications, changes in usage, etc. Simplified building documentation in the form of a building passport is processed for existing structures where documentation is either unavailable or outdated. With the complete and accurate information about a building, resulting from passportization, an object passport is created, serving as a key element in the process of BIM implementation [1]. The process of passportization, which collects building-related information, and BIM are both considered as essential information tools. Passportization can also be processed using the BIM method [2], [3], [4].

In the Czech Republic, there are 26 public universities that manage approximately 2,000 buildings. These public universities are primarily funded from the state budget, research support, revenues from assets, and supplementary activities [5], [6]. The age of these public universities varies significantly. For example, Charles University, the oldest public university, was founded in 1348. The majority of these building structures date back to previous centuries. Therefore, it is assumed that their documentation is not complete or up-to-date. An option to unify the documentation of these objects is to create uniform parameters. In order to compare and statistically avaluate data from faculties or public universities, it is important to have comparable data from these building passports. As a result, in 2018, the Ministry of Education, Youth, and Sports (MŠMT) initiated requirements for these uniform parameters and the MŠMT Methodology for the Passport of University Buildings according to ČSN EN 15221-6 [7].

The article focuses on the process of building passport development at the Brno University of Technology and at the Faculty of Civil Engineering (FCE) as part of the program 133 220 titled “Development and Renewal of the Material and Technical Base of Public Universities”. This program is managed by the Ministry of Education and is scheduled to conclude in 2027 [8].

Description of the present state

The Faculty of Civil Engineering consists of eight buildings with a total area of 17,771 square meters as illustrated in Fig. 1. Considering the age of these building structures ranging from 12 to 120 years, it is highly likely that their building documentation is outdated. Over time, records can become incomplete, lose accuracy, or fail

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to incorporate crucial updates made to the buildings. Consequently, there is a compelling need to revise and modernize this information.

Fig. 1 The building structures of the Faculty of Civil Engineering, according to State Administration of Land Surveying and Cadastre [9].

Building Passportization using the BIM Method

Passportization refers to the process of collecting data that is entered into a digital information system. Information about the building structure is processed into both graphical and non-graphical (descriptive) formats. The result of the passportization process is the creation of passports, each varying in terms of their level of detail and intended purpose . There are four basic types of passports: spatial, construction, technical, and technological. The passport document finds application in audits and subsidy applications from national or European subsidy programs.

BIM (Building Information Modeling) is the process of creating and managing data. This digital technology involves generating a digital representation of a physical object, resulting in a 3D information model. This 3D information model is valuable not only in the planning and construction phases but also in the management and analysis of the structure.

These data serve various purposes, including, for example, economic and technical management, assessing needs and planning of investment resources, efficient use of real estate, budgeting and information serving as a basis for IT systems (e.g. CAFM). The use of data creates the possibility of reducing the overall cost of the building object [2], [3], [4].

Passportization using the BIM methodology involves collecting and managing data in order to create a digital passport. Later, this data is usually consolidated into a common data environment (CDE) for access by various professionals and users. One of the breakthrough technologies in data collection is 3D laser scanning. As laser scanning technology becomes readily available and affordable, there is an increasing demand of using point cloud data collected from a laser scanner to create as-built building information modeling (BIM) models. These models are essential for quality assessment, schedule control and evaluation of energy performance within construction projects [10]. Point clouds, the output of 3D laser scanning, vary in size, density, and accuracy depending on the type of scanner that has been selected and the level of precision used. In comparison to technical documentation, passportization uses different parameters. The point clouds are subsequently processed into a 2D vector format for easier handling, and afterwards vector 2D drawings (such as floor plans and sections) are created. In turn 2D drawings can be used as a reference frame for creating a 3D model. Direct vectorization of the point cloud into a 3D format presents a number of challenges [11], [12]. Laser scanning can be used to collect geometrical and spatial information in the form of a 3D point cloud, and this technique is already used. However, as a point cloud representation does not contain any semantic information or geometrical context, such point cloud

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data must refer to external sources of data, such as building specification and construction materials, to be used in BIM [13].

To extend the lifecycle of a building structure, it is essential to allocate financial resources for investment activities, particularly in renovations and refurbishments. According to the Annual Report of Brno University of Technology (BUT) for 2022, potential solutions for terraces on Building Z were considered [14].

2 METHODOLOGY

Before initiating the passportization process, it is necessary to examine the latest documentation for verification and comparison with the actual construction acoording to Fig. 2. Available documentation is typically stored at the construction authority or within Brno University of Technology (BUT) specifically in the BUT Archive, where archival records are kept. The identified documents must undergo thorough verification and comparison with the actual state of the building structure.

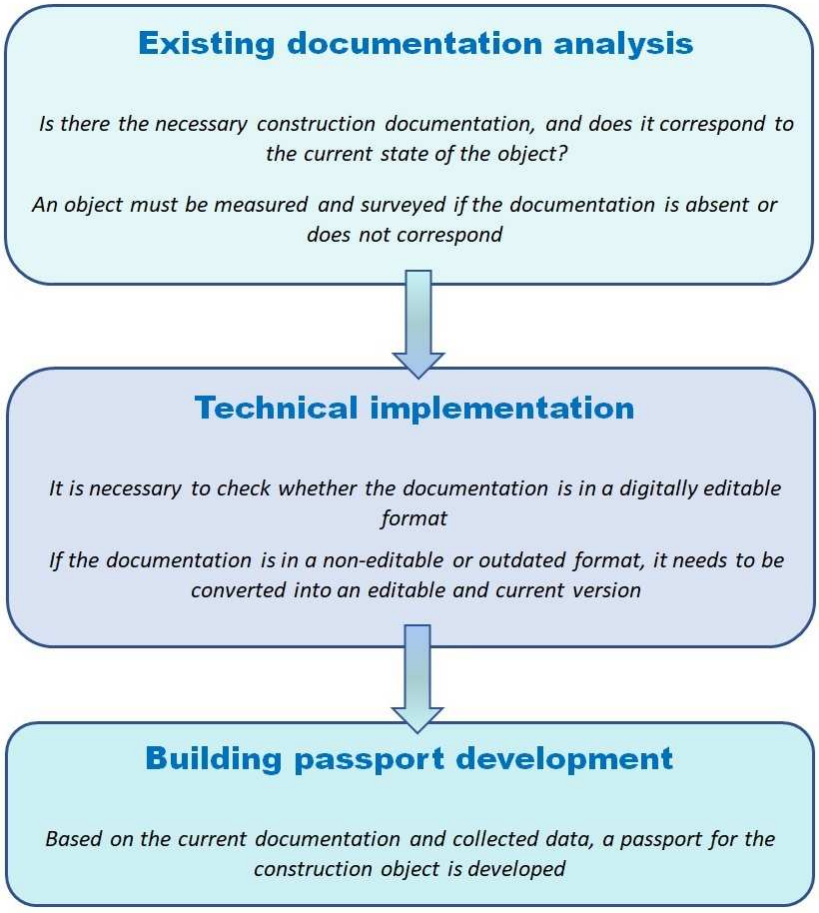

Fig. 2 Passportization methodology, according to [7].

The methodology established by the Ministry of Education, Youth, and Sports (MŠMT) focuses on spatial classification of areas with clear nomenclature for these specific spaces, unifying the perception of geometric space (usable area and net usable area), and establishing comparable parameters for the technical condition of wear and tear (long-term durability elements, short-term durability elements) without the need for reconstruction, with the need for reconstruction, or with the need for complete reconstruction. The basic division of the methodology falls into four categories: communication, primary areas, technical spaces, and building equipment. The MŠMT methodology provides a manual on how to specifically structure both graphical and non-graphical information.

As a consequence of standardizing the content of passport data for university properties, it is expected to reduce costs and provide more transparent information that can be used for facility management [7].

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3 RESULTS

According to the chosen methodology, the first step involves a comprehensive analysis of the existing documentation, revealing that the necessary construction data do not correspond to the current state of the object. In connection with the necessity for further surveying and measurements of the building, the most advanced scanning methodology has been selected. Among the first scanned building structures are the terraces on Building Z. This decision was made due to the necessity of the approaching terrace reconstruction. However it is assumed that the entire Faculty of Civil Engineering Brno University of Technology (FCE BUT) campus will undergo passportization.

The data obtained from the scanning process is shown in Fig. 3. According to the chosen methodology one of the most important stages in preparing a building passport is converting documentation into a digitally editable format. The Faculty of Civil Engineering (FCE), being a specialized institution with expertise in construction, has the capability to undertake this passportization process in-house, using its human resources. This approach involves both dedicated staff and active students. Rather than outsourcing the task to private companies that specialize in passportization, the faculty harnesses its own workforce and students academic potential. Hence, the decision was made to use the data obtained from the scanning for further processing in AutoCAD services. In Fig. 4 and Fig. 5, you can observe the finished drawings created based on the data obtained from the scanning.

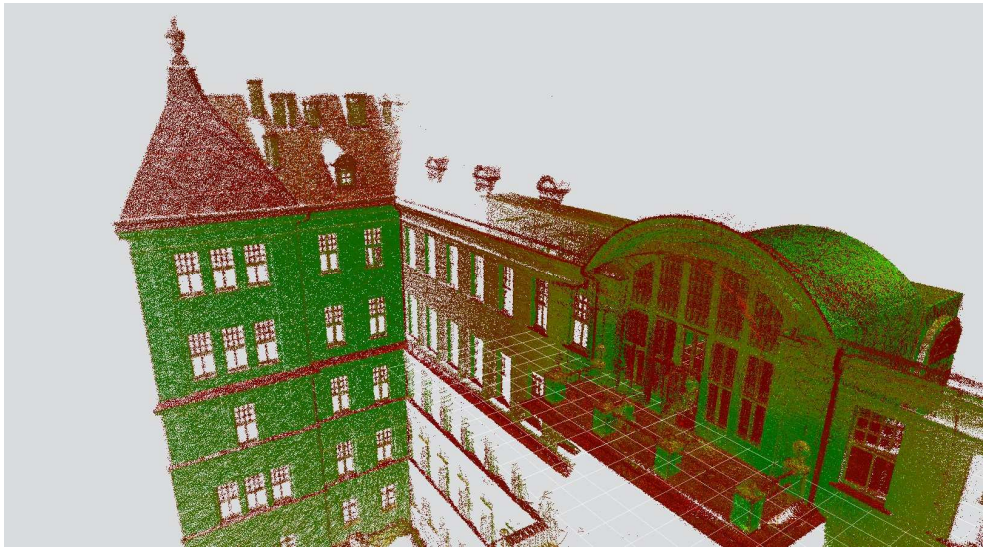

Fig. 3 Cloud points of the scanned terraces on Building Z (owner: FCE BUT).

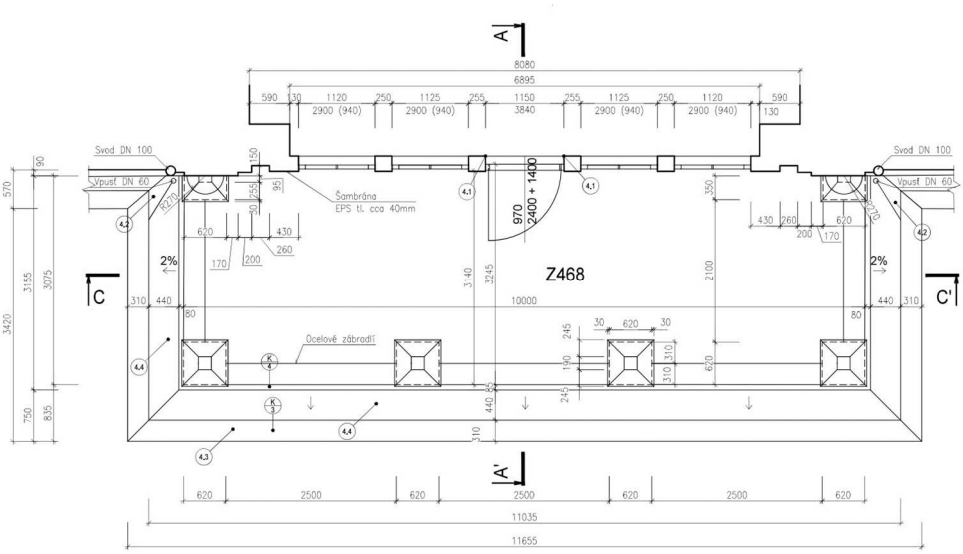

Fig. 4 Floor plan of the 4th-floor terrace (owner: FCE BUT).

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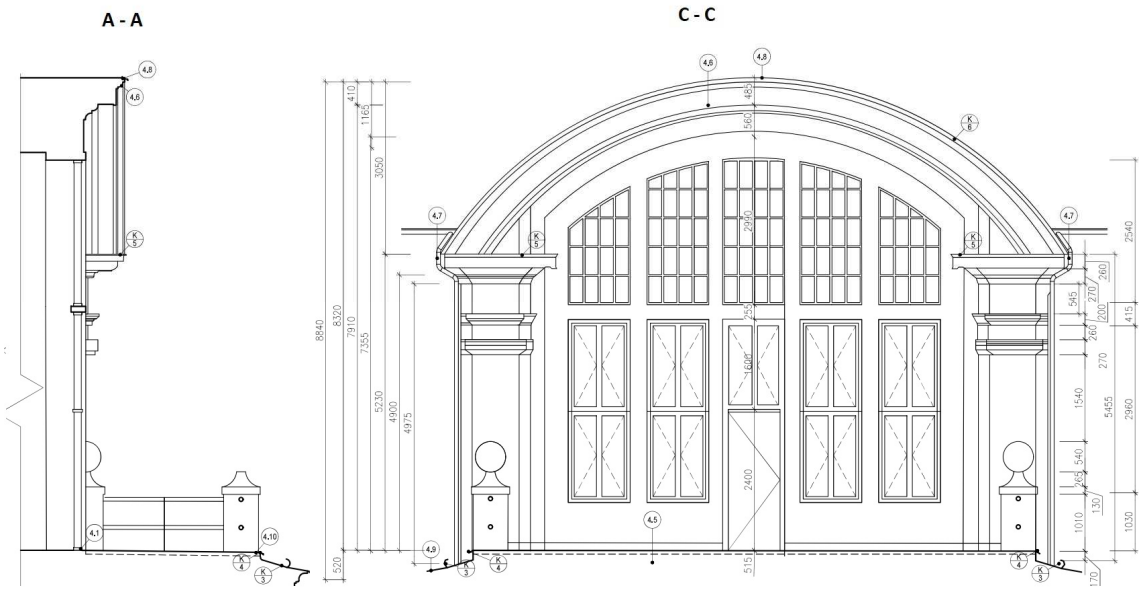

Fig. 5 Section of the 4th-floor terrace (owner: FCE BUT).

4 DISCUSSION

During the passportization process of the FCE BUT campus, arises the opportunity to transfer information into common mapping applications, such as ArcGIS, to create an interactive map with data utilization capabilities. For efficient building management, it is possible to integrate information from the passports and the visualization part from mapping applications into a CAFM (Computer-Aided Facility Management) system. This integration offers the maximum potential for cost reduction in building management and efficient allocation of financial resources when making optimal use of all available data. This theoretical concept is not limited to the FCE BUT campus alone but, most importantly, to the entire BUT campus, encompassing both real estate and movable assets of BUT.

5 CONCLUSION

Building passportization holds significant importance in construction and facility management. It serves as the cornerstone for the efficient and sustainable management of building structures throughout their lifecycle.

- Building passportization ensures that accurate and up-to-date information about a building is readily available. This information encompasses architectural, technical, and operational details, creating a comprehensive record of the structure.
- Furthermore, building passports are essential for regulatory compliance. They provide the necessary documentation for safety inspections, environmental audits, and adherence to building codes and standards. This compliance is vital not only for the well-being of occupants but includes avoiding potential legal and financial repercussions.
- Additionally, building passportization facilitates resource allocation. By having a clear understanding of a building's condition and requirements, organizations can effectively allocate financial and human resources. This optimization of resources is fundamental for budget management and ensures that funds are directed where they are needed most.
- Moreover, building passportization enables data integration, connecting it with modern technologies like BIM and GIS. This integration enhances the overall understanding and management of the building environment, contributing to better decision-making and improved building performance.

In conclusion, building passportization is a fundamental practice that empowers organizations to make informed, data-driven decisions. It enhances transparency, reduces operational costs, and supports long-term planning. As a result, it is pivotal in ensuring the functionality, sustainability, and quality of building structures in built environment.

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