Volume 3, Issue 1

January - April

Year 2019

ISSN 2530-8157

Building & Management http://www.polired.upm.es/index.php/Building & Management

Sławomir Wojtkiewicz and Damian Citko, "The use of BIM technology in spatial economy on the example of multi-family building project at Czestochowska street in Bialystok ". Building & Management, vol. 3(1), pp. 59-68, 2019

http://dx.doi.org/10.20868/bma.2019.1.3877

paper BM_19_07_05 received 25/11/2018 revised 10/03/2019 accepted 26/03/2019

GESTION EN EDIFICACION B&M BUILDING & MANAGEMENT

Escuela Técnica Superior de Edificación
Universidad Politécnica de Madrid

The use of BIM technology in spatial economy on the example of multi-family building project at Czestochowska street in Bialystok

El uso de la tecnología BIM en la economía espacial en el ejemplo de proyecto de construcción multifamiliar en la calle Czestochowska en Bialystok

Sławomir Wojtkiewicz
Faculty of Civil and Environmental Engineering, Bialystok University of Technology. s.wojtkiewicz@pb.edu.pl

Damian Citko
Faculty of Civil and Environmental Engineering, Bialystok University of Technology. damian.citko@gmail.com

The aim of the work is to show the use of BIM in a spatial economy. It will be achieved by carrying out research experience, which involves creation of the concept of functional and spatial architectural design of multi-family building at Czestochowska Street in Bialystok, Poland. The research experiment is carried out with: design intent - which contains: a function of building and its urban context, aesthetics of object, factor 4D and 5D in accordance with the methodology of BIM; evaluation of "existence" of building on today's market development, and number of factors about architecture and spatial economy; In conclusion, the authors described the potential use of BIM technology in one of the areas of spatial economy, which has the greatest influence in the life cycle of buildings - building management. This area is based on close cooperation between specialists in this field with specialists from other fields of AEC industry, and relationships online specialist-client. BIM technology meets the abovementioned factors because BIM software creates the possibility to realize attractive 3D presentation of building, which may increase the chance to sell presented "product"; BIM improves standard methods of presentation, enriching them with the possibility of detailed fit and conclusion of specific contents into individual customer needs and expectations; use of BIM does not require from specialist spend an inordinate amount of time to achieve satisfactory results, due to focusing in one database, which contain different data about building; BIM allows all participants, involved in the life cycle of the building, to work on one BIM model, which can be exported and imported in IFC format; BIM technology is based on cooperation between individual AEC industries, and its spectrum is so vast, that it is a universal tool to solve any issues and problems related to the life cycle of the building.

BIM; Arquitectural design

El objetivo del trabajo es mostrar el uso de BIM en la economía espacial. Se logrará mediante la realización de una experiencia de investigación, que implica la creación del concepto de diseño arquitectónico funcional y espacial del edificio multifamiliar en la calle Częstochowska en Białystok. El experimento de investigación se lleva a cabo con: intención de diseño - que contiene: función del edificio y su contexto urbano, estética del objeto, factor 4D y 5D de acuerdo con la metodología de BIM; evaluación de la "existencia" de construir sobre el desarrollo del mercado actual, y varios factores sobre la arquitectura y la economía espacial; En conclusión, los autores describieron el uso potencial de la tecnología BIM en una de las áreas de economía espacial, que tiene la mayor influencia en el ciclo de vida de los edificios: la administración de edificios. Esta área se basa en una estrecha cooperación entre especialistas en este campo con especialistas de otros campos de la industria de AEC y relaciones en línea con especialistas-clientes. La tecnología BIM cumple con los factores mencionados anteriormente porque: el software BIM crea la posibilidad de realizar una presentación 3D atractiva del edificio, lo que puede aumentar la posibilidad de vender el "producto" presentado; BIM mejora los métodos estándar de presentación, enriqueciéndolos con la posibilidad de un ajuste detallado y la conclusión de contenido específico en las necesidades y expectativas individuales del cliente; el uso de BIM no requiere que los especialistas dediquen una cantidad excesiva de tiempo para lograr resultados satisfactorios, debido al enfoque en una base de datos, que contiene datos diferentes sobre la construcción; BIM permite a todos los participantes, involucrados en el ciclo de vida del edificio, trabajar en un modelo BIM, que se puede exportar e importar en formato IFC; La tecnología BIM se basa en la cooperación entre industrias AEC individuales, y su espectro es tan amplio, que es una herramienta universal para resolver cualquier problema o problema relacionado con el ciclo de vida del edificio.

BIM; diseño arquitectónico

1. INTRODUCTION

The life cycle of the building is the basis for the modern functioning of each building. It is based on 5 phases: design, construction, operation, conversion, demolition/change of use function. All of these phases should be carried out in a way that brings the greatest benefits and the lowest costs - economic, spatial, time, etc. Searching for ever newer and innovative design methodologies is the basis for the development of many areas of the architectural, engineering and construction industries (AEC industry).

It is worth mentioning that spatial economy as a teaching direction is an important element of the AEC industry, and the implementation of various computer technologies in this field favors cooperation with other disciplines. The term BIM (Building Information Modeling) technology means a kind of design methodology based on a computer-aided design system, which uses specialized software allows to create a three-dimensional (3D) building model containing data (database), which can be used by interested participants of the building's life cycle during the process of its construction, design or operation [1].

The use of BIM technology is becoming more and more popular every year in the AEC industry [2]. The confirmation of the above statement is, inter alia, the fact that construction law in some highly developed countries introduced the obligation to perform projects in accordance with the BIM methodology and providing the building model in the base export and import format of BIM - IFC (Industry Foundation Classes) models [3].

The aim of the work is to present the application of BIM technology in spatial economy on the example of a multi-family building designed in BIM methods in Bialystok

2. WORK METHODOLOGY

The authors of the dissertation decided to achieve the aim of this work through the experience consisting in creating a functional and spatial concept of an architectural and construction project of a multi-family building at Czestochowska Street in Bialystok, Poland. BIM technology sets the contemporary global standard in the AEC industry ensuring integral cooperation between all participants of the building's life cycle.

The use of BIM technology in spatial management allows for increasing the efficiency of activities carried out, in relation to currently used tools. The form and scope of the project will be limited to the creation of those components that will determine: the function of the building together with its urban context; the aesthetics of the object; factor 4D and 5D in accordance with the BIM methodology; assessment of the "existence" of a building on the contemporary development market, including a number of factors determining architecture and spatial economy such as - economy, design, construction and construction solutions, functionality and ergonomics, marketing, implementation capabilities, demand and sales.

3. WHAT IS BIM?

In the currently literature, there are many definitions of BIM, whose content is significantly different from each other. The above problem may be caused by the relatively short period of functioning of the term BIM in modern times. According to the publication of the IFMA [4], the term BIM has been used around the world since the beginning of the 21st century, previously this term functioned as the term BPM (Building Product Models).

Discrepancies in relation to the content and understanding of the definitions of BIM forced the authors to create a definition for his own purposes. According to the authors, BIM (Building Information Modeling) is a kind of design methodology based on a CAD system, which uses specialized software allows to create a three-dimensional (3D) building model containing data (database), which can be used by interested participants of the building's life cycle during the process of its construction, design or operation.The content of the above definition was based on Rusin [2] and BuildingSMART [5] and the publication of the IFMA [4].

The result of using BIM technology is to create a model of a building referred to as the BIM model [6]. The BIM model is a digital 5-dimensional representation of the physical and functional parameters of the facility, available to all participants of the full life cycle of the building, performing functions of the object data source, as well as the basis for undertaking any projects during the full life cycle of the building [5].

The five-dimensionality of the BIM model is understood as the "enrichment" of the 3D parameter - defining the 3 basic spatial dimensions (length, width, height), by the parameters 4D and 5D. The 4D dimension is characterized by "time", i.e. time information (eg deadlines for individual elements of the object), while the 5D dimension describes "cost", i.e. information related to incurring financial costs, e.g. costs of purchasing building materials [3].

BIM is a technology used in products - programs, a large number of modern computer software producers (including companies: Autodesk, Graphisoft, Bentley), who are present in many architectural, engineering and construction industries. Therefore, in order to ensure interoperability in the above industries and minimize the possibility of data loss during the import of BIM models between different programs, the NIBS (National Institute of Building Sciences) created a base format for exporting and importing BIM - IFC models. Classes) [7].

Currently, the latest version of the IFC format used is the IFC4 type [8]. The IFC format contains the BIM model data characterizing: the object life cycle stage, the types of component elements of the object and relations between them, building data of the geometrical character, standard and non-standard properties assigned to building elements [7].

3.1. Application of BIM technology

According to a study by the IFMA foundation and Azhar [4], [6], BIM technology is increasingly used in many areas of the architectural, engineering and construction industries (AEC industry), where for many years only CAD technology has been used. As the main reasons for the implementation of BIM in the aforementioned industries, Azhar et al. [6] and Rusin [2] give two significant differences between technologies that affect the departure of the AEC industry from CAD:

- CAD technology creates a building project based on unrelated, in no technological way, two-dimensional (2D) views - plans, cross-sections, projections, etc., which when necessary to change on one of them, force "manual" updating of the others. However, in the BIM technology, the building design is created as a BIM model, which is created based for connecting with each other using the technology of all 2D and 3D views. Therefore, any changes in one 2D view are automatically updated in all other views;
- CAD technology maps individual components of a building in the form of simple 2D graphic elements such as lines, arcs, and circles. BIM technology creates a semantic BIM model in which each building element is defined as a 3D equivalent of the actual physical building element, e.g. wall, beam, ceiling, column, along with their description. This makes it easier for AEC industry professionals to "understand" the building and its essence before it can be built, renovated or maintained.

According to articles [7],[8], BIM technology is a perfect instrument in the AEC industry, intended for all participants of the object life cycle, including mainly for investors, designers (architects, constructors, installers), general contractors, prefabricated producers, facility owners, and its managers. This is because of BIM technology:

- is characterized by precision in the creation of individual elements of the model, which facilitates the construction of prefabricated elements used to construct the object;
- thanks to parameters 4D and 5D, guarantees liquidity in managing the construction project during its implementation;
- is based on coherent cooperation between specialists from various AEC industries, eg creating a BIM model involves the work of all specialists involved in building design, based on 1 virtual model, in which changes are updated in parallel - are introduced simultaneously to all participants forming model;
- through the use of mobile electronic devices (tablet, smartphone) allows free access for investors, property owners and their managers to use the BIM model.

3.2. Profits of using BIM

The main advantage of BIM is the ability to accurately geometric representation of individual components of the proposed assumption together with the integrated one and an extensive database [6]. Other significant advantages of BIM include:

- universality - BIM models can be used to a greater extent than traditional and digital documentation. This documentation provides information in the form of two-dimensional views and 3D solid or mesh models, which are supplemented with data sets presented in the form of tables and statements, which require precise and complicated interpretation because they do not often inform about various types of parameters relating to, for instance, the construction of the object [2];
- maintaining documentation consistency - individual elements of traditional documentation, often when they are interrelated, present the same information in various forms, resulting in problems with the consistency of documentation. The BIM model contains 1 global database, so that the documentation created on its basis regardless of the presented form always refers to the same database. This makes it possible to maintain the integrity of the documentation [2];
- streamlining and accelerating the production of prefabricated products - programs using BIM have detailed and precise tools for modeling, which, combined with extensive databases, allows increasing the accuracy and pace of production of prefabricated elements used in the project assumption [6];
- speed in data management - in BIM data can be quickly exchanged between participants at individual stages of the object life cycle and repeatedly used and modified [6];
- "improvement" of the design - the technology enables creating and comparing many concepts at once, the proposed simulations are created quickly and efficiently mapped, which enables the creation of innovativeand "ideal" design solutions [6];
- efficient, ongoing control of project costs - thanks to the concentration of many information in 1 global database, all kinds of cost estimates appearing at various stages of

the facility life cycle are implemented quickly and in detail [6];

- increasing the attractiveness of the "product" presentation and improving the contact between the "seller" and the "recipient" - in-depth visualizations and detailed matching of content presented for the "recipient", increases the chance of success and sales of the presented "product" [6];
- ensuring coordination between individual participants of the building life cycle stages - technology ensures continuous access to the BIM model, thanks to which the coordinator can observe the progress of work on the model.

and using the tools provided by the BIM software to supervise the project process [3]. Azhar's publication et al. [6] contains the results of research showing the financial and time benefits resulting from the use of BIM technology in relation to traditional methods of project preparation. They are presented as follows:

- a reduction of about 40% of related financial costs with the introduction of extra- budgetary changes in projects;
- increasing the accuracy of estimating costs by 3%;
- reduction of up to 80% of the time spent on making cost estimates;
- saving about 10% of financial resources allocated to the elimination of design defects;
- shortening the average time of preparation of project documentation by 7%.

Summing up all the previously described profits, the author of the work states with great certainty that: "The profits resulting from the use of BIM technology, in the next few years will translate into the increasingly widespread use of BIM technology by specialists from many areas of the AEC industry".

4. DEVELOPMENT OF A MULTI-FAMILY BUILDING PROJECT

4.1. DESIGN ASSUMPTIONS

The design of the multi-family building was designed at Czestochowska Street in Białystok, Poland. The form and scope of the project described in this chapter will be limited to the creation of those components that will determine:

- the function of the building together with its urban context;
- the aesthetics of the object;
- factor 4D and 5D in accordance with the BIM methodology;
- assessment of the "existence" of a building on the modern development market, including a number of factors determining architecture and spatial economy such as - economics, design, construction and construction solutions, functionality and ergonomics, marketing, implementation capabilities, demand, and sales.

The following subchapters will present the main design assumptions of the research experience that has been carried out, divided into general project assumptions and architectural assumptions of the designed building.

4.2. ARCHITECTURAL ASSUMPTIONS

Data about the building:

A detached, caged building in the shape of an "inverted" letter "C", closing the quarter from the north, in white color. Ceiling inverted green. Basic data on the building are included in table 1.

Data	Details
Length (in the longest place)	56,05m
Height (from the level of the area located in front of the lowest entrance to the staircase and its peak)	15,84m
Width (in the longest place)	19,25m
Number of above-ground storeys	4
Number of underground stories	1
Building area	1485,3m^2
Total surface area	7.227,8m^2
Total underground area	2.093,4m^2
Net area	6041,3m^2
net area of flats	2.556,3m^2
Net area of services	708,5m^2
net area of general communication	1.098,3m^2
net area of technical and economic rooms	93,6m^2
net space of storage cells	126,9m^2
net area of the underground garage	1.457,7m^2
Gross volume	21.588,0m^3
Net underground floor height	2,45m
The height of the above-ground storeys	2,55-3,00m
Number of places in the underground garage	47

Table 1: Basic data about the designed building

- The architectural function of the building:

The designed object is a multi-family residential building with a service function on the ground floors. The facility is a sealed enclosure integrated with the surroundings. The shape of the building of the above-ground stories takes the shape of the "inverted" letter "C" around the inner "courtyard" constituting the zone of rest and recreation of the residents of the building. Parking pitches were located in the underground story - to eliminate circular traffic within the quarter. The communication inside the building is based on fire-extinguished staircases with high-speed lifts adapted for the transport of disabled people.

- The architectural form of the building:

The building was designed in the modernist form with an orthogonal layout of the walls. The roof of the building is flat, in the form of an inverted green roof topped with an openwork roof. The object is characterized by high architectural and utility values thanks to the use of modern elements and finishing materials, among others glass balustrades and blinds, wooden enclosures, façade parts, steel openwork canopies of the flat roof. The color of the façade is dominated by white complemented with black elements (including the frame of windows, windows, and doors, balustrade fittings).

The scale of buildings and details is appropriate for the housing function. The design maintains its correctness and architectural originality by:

  - maintaining the proportions of horizontal dimensions to vertical ones,
  - lack of "excessive" interference in the architectural form of the object,
  - the division and size of window and door openings,
  - the use of wooden openwork casings and the introduction of glass blinds and other types of glazing that give the "raw" block of the building "lightness";
  - crowning of the flat roof with openwork roofing.

- Functional and spatial assumptions of the investment:

The planned investment provides 3 functions:

  - housing - which are 42 residential premises located on three floors of the building (first floor, second floor, third floor), accessible via staircases;
  - commercial service - which is 8 commercial and service premises located on the ground floor of the building, accessible from the ground level;
  - recreation and recreation - which is: a garden set located on the roof of the building, accessible via staircases; development of the area around the building, available from the ground level; a playroom for children with a seating area inside the building, located on the ground floor of the building, accessible via the north-east staircase.

The housing function of the object is connected by the internal communication

with leisure and recreation space. This is a conscious undertaking aimed at facilitating the use of residents of the building with this function. On the other hand, the service space has not been connected by communication with other functions, due to the commercial and public nature of services that could affect the "intimacy" and privacy of the residents of the facility (fig.1, 2).

Fig.1: Visualization of designed multi-family building (source: own study)

5. METHODOLOGY OF THE PROJECT IMPLEMENTATION

5.1. TECHNIQUE

Implementation of a multi-family building project at Częstochowska Street in Bialystok using computer software, mentioned in sub-chapter 4. Project design approach consists of 5 stages:

- Stage I - Review of available literature and legal acts outlining and determining the correct preparation of project documentation;
- Stage II - Acquisition of materials needed for the implementation of project documentation;
- Stage III - Creation of project assumptions;
- Stage IV - Selection of tools necessary to implement the project;
- Stage V - Preparation of the building project.

In stage I, the authors of the dissertation made a detailed analysis of the sources conditioning and outlining the correct preparation of the building design documentation.

The result of this stage was the acquisition, by the authors, of knowledge enabling the commencement of work related to the preparation of project assumptions and the search for materials and tools enabling comprehensive implementation of this project.

Stage II - Acquisition of materials needed to prepare project documentation.

This stage was partly carried out at the same time as stage III. It consisted in obtaining the appropriate map foundation of the Czestochowa Street, legal acts and access to the standards necessary to implement this research experience. The map's mapping in the form of a master map sheet in 1: 500 scale, intended solely for educational purposes, was obtained in the Department of Geodesy and Cartography of the Municipal Office in Bialystok.

The content of legal acts containing conditions and records having a significant impact on the "shape" of the building's design has been obtained in the Internet System of Legal Acts kept by the Chancellery of the Parliament of the Republic of Poland. The materials collected in this stage allowed the authors a dissertation to start the next stage of work on the implementation of the building's design.

Stage III - Creating "preliminary" design assumptions.

This stage consisted in developing by the authors the design assumptions of a multi-family building at Czestochowska Street in Białystok. It consisted in the preparation by the authors of concepts, solutions, compilations and "hand-written" drawings (projections, sections, diagrams). The final result of the described stage was the creation of "preliminary" building design assumptions.

Stage IV - Selection of tools necessary to implement the project.

This stage consisted of the authors taking a decision on the choice of tools - computer programs, with the help of which they would create a multi-family building project. The authors of the dissertation decided that they would use the educational versions of the GRAPHISOFT and ABVENT computer software. The authors of the work decided to use this software because:

- selected computer programs are offered for free use in the form of educational versions;
- GRAPHISOFT and ABVENT products are easy to use and open design environment, as well as the ability to create detailed documentation thanks to the 5D option of creating a building design [9];
- selected computer software will enable not only the implementation of this research experience but also the implementation of the work objective thanks to the BIM technology implemented in them [9].

The final result of this stage was the acquisition, installation, and familiarization with the computer software of GRAPHISOFT and ABVENT.

Fig. 2: Visualization of a designed multi-family building – white model (source: own study)

Stage V - Preparation of the building project.

Creating a building project is the last and most complicated stage of the multi-family building project at Czestochowska Street in Białystok. In this stage, the authors of the dissertation directly used the final results of stage III and IV. In addition, an important element of this phase was carrying out the so-called design adjustments, during which the authors of the work made comprehensive modifications and changes to the "initial" design assumptions (which eventually evolved to the "form" contained in subsection Project assumptions).

The authors of the dissertation began to create a building project from the import of the acquired map foundation to the ArchiCAD program. After internal compression of the base map, creation of the structure and the main body of the building began. As a result, they were created basic structural elements (including walls, ceilings, pillars, etc.) of the underground floor of the building - underground garage, and above-ground stories - ground floor, first, second and third floors.

The next step was to design communication inside the building (staircases) and the functional and spatial distribution of the object. Then, work began on creating a "shape" to the individual, until now "raw" facades of the building (among others created: window and door carpentry, glazing, fittings, blinds, structural partitions, etc.). After completing the above-described step, the interior space was begun - door woodwork was created, furnishings of the rooms, finishing of floors, walls, and ceilings, etc.

The last step in the implementation of the described project was the execution of, among others, a model of terrain, roads, buildings. All components of the multi-family building project at Czestochowska Street in Bialystok was created in one file.

After generating a 3D model of a multi-family building in ArchiCAD, the file containing the project was exported to the Atlantis Studio 5 program, where a detailed graphics processing of the virtual building was made and the rendering process was carried out. The result of which was the "attractive" visualization of the designed object, presented in Figures 3, 4.

Fig. 3: Visualization of a designed multi-family building – white model (source: own study)

5.2. CREATION OF A VIRTUAL MULTI-FAMILY BUILDING

The GRAPHISOFT product - ArchiCAD, is one of the presents on the market, computer-aided design systems using the latest BIM technology standards. ArchiCAD is a computer program that was the first to depart from the idea of 2D designing of flat drawings in favor of the idea of BIM methodology, the result of which is the 3D design of digital models of architectural objects - so-called virtual buildings, BIM (Building Information Model) models.

The digital model of the object is implemented from the very beginning of the project to its end, and all data (including 4D and 5D data) associated with the 3D model are available during each stage of its creation [8].

According to Sleka [8], modeling in a virtual three-dimensional environment is much more efficient in relation to working in 2D. In addition, work in 3D space introduces the idea of thinking about all aspects of the designed object, and not only about creating 2D documentation [8]. Conducting any work on the building project is automatically creating a virtual building, as shown in Figure 4.

Fig. 4: Front elevation ov virtual buildingcreated with the help of BIM software (source: own study)

The selected program is a graphical program that bases its operation on the so-called "Object logic". The selected types of objects are assigned to various types of building elements (eg wall, ceiling, column, beam) and other predefined elements (e.g. windows, doors, furniture, plants).

The above-described "mechanics" of operation allow for the comprehensive creation of very complex building projects, and the 3D capabilities of imaging the structure, installation, and equipment of the facility simplify the preparation of detailed design documentation.

Service of the program does not require the user to speak a foreign language, because the software exists in many language versions, including in the Polish language edition.

This chapter will not be a kind of detailed guidance on how to use the program. The authors of the dissertation decided to focus solely on the description of the nature of creating a virtual model of the building.

The idea of implementing a virtual multi-family building was based on the use of specialized tools and program functions to create defined objects and give them parameters. According to the article by GRAPHISOFT [3], this type of methodology can be described as the "philosophy" of BIM design.

The essence of creating virtual buildings by professionals from the AEC industry is mainly:

- facilitating cooperation between individual participants of the design process;
- avoiding the creation of so-called design collisions - errors in creating the content of the project's design documentation;
- improving the creation of various functional and aesthetic solutions of designed buildings;
- the possibility of a detailed estimation of the cost of implementation of the proposed building.

Creating defined objects that are elements of the BIM model, involves creating so-called structural elements and parametric objects.

According to the GRAPHISOFT [10] study, the virtual equivalents of real 3D building components should be defined as construction elements. These include: walls, pillars, beams, ceilings, roofs, nets, zones and structural partitions, shapes and shells. In the 3D window, these elements are presented in the form of 3D components with a specific volume (Fig. 5).

Parametric objects are defined as objects that are inserted into the BIM model as so-called library elements, and their physical parameters and properties, can be freely configured using the program dialogs assigned to them - without having to modify the external source of this object. Included in them are inserted objects:

- using the following tools: object, door, window, stairs, skylight;
- automatically through commands or additions: tags, labels, Roof Maker and Truss Maker elements.

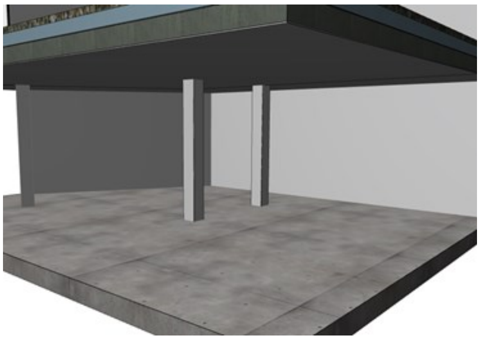

Fig. 5: An example of construction elements (wall, ceiling, pole) used in creating a virtual multi-family building, (source: own study)

ArchiCAD's extensive internal library contains the number of GDL objects that are needed in most design processes (Fig. 6) presents examples of parametric objects used in the implementation of the research experience. The tools and functions of the program used for assigning parameters to the above-described structural elements and parametric objects include the tools contained in the info palettes and auxiliary palettes, as well as the attributes and tool settings window.

Fig. 6: The example of parametric objects (the door, the window, object – balustrade, the shutter) used in creating a virtual multi-family building. (source:own study)

The info palette, according to the GRAPHISOFT [10] study, is the place where the most important sets of options and parameters for the selected BIM component are concentrated (Fig. 7)

Fig. 7: An example of sets of options and parameters of the info wondow pallete object – used in creating a virtual multi-family building (source: own study)

The auxiliary palette is a set of commands and options that automatically appear when entering or editing objects. The content of the palette depends on the type of the selected element or its fragment and the active program window (Fig. 8).

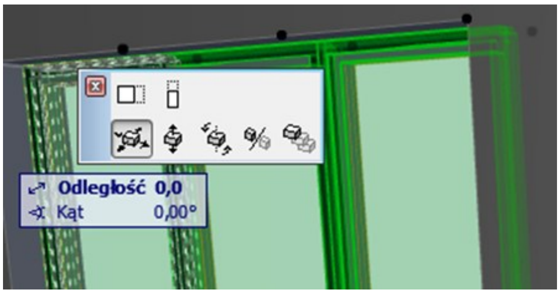

Fig. 8: Example of command sets and options of the auxiliary palette of the window object – used in creating a virtual multi-family building
(source: own study)

Due to the limited number of displayed options and commands or parameters, the above-presented palettes allow only for quick modification of the basic parameters of the created object.

The aim of comprehensive and correct creation of a virtual building is to give parameters to objects by using the tool settings dialog. This window is the basis and beginning of the design process according to the BIM philosophy. The content of this window depends on the type of object being created and contains settings defining its appearance, parameters and other types of data (Fig. 9).

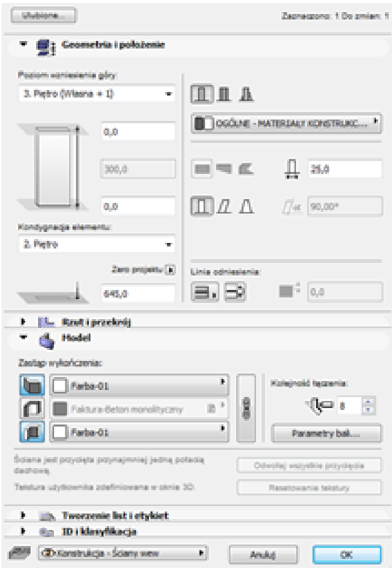

Fig. 9: The contents of the tool settings window for the wall construction element - used in creating a virtual multi-family building
(source: own study)

An equally important function as the tool settings window is the attributes function. According to the GRAPHISOFT [10] study, ArchiCAD attributes are sets of parameters that are used when conducting project work.

These include: layer settings, line types, fill types, building materials (Fig.10), layered structures, pens and colors, finishing types, zone categories, design highlighter styles, profile manager, attributes of remodeling elements, usage profiles. Each of the above options has a real impact on the "shape"5D BIM model and moderates the most important data contained in it.

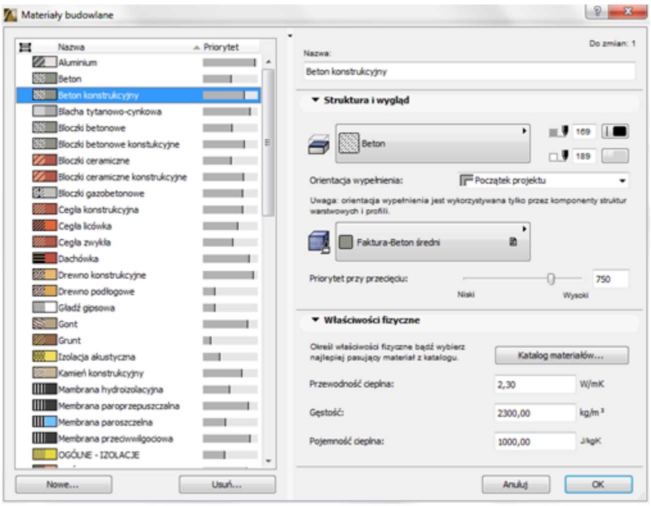

Fig. 10: Characteristics of building material - constructional concrete – applied in the ceilings of a virtual multi-family building
(source: own study)

Creating objects along with setting parameters are the most important element in the BIM design methodology. The program offers many other tools and functions that support its functioning. The most important of them include:

- Library function: libraries that contain external or attached files: geometric library elements or parametric objects (Fig.11). A large number of editable GDL objects increases the speed of creation of virtual buildings, while enriching the BIM model with additional sets of information [11].

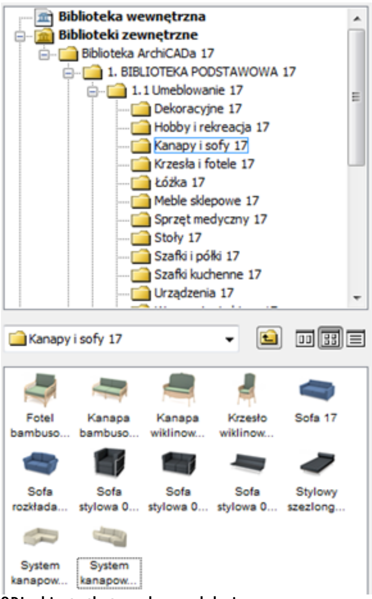

Fig. 11: Examples of GDL objects that can be used during creating a virtual multi-family building
(source: own study)

- Model view function: This function is the basic access to the virtual building model, because through the views the object is implemented and given parameters, and the presentation of various aspects of the virtual building:
  - 3D perspective (Fig.12), In which you can follow the current look of the virtual building;
  - projection (Fig.13), In which the virtual building is presented in the form of a 2D technical drawing; cross-sections, elevations, wall extensions, generated on the basis of the 3D model with the possibility of partial editing of objects;
  - 3D document;
  - interactive statements that show a virtual building as a tabularly ordered set of data.

Conducting design works in one of the above-mentioned views of a virtual building will automatically update and apply changes in other views.

Fig. 12: Virtual multi-family building in 3D perspective view
(source: own study)

Fig. 13: Virtual multi-family building in the projection view
(source: own study)

6. Conclusions

The direct result of the research experience is the creation of a functional and spatial concept of an architectural and construction project of a multi-family building at Czestochowska Street in Bialystok.

The authors of the work are aware of the fact that the use of BIM technology in Poland, it is negligible and that there are not many literature items dealing with this type of subject.

However, worldwide progress in the use of BIM technology in the AEC industry, it is the perfect impulse to start a broad discussion on the implementation of BIM in Poland.

BIM technology should be used in specific spatial economy areas.

The field of property management and management is based mainly on shaping:

- close cooperation between specialists in this field with specialists from other fields of the AEC industry;
- appropriate contacts and relations between the specialist and the client.
- Therefore, it is desirable to apply practices and use tools that in a significant and uncomplicated way affect the shaping of previously described relationships. BIM technology meets the above-mentioned factors because:
- computer software using this technology has, until now, generally created unused opportunities for attractive 3D building presentation (including using the 3D section), which can increase the chance of success, sales of the presented "product";
- BIM makes the standard methods of presenting objects more attractive, enriching them on the possibility of detailed matching and concluding specific content to the individual needs and expectations of the client and specialists from other fields of the AEC industry;
- the use of BIM technology does not require specialists to spend a lot of time on achieving satisfactory results, thanks to the concentration in one place, various building databases;
- BIM methodology is able to involve all participants in the building's lifecycle, basing their work on one BIM model, which can be exported and imported in IFC format;
- simple and quick access to the possibilities offered by BIM enables specialists to use specialized computer software and applications using BIM, on all types of portable devices, which, even in the least expected situations, does not constitute a major problem for access to the BIM model;
- BIM technology is based on the cooperation of individual AEC industries, and the spectrum of its application is so extensive that it is a universal tool for solving all types of issues and problems related to the building's lifecycle processes.

Creating a complete virtual building model is a creative job in many areas of the AEC industry. Hence, its implementation should be undertaken by a group of specialists who, through cooperation among themselves, would create a virtual building at a fast pace, while avoiding making many mistakes that could significantly slow down the process of its creation.

7. Acknowledgements

This research was carried out as part of statutory research no.S/WBiIŚ/2/16 at Białystok University of Technology

8. References

[1] K. Lalit Narayan "Computer Aided Design And Manufacturing", Prentice-Hall of India, New Delhi, 2008, pp. 3-4,

[2] J. Rusin, 'Czym jest BIM?" (2018, April 14). Networks (1st ed.) [Online]. Available: http://www.bimblog.pl

[3] M.A.D. Engineers. "BIM." (2018, April 14). Networks (1st ed.) [Online]. Available: http://www.bimblog.pl

[4] IFMA, E. Teicholz, "BIM for Facility Managers", John Wiley & Sons, Hoboken 2013, pp. 17-34,

[5] BuildingSMART. (2018, April 14). Networks (1st ed.) [Online]. Available: http://buildingsmart.pl

[6] S. Azhar, "Building Information Modeling (BIM): Benefits, Risks, and Challenges", Journal of Software Engineering and Application, Auburn University, Auburn 200

[7] M. Dejer "Czy BIM to Revit...?" (2018, April 14). (1st ed.) [Online]. Available: http://www.bimblog.pl

[8] R. Sleek, "ArchiCAD. Wprowadzenie do projektowania BIM", Wyd. Helion, Gliwice 2013, pp. 90-120,

[9] NIBS. "IFC4 officially released." (2018, April 14) (1st ed.) [Online]. Available: http://www.buildingsmart-tech.org/news/ifc4-officially-release

[10] GRAPHISOFT, Graphisoft BIMx usage guide for ArchiCAD 17, access in the form of a pdf file via ArchiCAD 17 (2018, April 14). (1st ed.) [Online]. Available: https://www.graphisoft.com/.pdf

[11] K. Orlińska-Dejer "IFC - kilka suchych faktów". (2018, April 14) (1st ed.) [Online]. Available: http://www.bimblog.pl/2011/12/ifc-kilka-suchych-faktow

WHAT DO YOU THINK?