Ph.D. Dissertation Booklet

BIM Adoption in Local-based Architecture and Engineering SMEs

Developing an Application-based Method to Pinpoint Objective BIM Uses and Align Them with Business Standards to Facilitate the Execution of BIM Projects in Prospective Architecture and Engineering SMEs

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1. Introduction

The research studies the adoption of Building Information Modeling (BIM) methodologies in the workflows of professional firms within the building industry. The Architecture, Engineering, Construction, and Operation (AECO) sector rapidly grows, and this growth is accompanied by plenty of technological developments on several levels to adapt with the market's trends, needs, and requirements. Integrating BIM in the delivery and operation phases of built assets is considered a priority for AECO firms seeking digital transformation and enhanced efficiency.

BIM can be simply described as the method of using digital model to fulfill defined objectives and tasks within building projects supported by the rapid technological development that allows the integration of different methods and tools to enhance the delivery and operation stages of built assets. In response to the increased demand and market trends toward digitization to improve outcomes and efficiency, this research is dedicated to study the adoption of BIM by focusing on the organization and digitization of information on the delivery firms' level, including Architecture and Engineering (AE) firms. The research targets the local Hungarian building industry, and specifically the Small and Medium-sized Enterprises (SMEs) that are based in the South Transdanubia (ST) region, as an attempt to assist domestic smaller-sized AE firms to overcome digitization difficulties and increase their productivity. Moreover, the research may be applicable for other national and international building industry firms that share the same challenges against the adoption of BIM processes.

Several primary and secondary motives shaped the framework of this research and its components. This document will highlight the research drivers, questions, scope, theses, results, summary, and scientific contributions, to provide a brief overview for the conducted research work that is associated with the submitted dissertation.

2. Research drivers

The research drivers for the conducted study include two main groups: primary and secondary. The primary drivers include research motives discovered at the very beginning of the research journey, during the initial stages of the study. On the other hand, secondary research drivers include research motives derived from later on conducted research stages during the progress of the research study. Primary drivers are considered the main boosters to initiate the study in this specific topic. Later on, secondary drivers appear by the development of the research and deriving initial results and conclusions. By the time the research work evolves, new secondary drivers are derived to point the research toward the right direction of accomplishing the overall objectives, and pave the way for proper research decision making, e.g., research domains, borders, baselines, target groups, etc.

Please note that the classification (primary and secondary) does not reflect the importance of the research drivers, both groups are alike in terms of importance level, this grouping classification only indicates the formulation time of these drivers whether it is during the initial stage or the later on development stages of the research work. Moreover, the secondary drivers do not interfere with primary drivers in principle, the secondary drivers complete the primary ones to form one set of coherent research drivers that will meet the defined research objectives. Hence, the reason that stands behind preventing the clear definition of secondary drivers at the initial stage of the research

is due to the difficulty to formulate these drivers without conclusions from a conducted scientific research effort.

2.1. Primary drivers

- Local-based observations regarding the dissatisfaction of employees at the building industry firms (especially employees from ST-based smaller-sized AE firms) including work operability, system processes, workflows, and coordination issues. Complaints arise from local AE professionals in connection with the lack of BIM-based processes in their conducted projects and dominance of traditional methods in daily practice. Moreover, practitioners reveal that lack of coordination between different project disciplines and their representatives results in increased challenge during the delivery of built assets.
- According to the country fact sheet published by the European Commission under the European Construction Sector Observatory in 2020 and 2021 for the Hungarian building industry, local Hungarian firms in the building industry face practical challenges to adopt BIM workflows, including business standards, standardization (of terms, methods, and interfaces), and data security. The report highlights that there are no set laws or binding obligations on public authorities for using BIM processes, so it is highly recommended for contracting authorities to impose BIM on tenderers, as an encouragement for local building industry firms to implement BIM-based processes and workflows.
- According to the country fact sheet published by the European Commission under the European Construction Sector Observatory in 2020 and 2021 for the Hungarian building industry, SMEs in the broad building industry (including building industry-related manufacturing, construction, real estate activities, and architectural/engineering activities) employed around 91.7% of the total number of people employed in the broad building industry, which is higher than the EU-27's average (87.1%) for 2018. This highlights the significance of SMEs in the Hungarian building industry.
- Severe shortage in local-based Hungarian studies and scientific contributions regarding BIM implementation in the building industry on the domestic level. This shortage is clear regarding published scientific contributions in English and Hungarian languages alike, about BIM adoption in domestic building industry firms.
- Lack of statistics regarding the allocation of local building industry firms based on their main activities (main function/scope) and size indicators.
- Lack of statistics regarding the allocation of local BIM-compliant firms within the building industry.
- Local-based observations show the misconception of BIM processes and workflows for many building industry professionals, this may lead to unrealistic claims in connection with BIM-compliance and implementation providing misleading metrics.

2.2. Secondary drivers

- Low values of Construction Production (CP) for the building industry firms based in the Hungarian ST region from 2016-2020 and compared to CP values for other small regions in the country and at the same period of time.
- The low values of CP for building industry firms located in the ST region are associated with severe lack in BIM-compliant firms that publicly share their BIM-based services (through business portfolios and references) in the region.
- There is significant dominance for AE firms within the studied region over other types of building industry firms. The dominance of AE (including architectural, structural/civil, and building services engineering) firms is based on the firms' count compared to other specialized building industry firms in the market.
- Size-related observations regarding the collected local-based building industry firms.

- Measuring BIM adoption and its barriers is considered the initial step for region-based BIM-related studies, despite the high dependency of BIM adoption barriers identification on the studied region or country, there is lack of Hungarian-based research regarding the barriers against BIM adoption in the local building industry.
- Defining key BIM adoption barriers by local AE firms assists to pinpoint the scope for the intended BIM adoption mission.
- Publishing the draft regulation (BIM-based planning and implementation) in 2024 by the Hungarian Ministry of Construction and Transport, the regulation sets conditions for adopting BIM to enhance public construction investments by providing high-quality, lifecycle-focused information models, to improve design, construction, and operation of built assets. The regulation technical aspects are derived from the ISO 19650 business processes, highlighting the potential of this standard series for domestic building industry firms that intend to take part in public or private BIM-based projects.
- The published draft regulation (BIM-based planning and implementation, 2024) by the Hungarian Ministry of Construction and Transport clearly states that the designer (architect or engineer) is the responsible party for developing the digital model. In addition, the regulation highlights the importance of BIM Uses identification in alignment with ISO 19650 business processes to ensure high level execution of BIM-based projects.
- Practice-based observations show the lack of common accurate BIM Use (BU) definition among the project's representatives from different disciplines and parties.
- Practice-based observations indicate the lack of a BUs definition method that systematically guides professionals who intend to carry out BIM-based projects and enables them to pinpoint specific BUs based on consistent step-by-step workflow that can be applicable for any appointment.

3. Research questions

- What is the study region? What is the reason behind nominating the selected study region?
- What is the allocation (discipline, count, and size) of building industry firms in the study region?
- What are the sizes of building industry firms in the study region? What is the market share of SMEs or smaller-sized firms from the total collected firms?
- According to the available collected and analyzed data, what are the potential building industry firms and their disciplines within the study region?
- Among the defined potential firms and their disciplines, what is the allocation of the firms that adopt BIM workflows in their practice?
- According to the potential firms, what are the key barriers against the implementation of BIM processes in their practice?
- What is the BIM adoption mission that intends to overcome defined key BIM barriers?
- What is the proposed method that corresponds with the BIM adoption mission to overcome its key barriers?
- How to validate the leverage of the proposed method with the BIM adoption mission to overcome related key barriers defined by the potential building industry firms?

4. Research scope

The overall objective of the research study is to assist BIM adoption in local-based prospective building industry SMEs. The study approaches the overall objective through several research steps, including selecting the study region, defining potential local-based building industry SMEs, investigating BIM adoption level and its key barriers at the potential SMEs, setting BIM adoption

mission to overcome key barriers, developing a method that corresponds to the mission, automating the developed method, and validating the leverage of the automated method to answer the BIM adoption mission and assist prospective building industry SMEs in BIM implementation.

- Define the potential of AE SMEs in the ST region, through:
  - Select study region.
  - Gather study region-based building industry firms and their related data.
  - Classify building industry firms based on business classes.
  - Size-based nomination of collected SMEs.
  - Define potential business classes among nominated SMEs.
- Define BIM adoption level and its key barriers in local AE SMEs:
  - Collect and analyze BIM barriers.
  - Structure and share surveys.
  - Define level of BIM adoption in local AE SMEs.
  - Define key adoption barriers in local AE SMEs.
  - Derive an objective BIM adoption mission based on the defined key barriers.
- Develop a method to answer the BIM adoption mission (BUs definition method aligned with business standards to facilitate BEP development by the management team):
  - Define academic component (academic comprehensive/particular sources and BUs definition roadmap).
  - Define practice component (infromation requirements, project phases/parties, and information delivery plan).
  - Align the components and introduce the method.
- Develop an application to automate the method and test its leverage for potential AE SMEs:
  - Introduce the significance of automation
  - Develop the application
  - Validate the application
  - Define the leverage of the developed application-based method

5. Thesis points

There are four thesis points that will be introduced, associated with the submitted dissertation. It is noteworthy to highlight the respective dependencies between the introduced thesis points, meaning that the research work associated with the later thesis points cannot be conducted without accomplishing the research work of the earlier thesis points and derive all of their results and conclusions that will assist in the development of the later upcoming theses. Hence, the arrangement of the thesis points follows the time sequence of the conducted research work during the study duration.

5.1. Thesis I

The research proves the high potential of *Architecture and Engineering (AE) Small and Medium-sized Enterprises (SMEs)* in the studied *South Transdanubia (ST)* region, with respect to the available primary indicators, and compared to other region-based building industry *SMEs.*

- I performed mass-filtering with 240 search attempts to collect region-based 169 building industry firms, of which 93% are considered *SMEs* according to an introduced size-based nomination method supported by a statistical measure of spread among the set of values for related size indicators.

- I compared all nominated *SME* building industry business classes based on the available primary indicators; the results prove the high potential of region-based *AE SMEs*, accounting for 62.8%, 38.4%, and 28.6%, including number of firms, number of employees, and net revenues, respectively.

5.2. Thesis II

The research confirms that the level of BIM adoption and its standards among local-based *Architecture Engineering (AE) Small and Medium-sized Enterprises (SMEs)* is lagging behind, due to the lack of methods and standards definitions.

- I performed systematic literature review, collected 270 barriers, analyzed the barriers by classifying and merging processes, and derived a list of 18 comprehensive barriers to be included in a twin survey round to define the adoption level and its key barriers.
- I revealed the low percentages of BIM-compliant *AE SMEs* on the domestic level accounting for 22% at the ideal scenarios in both survey rounds.
- I revealed the low percentages of ISO 19650 adoption at the BIM-compliant *AE SMEs* on the domestic level, accounting for 9% and 13% for the 1st and 2nd survey rounds, respectively, raising questions about the credibility of related BIM-compliancy claims.
- I proved that 47% of the adoption barriers are processes/uses and legal/management related, including six key barriers, which combined will formulate an objective BIM adoption mission, that aims to assist prospective *AE SMEs* in overcoming almost half of the critical challenge toward carrying out BIM-based projects.

5.3. Thesis III

The research develops a method to pinpoint specific objective *BIM Uses (BUs)* for BIM-based projects and align them with relevant practice details, to correspond with the intended objective BIM adoption mission.

- I performed an extensive review for related scientific references including 33 articles and 25 textbooks, then introduced a roadmap to define objective specific *BUs* from a collection of over 380 options, introducing the method's academic component.
- I derived essential practice business processes from *ISO 19650-1/2*, including practice *Information Requirements (IRs)* and *BIM Execution Plan (BEP)* details, and aligned them with the defined objective specific BUs, introducing the method's practice component.
- I introduced the method's cornerstone, represented by matching defined specific *BUs* from the academic component with their counterparts *IRs* from the practice component, and grouping them into sets based on their predecessors on the objective roadmap and supported by a developed code syntax for identification and classification purposes.

5.4. Thesis IV

The research confirms the potential of the introduced method to assist prospective *Architecture and Engineering (AE) Small and Medium-sized Enterprises (SMEs)* in overcoming key adoption barriers and carrying out BIM-based appointments.

- I developed a Windows-based application that automates the method of defining objective specific *BIM Uses (BUs)*, matching them with associated *Information Requirements (IRs)*, and aligning them with essential practice information, to produce a document that includes primary details to kick-off a BIM-based project and develop the *BIM Execution Plan (BEP)* by the management team.

- I validated the potential of the developed application through response rank analysis and comparative studies after performing another twin survey round with paired samples to the former conducted rounds.
- I proved that the developed application supports accomplishing the objective BIM adoption mission by assisting prospective *AE SMEs* in overcoming the defined key and other adoption barriers with a total of 62.94% and 12.56%, respectively.

6. Results

6.1. Thesis I

- Based on the analyzed data regarding construction outcomes for small regions in Hungary by the location of the building industry firms, the ST region has the lowest value of CP compared to other small regions in the country. The study presents the percentage of construction production of building industry enterprises based on the ST region and compares it with the percentages for other small regions in Hungary for five years (between 2016 and 2020). The results show that building industry companies in the ST region suffer from severe low values of CP (6%) compared to same value from the country's other small regions that reach up to 9%, 9%, 9%, 10%, 13%, 14%, and 30%, for Central Transdanubia, Western Transdanubia, Northern Hungary, Norther Great Plain, Pest, Southern Great Plain, and Budapest, respectively.
- Based on the introduced size-based nomination method, which is supported by a statistical measure of spread among the set of values for related size indicators, the research reveals that the majority of the collected building industry firms in the ST region are small size firms or SMEs accounting for 93% (158 firms) of the total collected 169 building industry firms. Including the following NACE (Statistical Classification of Economic Activities in the European Community) business classes: 25.11, 28.99, 35.30, 41.10, 41.20, 42.13, 42.21, 42.91, 43.21, 43.22, 43.34, 43.99, 45.21, 47.52, 68.10, 68.20, 68.31, 70.22, 71.11, 71.12, 74.90, and 80.20, representing the following main activities: manufacture of metal structures and parts of structures, manufacture of other special-purpose machinery, steam and air conditioning supply, development of building projects, constructions of residential and non-residential buildings, constructions of bridges and tunnels, construction of utility projects for fluids, construction of water projects, electrical installation, plumbing, heat, and air-conditioning installation, painting and glazing, other specialized construction activities, general construction of buildings and civil engineering works, retail sale of hardware, paints, and glass in specialized stores, buying and selling of own real estate, renting and operating of own or leased real estate, real estate agencies, business and other management consultancy activities, architectural activities, engineering activities and related technical consultancy, other professional, scientific, and technical activities, and security systems service activities, respectively.
- Based on the introduced size-based nomination method, which is supported by a statistical measure of spread among the set of values for related size indicators, the research reveals that minor group (13 firms) of the collected building industry firms in the ST region are considered large firms, accounting for 7% of the total collected 169 building industry firms, including the following NACE business classes: 16.22, 23.61, 25.21, 5x41.20, 2x42.21, 43.22, 71.11, and 71.12, that represent the following main activities: manufacture of assembled parquet floors, manufacture of concrete products for construction purposes, manufacture of central heating radiators and boilers, constructions of residential and non-residential buildings, construction of utility projects for fluids, and plumbing, heat, air-conditioning installation, architectural activities, and engineering activities and related technical consultancy, respectively.

- The research reveals the high potential firms from the defined target group small-size (SMEs) building industry firms. According to the results of the conducted comparison study between all target group firms and based on the values of their key indicators, the highest potential firms are AE firms with the following NACE business classes: 71.11 and 71.12, and main activities: architectural activities and engineering activities & related technical consultancies, respectively. The potential AE firms in the ST region account for 62.82%, 38.39%, and 28.57%, of the total share for the available main three indicators: number of firms, number of employees, and net revenue, respectively.

6.2. Thesis II

- The level of BIM adoption among local AE SMEs that are based in different Hungarian regions and surveyed according to a convenience sampling method is lagging behind the industry, the percentage of the firms that adopt BIM processes (minimum NBS BIM Level 02) is significantly low, accounting for 21.74% at the optimal case.
- The level of ISO 19650 standards adoption among local AE SMEs that are based in different Hungarian regions and surveyed according to a convenience sampling method is lagging behind the industry, the percentage of the firms that adopt ISO 19650 standards is significantly low, accounting for 9%.
- The level of BIM adoption among the potential AE SMEs that are based in the ST region and surveyed according to a purposive sampling method is lagging behind the industry, the percentage of the firms that adopt BIM processes (minimum NBS BIM Level 02) is considered low, accounting for 21.74% at the optimal case. and goes down to 13.04% at the inadequate case.
- The level of ISO 19650 standards adoption among the potential AE SMEs that are based in the ST region and surveyed according to a purposive sampling method is lagging behind the industry, the percentage of the firms that adopt ISO 19650 standards is considered low, accounting for 13.04%.
- The research reveals key BIM barriers for local AE SMEs based on scored relative weights derived from two survey rounds. Local AE professionals share similar concerns regarding BIM adoption barriers, which assist in developing a research mission to overcome defined key barriers.
- The research prioritizes BIM barriers based on their relevant weights according to local AE SMEs, it is concluded that processes, uses, legal, and management barriers account for the highest and almost double the priorities of other barriers. Followed by the business culture, client culture, knowledge, experience, policy, and time related BIM barriers with medium priority level compared to key barriers. Lastly, the low priority barriers include tools cost, expertise cost, return, benefit, ICT, and efficiency related barriers.
- The research formulates an objective BIM adoption mission, which is derived from key BIM barriers defined by local AE SMEs. The main intention of the mission is to develop a method for overcoming associated BIM barriers and assisting in BIM implementation at prospective AE SMEs, and other building industry firms with similar challenges.

6.3. Thesis III

- By studying and reviewing a collection of particular and comprehensive academic sources, the research derives an academic-based roadmap to pinpoint objective BUs on a multi-level functional-based manner, representing the academic component of the developed method.
- By studying and reviewing the ISO 19650-1/2 BIM-related standards, the research derives a set of practice potential points to be embedded in the practice component of the developed

method, including information requirements, phases, parties, and information delivery plan.

- The study connects the academic and practice components by matching BUs and IRs, and suggests a code syntax to classify and arrange defined specific BUs from the academic component with the corresponding IRs and their practice related details from the practice component.
- The research develops a methodology to pinpoint objective BUs for BIM-based projects aligned with business standards to facilitate the development of the BEP document by the management team. The method is based on developing a BUs' roadmap based on academic sources and aligning it with the BEP's essential details according to the practice business standards.

6.4. Thesis IV

- The research designs and develops a windows-based application that automates the previously introduced methodology. The application facilitates workability, applicability, and testability of the introduced method. The developed application reduces the complexity of the introduced method, enhances the user experience, and supports customizability to match the company's scope. The application intends to assist in overcoming key BIM barriers against the adoption of BIM workflows by prospective building industry firms.
- A convenience sample of local AE SMEs testified the high potential of the developed application to overcome defined key BIM barriers against the adoption of BIM workflows. By scoring high potential weights (> 0.0750) and increased difference ratios (based on paired comparison) that account for 18.269%, 21.198%, 7.658%, 26.421%, 19.484%, and 15.858%, representing the following key BIM barriers: B01 (lack of BIM adoption definition methods/workflows), B02 (lack of BIM Uses definitions and objectives), B03 (lack of BIM-based project parties' collaboration), B04 (undefined security, legal liability, and responsibility), B05 (management/contractual BIM processes, e.g., BEP), and B06 (undefined related business standards for BIM adoption), respectively.
- A purposive sample of local potential AE SMEs that are based in the ST region testified the high potential of the developed application to overcome defined key BIM barriers (B01-B06) and other barriers (B11 and B13) against the adoption of BIM workflows. By scoring high potential weights (> 0.0750) for key BIM barriers and relatively high potential weights (0.0500-0.0750) for the other two barriers. In addition, the research reports an increased difference ratios (based on paired comparison) accounting for 35.849%, 39.052%, 38.858%, 30.602%, 32.371%, 41.199%, 20.377%, and 12.364%, representing the following BIM barriers: B01 (lack of BIM adoption definition methods/workflows), B02 (lack of BIM Uses definitions and objectives), B03 (lack of BIM-based project parties' collaboration), B04 (undefined security, legal liability, and responsibility), B05 (management/contractual BIM processes, e.g., BEP), B06 (undefined related business standards for BIM adoption), B11 (industry resistance and difficulty to change processes), and B13 (lack of BIM knowledge, awareness, and research), respectively.
- Based on the results of the response rank analysis and comparative studies between the conducted paired samples survey rounds, the developed application supports accomplishing the objective BIM adoption mission by assisting prospective AE SMEs in overcoming the defined key (B01-B06) and other (B11 and B13) adoption barriers with a total potential of 62.94% and 12.56%, respectively.

7. Summary

The overall objective of the research is to support BIM adoption in prospective local building industry Small and Medium-sized Enterprises (SMEs). The research develops an application-based method that assists professionals to pinpoint required objective specific BIM Uses (BUs) and align them with business standards and BIM Execution Plan (BEP) details to facilitate carrying out and executing BIM-based projects. The method is developed based on an extensive review of academic and practice sources, and with respect to the aspects of an objective BIM adoption mission, which was derived based on the defined key BIM adoption barriers according to prospective local Architecture and Engineering (AE) SMEs, which suffer from low BIM adoption levels. Generally, the developed method and its associated application are targeting any building industry firm that intends to carry out BIM-based projects and suffer from similar key adoption challenges. But on a specific level, the developed method and its application are targeting prospective local-based AE SMEs, which have the highest potential among other collected and nominated building industry firms located within the South Transdanubia (ST) study region.

The research can be briefly summarized by four main milestones, including a) defining the study region and potential building industry SMEs, b) defining the BIM-adoption level and its key barriers for potential building SMEs, c) developing a methodology that intends to overcome defined key barriers and assist potential SMEs in BIM adoption, and d) automating the methodology by developing an application that facilitates the objective of the method and validates the leverage of the method to overcome key barriers by the same potential firms.

First, the research carefully selects the target study region and the building industry firms that are based within the borders of the region. Then, it collects and analyzes data for each included building industry firm, and it defines the target SMEs group by performing a size-based nomination supported by a statistical measure of spread among the set of values for related size indicators. Further, and based on a comparison between the available key indicators for all nominated building industry SMEs, the research defines the high potential of region-based *AE SMEs* that will take part in the upcoming research steps.

Second, the research collects and analyzes BIM adoption barriers, then it defines the level of BIM implementation and its key barriers for local AE SMEs, including the defined potential AE SMEs by performing two survey rounds. Then, the research merges the defined key BIM barriers and formulates a federated objective BIM adoption mission, which corresponds to overcome the referred key barriers and forms the base for upcoming research steps.

Third, the study breaks down the content of the objective BIM adoption mission and develops a methodology that corresponds to the mission's elements. The methodology has two main components, the academic and practice components. Each component is developed separately, then a linking point is introduced to connect both the academic and practice components. By aligning and connecting both components the research introduces a method to accurately define specific objective BUs and align them with business standards to facilitate the execution of BIM projects. At this stage of the research, and due to the intensity of the developed methodology, questions are raised regarding the applicability and testability of the method by the intended potential firms, leading to the main driver for the last step of this research work.

Fourth, the research automates the introduced method by developing a Windows-based application that corresponds with the academic and practice components of the method. The application facilitates the workability and testability of the introduced method by reducing the

complexity, enhancing the user experience, and supporting customizability to match the firm's scope. The research performs another two survey rounds with paired samples to the former conducted ones, the results of the response rank analysis and comparative studies between the survey rounds successfully confirm the high potential of the introduced application-based method to accomplish the objective BIM adoption mission and overcome key BIM barriers. Hence, the research can assist local-based prospective AE SMEs and other building industry firms with similar BIM adoption challenges to kick-off BIM-based projects and carry out BIM-based workflows.

8. List of publications

M. Altamimi, M.B. Zagorácz, and M. Halada, "Studying the behavior of the Hungarian construction market by analyzing and comparing the statistics of the sector", 17th Miklós Iványi International PhD & DLA Symposium, Pécs, Hungary, 2021.

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DOI: https://doi.org/10.1556/606.2022.00584

M. Altamimi, M.B. Zagorácz, "Functional Distribution of Architecture, Engineering, and Construction Firms in Southern Hungary", 1st Ybl Conference on the Built Environment, Budapest, Hungary, 2023.

M. Altamimi, M.B. Zagorácz, "Common BIM Uses: experience-based research", 8th International Academic Conference on Places and Technologies, Belgrade, Serbia, 2023.

O. Rák, M.B. Zagorácz, **M. Altamimi**, and V.N. Rácz, "Üzemeltetési célú BIM követelményrendszer kidolgozásának főbb lépései és kritériumai", Digitális-építőipar, Budapest, Hungary, 2023.

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M. Altamimi, M.B. Zagorácz, and M. Halada, "Common BIM Uses: Experience-Based Research", Chapter in the Book of Proceedings for the 8th International Academic Conference on Places and Technologies, Belgrade, Serbia, 2024.
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Book DOI: https://doi.org/10.18485/arh_pt.2024.8

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M. Altamimi, O. Rák, and M.B. Zagorácz, "BIM in Practice: Aligned with ISO 19650", 2nd Ybl Conference on the Built Environment, Budapest, Hungary, 2024.

M. Altamimi, V.N. Rácz, O. Rák, and M.B. Zagorácz, "Developing an Application to Assist Management Teams Identifying BIM Uses for BIM-based Appointments", 9th International Academic Conference on Places and Technologies, Pécs, Hungary

O. Rák, N. Bakai, and **M. Altamimi**, "Épületek külső sztereo-fotogrammetriai felmérésének pontosítására irányuló módszertani fejlesztés", Műszaki Tudományos Közlemények, 2024.
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