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DIGITAL PROJECT ARCHIVING: HISTORICAL DATABASE IN BIM

CYFROWA ARCHIWIZACJA PROJEKTU: HISTORYCZNA BAZA DANYCH W BIM

Abstract

This article presents the concept of building a digital archive of architectural knowledge by enriching BIM models with cost data. Revit models with economic parameters create a historical database documenting 21st-century building thinking. The study demonstrated the accuracy of automatic quantity takeoffs and the diagnostic function of the process. The created archive can serve future architectural historians, conservators, and spatial culture researchers.

Keywords: BIM, cost estimation, digital archiving, digital twin, Revit

Streszczenie

Artykuł przedstawia koncepcję budowania cyfrowego archiwum wiedzy architektonicznej poprzez wzbogacanie modeli BIM o dane kosztowe. Modele Revit z parametrami ekonomicznymi tworzą historyczną bazę danych dokumentującą sposób myślenia o budowaniu w XXI w. Badanie wykazało dokładność automatycznych przedmiarów oraz funkcję diagnostyczną procesu. Utworzone archiwum może służyć przyszłym historykom architektury, konserwatorom i badaczom kultury przestrzeni.

Słowa kluczowe: BIM, kosztorysowanie, cyfrowa archiwizacja, cyfrowy bliźniak, Revit

1. INTRODUCTION – BETWEEN THE PRESENT AND MEMORY

Architecture, though material by nature and embedded in space, is also a phenomenon permanently linked to memory, knowledge, and values. Traditional design documentation – drawings, descriptions, sketches – has for years constituted the foundation for understanding the past and architectural heritage. Today, this role is being taken over by digital models based on BIM methodology. These can become archives of design knowledge that not only support investment processes but also document ways of thinking about space, technology, and building economics.

This study attempts to utilize an existing architectural model in the Revit environment as a basis for creating cost estimates and reflecting on how such activities can serve future research and education. The work combines a practical approach (creating schedules and cost analyses) with a broader perspective – thinking about the future of architecture as digital history.

The multi-family building model was developed using layered modeling methodology, which enabled precise generation of quantities for each structural element. All architectural components – foundations, walls, floors, columns, beams, roofs, and finishes – were created as separate structural layers with individually defined material parameters. Each layer received detailed material specifications, including concrete type (e.g., C30/37), reinforcement steel class, and types of finishing materials.

Long-term storage and archiving of digital data requires the application of appropriate technological solutions. For BIM model management, industry platforms such as Autodesk Construction Cloud can be utilized, offering a comprehensive environment for storing Revit models with full version history and design metadata. An alternative is the Bentley ProjectWise platform, which provides advanced capabilities for archiving engineering data with semantic resource organization functions. Institutional repositories, such as DSpace or Fedora, guarantee the long-term storage of research data in accordance with OAIS (Open Archival Information System) standards. Platforms supporting digital twin technologies, such as Azure Digital Twins, AWS IoT TwinMaker, or Autodesk Tandem, play a particular role. These solutions enable the connection of BIM models with operational building data, creating digital copies of objects with continuous information streams about their functioning.

Emerging Building Information Modelling (BIM) can exploit standard measurement methods to automate cost estimation process and improve inaccuracies. Structuring standard measurement methods in an ontologically and machine readable format for a BIM software can greatly facilitate the process of improving inaccuracies in cost estimation.¹

Such an approach goes beyond traditional design documentation, enabling dynamic monitoring and analysis of the entire object lifecycle, which represents a new level of architectural knowledge archiving.

2. COST ESTIMATE AS SPATIAL INTERPRETATION – WORKING WITH DATA

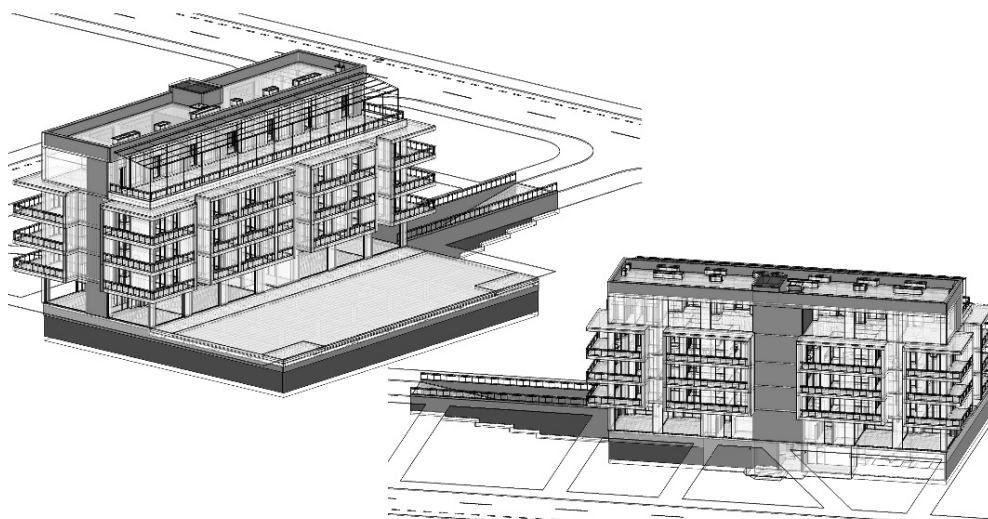
The architectural model that was the subject of analysis contained a comprehensive set of parametric data that could be automatically utilized as a basic information structure for

¹ F.H. Abanda, B. Kamsu-Foguem, J.H.M. Tah, *BIM – New Rules of Measurement Ontology for Construction Cost Estimation*, “Engineering Science and Technology” 2017, no. 2, p. 443, <https://www.sciencedirect.com/science/article/pii/S2215098616309156> (access: 8.10.2025).

developing a preliminary cost estimate. “BIM has made it possible to represent the architecture of a building in a completely new way, but it has also necessitated the invention of new processes that have changed the way architecture is created.”² The Revit environment, functioning as a BIM technology application, enabled data extraction through mechanisms for automatic generation of material schedules and structural element specifications. The parameters implemented in the model encompassed a set of information that could be classified according to the following data categories:

- volumes and areas of materials (e.g., concrete, insulation, plasters),
- element locations (division by floors: basement, ground floor, upper floor),
- types and classifications of objects (walls, floors, roofs, etc.),
- layer thicknesses, finish types, and types of materials used.

The obtained parametric data constituted a fundamental information base for further analyses; however, their scope proved insufficient for developing a comprehensive cost estimate compliant with industry standards.



Wall quantity takeoff - construction materials									
Material	Volume	Surface area	Steel price per 1kg (PLN)	Steel quantity per 1m³ (kg)	Total steel cost (PLN)	Price per 1m³ of concrete (PLN)	Total concrete cost (PLN)	Reinforcement labor per 1m³ (PLN)	Total labor cost (PLN)
Concrete C30/37	217,67 m³	1088,75 m²	5,00 PLN	100	108 832,60 PLN	400,00 PLN	87 066,08 PLN	224,00 PLN	48 757,00 PLN
Concrete W8	137,13 m³	685,63 m²	5,00 PLN	100	68 562,72 PLN	490,00 PLN	67 191,46 PLN	224,00 PLN	30 716,10 PLN
Total	354,79 m³	1774,38 m²			177 395,32 PLN		154 257,55 PLN		79 473,10 PLN

III. 1. Zuzanna Wątróbska, *Wall quantity takeoff – construction materials*, 2025, source: authors' elaboration in Revit

² A.S. Borkowski, *Evolution of BIM: Epistemology, genesis and division into periods*, “Journal of Information Technology in Construction” 2023, vol. 28, p. 648, <https://www.itcon.org/paper/2023/34> (access: 8.10.2025).

2.1. DATA SUPPLEMENTATION – FROM MATERIALS TO LABOR

To develop a preliminary cost estimate, it proved necessary to manually enrich the model's data structure with additional economic and organizational parameters. This data should be sourced from reliable statistical and industry sources, such as publications from the Central Statistical Office (GUS), which regularly publishes indicators for construction and assembly work costs, construction material prices, and data on wages in the construction industry. Additionally, industry price lists such as KNR (Catalog of Material Resources) and Intercenbud constitute current sources of time and cost standards for individual types of construction work. This process required the implementation of a series of cost variables that were integrated with the existing parametric database of the BIM model or directly introduced into the generated quantity schedules. The scope of supplemented data encompassed the following information categories:

- unit economic values of construction materials, developed based on comparative analysis of publicly available industry price lists and current market rates,
- organizational parameters of execution processes, including standardized labor rates and time consumption indicators for the implementation of individual structural and finishing elements,
- human and time resources, determining the number of work hours and required personnel inputs necessary to execute specific categories of construction work.

The integration of the above parameters with the original data structure of the model enabled the generation of comprehensive cost estimate schedules characterized by greater prognostic accuracy. The resulting calculations encompassed both direct material costs and estimated financial inputs related to the implementation of work processes, thereby creating a more adequate representation of actual investment costs.

2.2. COST ESTIMATE AS A PROJECT CONTROL TOOL

The cost estimation process also served a diagnostic function, enabling the identification and categorization of structural errors occurring in the BIM model. “Model-based cost estimating became possible after the implementation of object-based parametric modeling in the building-modeling software. BIM-enabling software programs use parameters and rules to determine the geometry, as well as non-geometric properties and features of objects.”¹ This analysis revealed the presence of the following categories of irregularities:

- errors in object classification, consisting of unassigned categories to some model elements, which resulted in their exclusion from automatic quantity schedules,
- element duplication, including duplicates of structural elements (e.g., overlapping walls), which led to erroneous material quantity calculations and cost overestimation,
- geometric inconsistencies, manifesting as errors in spatial representation of objects, which caused incorrect calculations of volumes and areas.

¹ D. Forgues et al., *Rethinking the cost estimating process through 5D BIM. A case study* [in:] Cai H. et al (eds), *Construction Research Congress 2012*, American Society of Civil Engineers, Reston 2012, p. 779, https://www.researchgate.net/publication/268589485_Rethinking_the_Cost_Estimating_Process_through_5D_BIM_A_Case_Study (access: 8.10.2025).

Cost estimation generated from the BIM model also enables analysis of the economic efficiency of design solutions at the conceptual stage.

Theoretically, all the information can be shared directly among different phases with the support of open data exchange standards for BIM, such as the Industry Foundation Classes (IFC) standard. Thus, information contained in the BIM-based design model can be shared directly for cost estimation for tendering of building projects (TBP), which can reduce the heavy human workload and manual errors in traditional work.²

Identification of non-optimal design decisions may include the following categories:

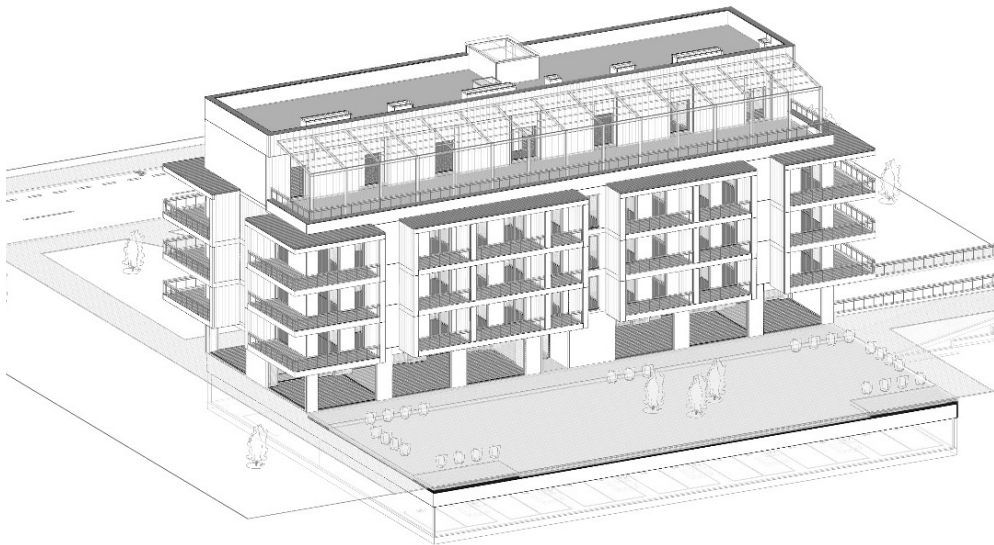
- inadequate finishes relative to room functions, such as the use of expensive materials in circulation spaces (corridors) or overly delicate finishes in intensively used rooms,
- excessive glazing proportion in the facade, which generates increased heat losses in winter and overheating in summer, leading to higher operating costs for heating and cooling systems,
- excessive quantity of elements requiring intensive maintenance, such as glass balustrades or handrails, which increase building maintenance costs,
- irrational volumetric proportions, manifesting in excessive height of residential rooms, which increases heating and ventilation costs,
- complex structural solutions requiring specialized technologies and materials, which could be replaced with simpler and more economical alternatives without loss of functionality.

Detected errors can directly impact the accuracy of investment cost estimation and lead to discrepancies between planned and actual financial inputs. Their identification indicates that cost estimation in the BIM environment extends beyond standard quantity calculations, simultaneously constituting a method for verifying model correctness and controlling its consistency. In this way, the cost estimation process serves a dual function – it serves not only to estimate costs but also to detect modeling errors at the design stage, which allow for early correction of documentation and reduction of investment financial risk.

In the early stages it provides the base for a preliminary cost estimate for the project; in the tendering stage it is used to assist in the estimation of the project's cost and duration of the construction activities; before the construction stage it is used to forecast and plan the construction activities; and during the construction stage it is used for the economic control of the project. An accurate quantity takeoff is decisive for the economic balance of the contractor's finances as it is the only way of achieving a thorough analysis of the productivity and of the different types of costs in a particular project.³

² Z. Ma, Z. Wei, X. Zhang, *Semi-automatic and specification-compliant cost estimation for tendering of building projects based on IFC data of design model*, "Automation in Construction" 2013, vol. 30, p. 126, <https://www.sciencedirect.com/science/article/abs/pii/S0926580512002154> (access: 8.10.2025).

³ A. Monteiro, J. Poças Martins, *A survey on modeling guidelines for quantity takeoff-oriented BIM-based design*, "Automation in Construction" 2013, vol. 35, p. 238, <https://www.sciencedirect.com/science/article/abs/pii/S0926580513000721> (access: 8.10.2025).



Installation location	Material	Thickness [cm]	Surface area [m ²]	Unit cost per m ² [PLN]	Labor hour [PLN]	Hours per m ² of insulation [hrs]	Total labor hours [hrs]	Number of workers	Cost per worker [PLN]	Finishing cost - Material [PLN]	Cost for all workers [PLN]	Total price [PLN]
Elevator shaft soffits	XPS polystyrene	5	134,68 m ²	28,00 PLN	38,00 PLN	0,09	11,99	2	227,75 PLN	3 771,11 PLN	455,50 PLN	4 226,61 PLN
Loggia floor	XPS polystyrene	5	575,83 m ²	28,00 PLN	38,00 PLN	0,09	51,23	5	389,49 PLN	16 123,38 PLN	1 947,47 PLN	18 070,85 PLN
External garage floor	XPS polystyrene	10	626,81 m ²	56,00 PLN	38,00 PLN	0,09	55,79	5	423,98 PLN	35 101,41 PLN	2 119,88 PLN	37 221,31 PLN
External garage floor	XPS polystyrene	20	177,24 m ²	112,00 PLN	38,00 PLN	0,09	15,77	2	299,71 PLN	19 850,72 PLN	599,42 PLN	20 450,15 PLN
Roof floor	XPS polystyrene	25	578,21 m ²	140,00 PLN	38,00 PLN	0,09	51,46	5	391,10 PLN	80 949,76 PLN	1 955,51 PLN	82 905,28 PLN
Subtotal			2092,78 m ²				186,26		1 732,03 PLN	155 796,42 PLN	7 077,78 PLN	162 874,20 PLN
Internal floor	Acoustic polystyrene	5	2521,46 m ²	52,00 PLN	38,00 PLN	0,09	224,41	10	852,76 PLN	131 116,14 PLN	8 527,59 PLN	139 643,75 PLN
Subtotal			2521,46 m ²				224,41		852,76 PLN	131 116,14 PLN	8 527,59 PLN	139 643,75 PLN
Internal stair landing	Mineral wool	3	70,63 m ²	20,00 PLN	40,00 PLN	0,07	4,87	1	194,94 PLN	1 412,59 PLN	194,94 PLN	1 607,52 PLN
Attic wall	Mineral wool	5	76,47 m ²	24,00 PLN	40,00 PLN	0,07	5,28	1	211,06 PLN	1 835,28 PLN	211,06 PLN	2 046,34 PLN
Floor above loggia	Mineral wool	12	217,52 m ²	62,00 PLN	40,00 PLN	0,07	15,01	3	200,12 PLN	13 486,46 PLN	600,37 PLN	14 086,83 PLN
Loggia floor	Mineral wool	20	769,47 m ²	112,00 PLN	40,00 PLN	0,07	53,09	8	265,47 PLN	86 180,08 PLN	2 123,72 PLN	88 303,80 PLN
Subtotal			1134,09 m ²				78,25		871,58 PLN	102 914,41 PLN	3 130,08 PLN	106 044,49 PLN
Internal garage floor	Rock wool	12	600,67 m ²	62,00 PLN	40,00 PLN	0,07	41,45	5	331,57 PLN	37 241,60 PLN	1 657,85 PLN	38 899,45 PLN
Subtotal			600,67 m ²				41,45		331,57 PLN	37 241,60 PLN	1 657,85 PLN	38 899,45 PLN
Total			6349,00 m ²				530,37		3 787,94 PLN	427 068,57 PLN	20 393,31 PLN	447 461,88 PLN

III. 2. Sylwia Nykaza, *Floors insulation quantity takeoff*, 2025, source: authors' elaboration in Revit

3. COMPARISON AND ANALYSIS – BETWEEN PROFESSIONALISM AND EDUCATION

To verify the accuracy of the developed cost estimate, a comparative analysis was conducted with an analogous document prepared in the Norma Expert Pro software. This comparison aimed to assess the reliability of results obtained from the BIM model and identify potential discrepancies resulting from methodological differences between platforms. “The main activities in this phase include collecting cost information (for instance, published unit rates or historical cost data), estimation of construction costs based on relevant regulations and methodology, gathering cost information and optimization of the estimate.”¹

¹ E. Plebankiewicz, K. Zima, M. Skibniewski, *Analysis of the first Polish BIM-based cost estimation application*, “Procedia Engineering” 2015, vol. 123, p. 408, <https://www.sciencedirect.com/science/article/pii/S1877705815031653> (access: 8.10.2025).

Norma Expert Pro constitutes a professional cost estimation tool based on current Polish industry standards, enabling the creation of cost estimates compliant with the requirements of the Public Procurement Law. The system operates on the KNR (Catalog of Material Resources) and Intercentbud price databases, which are systematically updated and reflect current prices of materials, labor, and equipment in the Polish construction market. The program automatically calculates direct costs (materials, labor, equipment) and indirect costs (general construction costs, contractor's profit), generating comprehensive cost estimate schedules with division by trades and work categories. BIM Level of Development directly impacts the accuracy of cost estimation in public procurement processes. "Depending on the project phase, different levels of model detail are distinguished, defined as the level of graphical detail of the model – Level of Detail (LOD) and the level of non-graphical information of the model – Level of Information (LOI)."²

The accuracy of Norma Expert Pro in standard applications ranges between 5–10% relative to actual implementation costs, making it a reliable tool for precise financial planning of investments. For example, for the multi-family building analyzed in the study, the program generated a total cost of PLN 1,948,267.03 for floor elements, while the Revit model showed PLN 1,689,133.61, representing a difference of 15.3%. This discrepancy primarily resulted from Norma Expert Pro's automatic inclusion of labor costs amounting to PLN 568,010.25, which the BIM model did not contain. In the case of structural materials, the differences were significantly smaller – Revit: PLN 968,319.00 versus Norma Expert Pro: PLN 982,924.77 (1.5% difference), which confirms the high accuracy of automatic quantity takeoffs generated from the BIM model, however, indicates the necessity of supplementing them with organizational and economic parameters to obtain a comprehensive investment cost estimate. "Digital information becomes increasingly pervasive with such widespread, cost-effective, availability of powerful computational devices in project delivery."³

4. DIGITAL HERITAGE – COST ESTIMATE AS A RECORD OF AN ERA

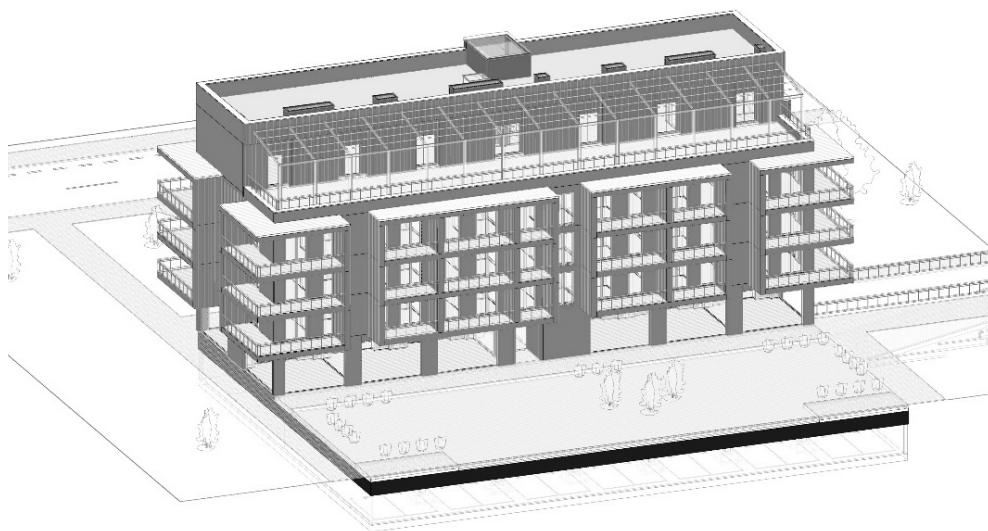
Thanks to its structure, the Revit model – enriched with cost data – can become a document of an era, a digital equivalent of historical architectural projects that have survived in paper form. Just as historical architectural drawings today constitute a source of knowledge about construction technologies, materials, and the aesthetics of past eras, contemporary BIM models contain comprehensive information about current design methods, available construction technologies, material prices, and economic assumptions accompanying the investment process. This digitized data may in the future serve not only practitioners – architects, engineers, or investors – but also representatives of the humanities: architectural historians studying the evolution of design thinking, heritage conservators analyzing 21st-century construction technologies, or spatial culture researchers exploring relationships between economics and the shaping of the built environment.

² A. Juszczak, *BIM in the construction process – selected problems at the stage of implementation in Polish road engineering*, "Archives of Civil Engineering" 2022, no. 1, p. 627, <https://ace.il.pw.edu.pl/pdf-141981-106330?filename=BIM%20in%20the%20construction.pdf> (access: 8.10.2025).

³ J. Whyte, *How Digital Information Transforms Project Delivery Models*, "Project Management Journal" 2018, no. 2 p. 2, https://www.researchgate.net/publication/327273172_How_Digital_Information_Transforms_Project_Delivery_Models (access: 8.10.2025).

In this context, the cost estimate ceases to be merely an investment valuation tool, and assumes the role of a testimony to a way of thinking about the building process characteristic of a specific historical moment. The data contained within it reflect not only technical and financial aspects but also social priorities, quality of life standards, and value hierarchies influencing design decisions. The ability to read and interpret the complex values of space – encompassing aesthetic, economic, social, and environmental dimensions – currently constitutes one of the fundamental elements of architectural education, preparing future designers for conscious decision-making in the process of creating the built environment.

A key aspect of long-term digital archiving is ensuring data durability and interoperability. In the context of BIM models enriched with cost data, the IFC (Industry Foundation Classes) format, which constitutes an open, international standard for building data exchange, gains particular significance.



Wall insulation quantity takeoff												
Installation location	Material Name	Thickness [cm]	Surface area [m²]	Unit cost per m² [PLN]	Labor hour [PLN]	Hours per m² of insulation [hrs]	Total labor hours [hrs]	Number of workers	Cost per worker [PLN]	Material finishing cost [PLN]	Labor cost [PLN]	Total price [PLN]
Chimney	XPS polystyrene	5	12 m²	28,00 PLN	38,00 PLN	0,3	3,66	1	139,15 PLN	346,40 PLN	139,15 PLN	485,56 PLN
Chimney	XPS polystyrene	10	70 m²	56,00 PLN	38,00 PLN	0,3	20,83	1	791,51 PLN	3 940,66 PLN	791,51 PLN	4 732,17 PLN
External garage wall	XPS polystyrene	5	157 m²	28,00 PLN	38,00 PLN	0,3	46,36	2	880,93 PLN	4 385,84 PLN	1 761,86 PLN	6 147,70 PLN
External garage wall	XPS polystyrene	10	81 m²	56,00 PLN	38,00 PLN	0,3	23,95	1	909,95 PLN	4 530,35 PLN	909,95 PLN	5 440,31 PLN
Subtotal			320 m²				94,8		2 721,55 PLN	13 203,26 PLN	3 602,48 PLN	16 805,74 PLN
Internal wall	Mineral wool	3	301 m²	9,00 PLN	40,00 PLN	0,16	47,02	3	626,90 PLN	2 712,56 PLN	1 890,71 PLN	4 593,27 PLN
Internal wall	Mineral wool	10	88 m²	56,00 PLN	40,00 PLN	0,16	13,66	1	546,52 PLN	4 904,64 PLN	546,52 PLN	5 451,15 PLN
External wall	Mineral wool	15	2558 m²	70,00 PLN	40,00 PLN	0,16	399,07	10	1 596,76 PLN	179 067,74 PLN	15 967,61 PLN	195 030,35 PLN
Subtotal			2947 m²				459,75		2 769,68 PLN	186 684,94 PLN	18 389,84 PLN	205 074,78 PLN
Internal garage wall	Mineral wool	12	277 m²	62,00 PLN	40,00 PLN	0,16	43,27	3	576,95 PLN	17 197,69 PLN	1 730,86 PLN	18 928,55 PLN
Subtotal			277 m²				43,27		576,95 PLN	17 197,69 PLN	1 730,86 PLN	18 928,55 PLN
Total			3545 m²				597,82		6 068,18 PLN	217 085,89 PLN	23 723,18 PLN	240 809,07 PLN

III. 3. Sylwia Nykaza, *Walls insulation quantity takeoff*, 2025, source: authors' elaboration in Revit

4.1. IFC AS A LONG-TERM ARCHIVING FORMAT

The IFC format, developed by buildingSMART International, offers a neutral platform for storing information about building objects regardless of the source software. Unlike native formats (such as .rvt files in Revit), which are dependent on specific software vendors, the IFC format ensures data accessibility for decades, independent of the technological evolution of individual CAD/BIM platforms.

Exporting Revit models enriched with cost data to the IFC4 format enables the preservation of not only object geometry but also their economic parameters through the Custom Property Sets mechanism. Cost data can be stored as:

- material properties (IfcMaterial) containing unit prices of raw materials,
- structural element properties (IfcBuildingElement) with assigned execution costs,
- design property sets (IfcPropertySet) grouping economic parameters by work categories.

4.2. METADATA AND SEMANTICS OF COSTS IN IFC

The IFC structure allows for semantic description of relationships between structural elements and their economic characteristics. Each building object can contain a hierarchy of cost information:

- basic material cost,
- labor cost related to assembly,
- operational cost during the element's lifecycle,
- dismantling and disposal cost.

Such data organization enables future researchers not only to read cost values characteristic of a given historical period but also to understand the methodology of their calculation and the hierarchy of economic values assigned to individual categories of construction work.

4.3. ARCHIVAL IFC REPOSITORIES

For long-term storage of IFC models with cost data, the infrastructure of institutional repositories based on OAIS (Open Archival Information System) standards can be utilized. Platforms such as DSpace or Fedora, enhanced with specialized plugins supporting the IFC format, can form the basis of national archives of digital architectural heritage. Repositories of the BIM Server type, which not only store IFC files but also enable their viewing and analysis using web browsers, present particular value. Examples of such solutions include the BIMcollab or Dalux platforms, which allow access to archived models without the need to install specialized CAD software. In this way, the IFC format becomes not only a tool for data exchange between different BIM platforms but also a medium for long-term archiving of knowledge about the ways of thinking about building economics characteristic of the early 21st century. Models archived in this manner may in the future serve as a data source for historical-economic research on the evolution of construction costs, changes in material value hierarchies, and transformations in approaches to economic optimization of architectural projects.

5. CONCLUSIONS – BETWEEN EDUCATION AND THE FUTURE

The conducted study demonstrated that the use of BIM models in the Revit environment for creating cost estimates constitutes a promising method for integrating design processes with economic analysis. Working with cost data in BIM technology can serve a dual role: as an analytical tool supporting professional design practice and as an educational instrument enabling students to comprehensively understand the complexity of construction processes.

Key research achievements – The analysis showed that automatic quantity takeoff generation from the BIM model ensures high accuracy in terms of material quantities, which is confirmed by minimal differences (1.5%) between Revit results and the Norma Expert Pro program for structural materials. Simultaneously, the main limitation of this method was identified – the necessity of manually supplementing data with organizational and economic parameters, which constitutes a significant element in the process of creating a comprehensive cost estimate.

The cost estimation process in the BIM environment extended beyond standard quantity calculations, serving a diagnostic function for the model. The identification of structural errors (incorrect object classification, element duplication, geometric inconsistencies) and analysis of economic efficiency of design solutions (inadequate finishes, excessive glazing proportion, complex structural solutions) confirmed the value of this method as a project quality control tool.

Implications for architectural practice – The study results indicate the potential of BIM models enriched with cost data as a tool supporting informed design decision-making at the early conceptual stage. The ability to immediately verify the economic viability of design variants can significantly impact the optimization of architectural solutions in terms of building lifecycle costs.

Educational significance – In the context of architectural education, the presented methodology enables students to take a holistic approach to design, combining aesthetic, functional, and economic aspects. This allows for the development of competencies in conscious design decision-making while considering real financial and organizational constraints.

Digital archiving perspectives – BIM models enriched with cost data can become documents of an era, digital equivalents of historical architectural projects.

In order to perform a comprehensive audit on existing buildings, the mentioned data capturing techniques might be combined with other methods of non-destructive testing to analyze materials and properties. Possible methods could include material- or texture-based recognition and structure recognition beyond surface through ground penetrating radars, radiography, magnetic particle inspection, sonars or electro-magnetic waves or tags installed during retrofits.¹

¹ R. Volk, J. Stengel, F. Schultmann, *Building Information Modeling (BIM) for existing buildings – Literature review and future needs*, “Automation in Construction” 2014, vol. 38, p. 120, <https://www.sciencedirect.com/science/article/abs/pii/S092658051300191X> (access: 8.10.2025).

The information contained within them about technologies, materials, prices, and economic assumptions may in the future serve not only practitioners but also architectural historians, heritage conservators, and spatial culture researchers, documenting the way of thinking about the building process characteristic of the 21st century.

Recommendations for further research – Future research should focus on:

- automation of the cost data supplementation process from external databases (GUS, KNR, Interbud)
- development of metadata standards for long-term archiving of BIM models
- integration of digital twin technologies with cost estimation processes
- studying the impact of different modeling methodologies on cost estimation accuracy

The presented study fits into the broader current of thinking about the future of architecture as a field that not only designs space but also creates digital building history. BIM technology, by integrating design processes with economic analysis, opens new possibilities for conscious shaping of the built environment while considering its financial, social, and cultural complexity.

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