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Research Article

Exploring the Application of Building Information Modeling (BIM) in Town Planning: Key Roles in the Relationship Between Buildings and Parcels

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Abstract:

The configuration of buildings is influenced by various parameters, including ground floor area, horizontal distances, static structure, and construction materials like reinforced concrete or steel, as well as electrical and mechanical project systems. The parcel is the foundational element in building formation, determining the building's boundaries according to the structural form feature of the parcels, height ratios, and comparable construction rates. This study explores the relationship between buildings and their parcels using building information modeling (BIM) and its implications for town planning and construction. BIM is a comprehensive tool that harnesses advanced information modeling to integrate building data and resources, providing real-time insights and enabling precise coordination between architectural elements and town parcels. Modeling the entire lifecycle of building development—from initial planning to completion—enhances decision-making and operational efficiency, streamlining planning and construction process efforts through data-driven management at each stage. The study aims to clarify the process by which a building is shaped on its parcel and identifies key considerations, offering a process framework for understanding the correlation between building and parcel criteria.

1. Introduction

With the development of technology, changing needs, and the emergence of the need and desire to carry out more extensive and complex projects, new management models with innovative approaches are being developed in addition to traditional management processes in the construction sector [1]. With the emergence of the computer-aided drawing model in the 1960s and the widespread use of computers in the 1970s, the construction sector has also started to benefit from technological developments [1,2]. The first steps of building information modeling (BIM) were taken with the creation of the computer-aided drawing model. BIM, which started to develop in the 1990s and has become widespread in the construction sector since the early 2000s, has become one of the most essential building blocks of the sector with the development of technology in recent years [1,3]. BIM refers to technological processes that define design, planning, construction, and operation processes in a computer environment and support them with numerical data [1,4].

The construction sector is a major consumer of natural resources. Therefore, ensuring environmental sustainability is essential. In the construction sector, construction materials come to the forefront of resource use and waste production [5]. The use of recyclable materials with low environmental impacts is one of the solutions that can be applied to environmental problems [5,6]. Life cycle assessment is one of the main methods used for environmental impact assessment of construction materials in the construction sector. With this method, the environmental impacts of materials are analyzed throughout the entire process, starting with the acquisition of raw materials, production, use in the structure, and recycling at the end of use [5,7]. Environmental impact estimates of structures are made with the results obtained by taking into account the operating parameters of structures with life cycle analyses [5,8].

The construction sector has a fragmented structure formed by professionals from different sectors, such as architects, civil engineers, and electrical and mechanical engineers. This dispersed form of organization not only causes problems in switching to new systems and applications but also creates an obstacle in the implementation of current information technologies [9]. The main reason for the problem is that the small organizations mentioned cannot cover the technological change costs caused by software and hardware. Even if these teams can switch to new systems, they cannot synchronize with other disciplines, so there are interoperability problems between teams [9,10]. However, BIM offers a collaborative process that prevents data and labor losses experienced in the construction sector's interdisciplinary production and applications among people, systems, and disciplines [9,11]. It also increases the efficiency of projects at every stage of their life cycle [9,11]. In order to create more successful projects in the architecture, engineering, and construction (AEC) industry and to quickly solve the changes and problems experienced during the implementation of construction projects, BIM has been developed with the help of technology. BIM can be defined as a process and system in which project products are created in three dimensions instead of two by using different software and hardware together, which increases cooperation and information sharing between project participants, reduces the error rate in the process thanks to the cooperation it provides, provides profit in terms of time and cost, and continues its existence from the idea stage of the structure to the demolition stage [12].

BIM is described as a revolution in the AEC industries [13,14]. BIM technology is the creation of a virtual copy of a building in a computer environment before the construction phase. This digital model supports the design with analysis at every phase and provides more control than the manual process. When the model is completed, it contains the exact geometry and related data for construction, manufacturing, and procurement activities [14]. BIM is a potential breakthrough in the AEC sector [4,15]. BIM technology digitally creates one or more accurate virtual models of a building [15].

2. Methodology

In projects where BIM is used, unexpected economic situations for employers have decreased due to healthier cost calculations and reduced situations such as disputes and conflicts [12,16]. BIM creates a three-dimensional model that consists of data related to the building, such as geometry, material, shape, cost, physical environment control, etc. It ensures that the created three-dimensional model is used jointly by the construction sector units. The created three-dimensional model can be used in the processes covering the project's entire life cycle, such as planning, design, projecting, construction, and operation. The ability of different units to use the same model increases consistency and provides easy revision. It dramatically reduces information change operations, repeated production of information (replication), and additional association or coordination requirements between project documents [17,18]. What distinguishes the Building Information Model from other conventional two-dimensional designs and three-dimensional models is that the model is parametric and object-based. Thanks to this structure, model elements can be shaped with parameters and attribute information can be entered. Designing in two dimensions requires projects from different disciplines to be brought to the same local reference system. This reduces project reading in complex structures, that is, visuality [19]. The three-dimensionality of the Building Information Model allows viewing from different perspectives, which provides visual communication between designer and non-designer stakeholders. Vertical sections and plan sections created using two-dimensional traditional methods work independently of each other [19]. In other words, any correction or design change to be made must be corrected separately in both views. In the Building Information Model, the views are related to each other. Any change made is automatically processed to the other section. Since the object-based data management system provides addressability to model elements, the desired design change to be made in common model elements can be made in a very short time. Considering that there may be many design changes in complex projects, especially during the construction phase, this feature of the Building Information Model provides significant advantages [19]. BIM consists of three concepts: modeling, model, and management. The concept of modeling consists of information and aims to create. It is the part where architecture, engineering, and all expertise are located, and the life cycle is addressed. The concept of the model is the phase where the digital and concrete delivery of the construction process is made. The management concept includes the necessary resources and source data in the construction process [20]. BIM is the process of generating and managing data throughout the life cycle of a building. Typically, this process uses three-dimensional and real-time building modeling software, which includes geometry, spatial relationships, geographic information, quantities, and other various features for design processes [1,21]. BIM can be defined as a set of technologies, methodologies, and processes that can support design processes, pre-project, project construction, and post-project processes and offer advantages compared to traditional methods [1,22,23]. Unlike traditional two-dimensional CAD (computer-aided design) drawings and designs, BIM provides the opportunity to store data containing the parameters and properties of these elements and provide a three-dimensional representation of each element that makes up the design [1,24]. BIM offers the opportunity to coordinate, model, analyze, and visualize geometric and numerical information [1,25]. BIM is a design process that provides coordination and practicality in pre-design, project, and post-project processes, as well as the ability to control quantity take-offs and other numerical data and test structure-related issues [1,26]. BIM is not a digital computer program but a design process with comprehensive and detailed information content [1,27]. In other words, BIM represents the process based on technological and numerical data that defines the building's planning, construction, and subsequent processes [1,4].

3. Results and Discussion

After determining the general and main lines of the BIM model, the correlation dimension between the parcel and the building in the study requires first establishing definitions for both the parcel and the building. If the parcel is in a condition where construction can be done, it is called a zoning parcel. If not, it is called a cadastral parcel. In other words, it is necessary to ensure that construction can proceed according to the features outlined in a parcel plan, especially in cases both within and outside of zoning regulations. The structure to be built on it also starts the process of this parcel becoming a construction with its boundaries determined based on the parcel features. With this process, information modeling can significantly facilitate the determination of the building's carcass, foundation, static structure, reinforced concrete, architecture, situation, independent section lines, and the estimation of costs, including the amount and type of materials required, thereby streamlining the subsequent processes of time and economic efficiency.

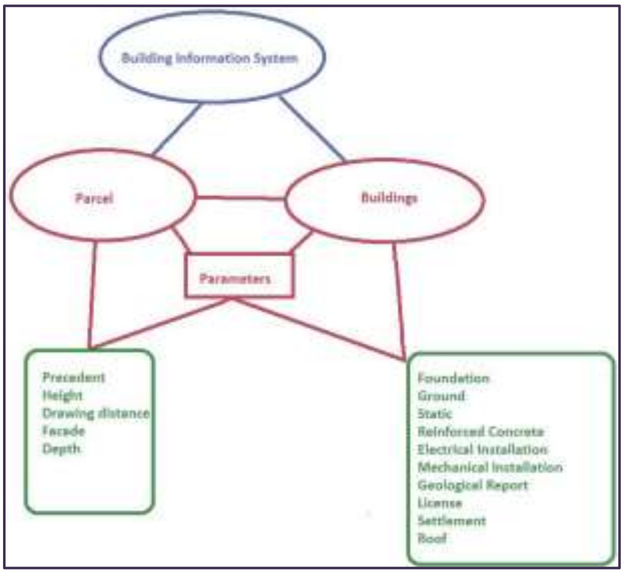

Figure 1. *The points that should be critical in the planning and construction process of the building with the parcel*

In Figure 1, the turning points that each of the parcels and the building should be considered during the start and finish process are indicated. Considering these issues, the minimum error and maximum accuracy in time and cost analysis as a result of modeling with a 2 and 3-dimensional association were sought with appropriate sensitivity. The precedent from the parcel parameters, the total construction area from the building parameter, the height from the parcel, the number of floors from the building, the withdrawal distance from the parcel, the ground and foundation seating area from the building, the slope from the parcel, the number of flats from the building, the square meter unit price of the parcel will again be affected by the labor per flat plus the land share value. The model help with archiving-calculating between the start and finish.

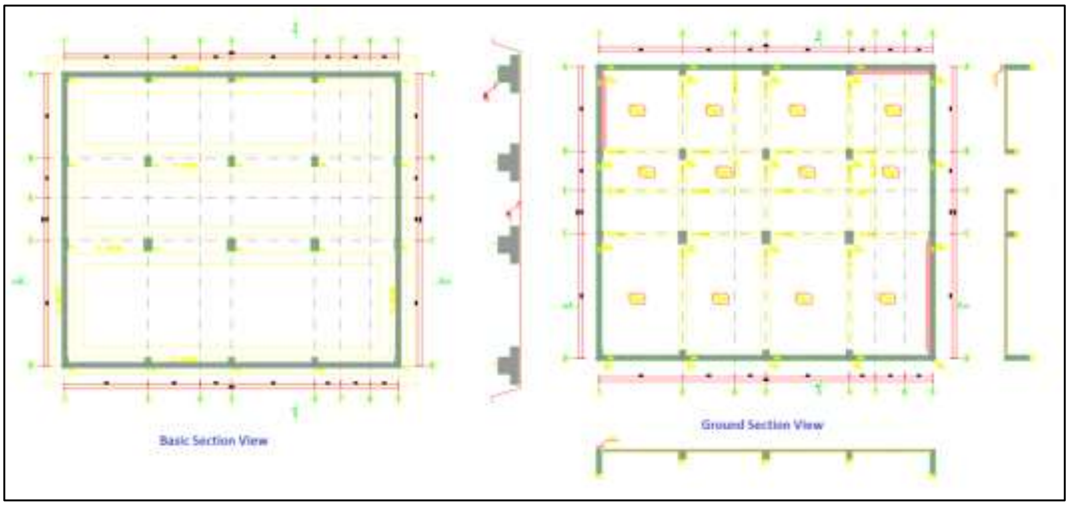

Figure 2. *Building foundation and ground section view*

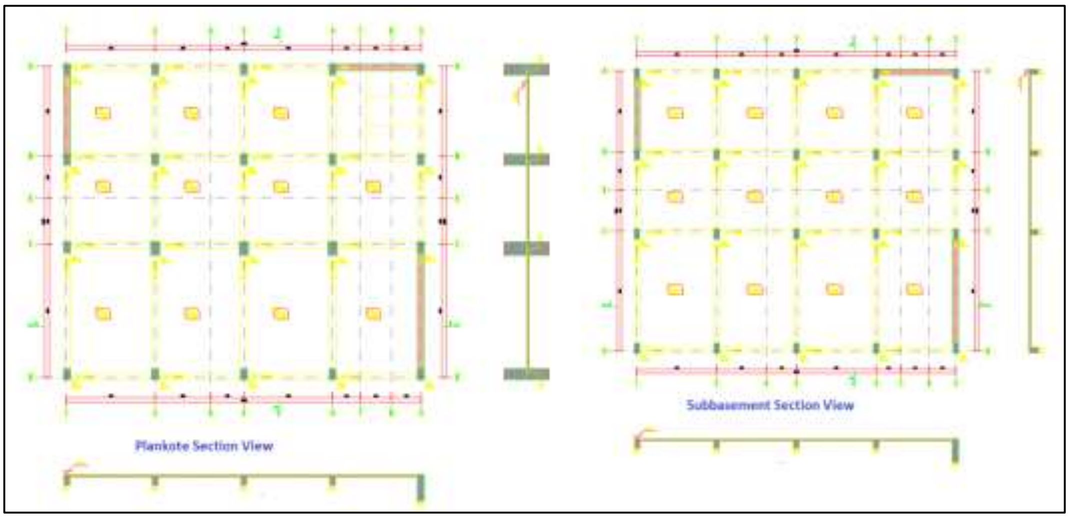

Figure 3. *Parcel plan, building basement elevation view*

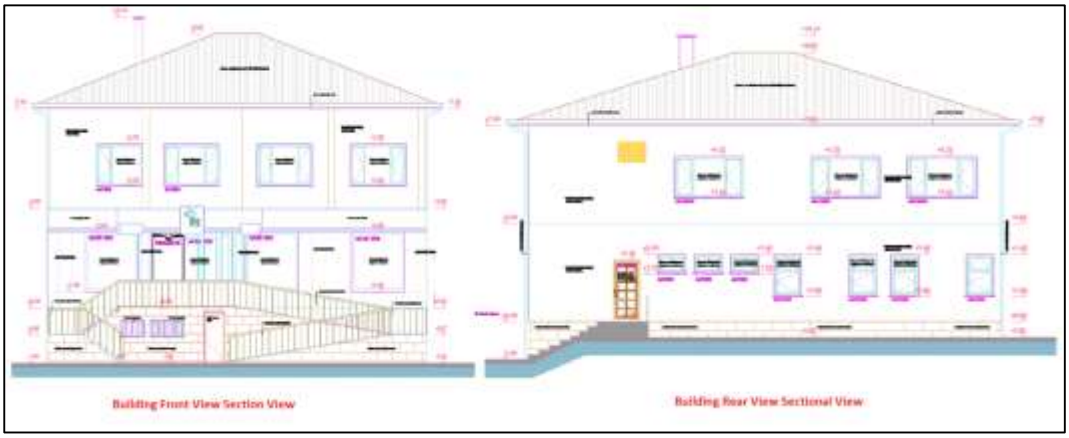

Figure 4. *Front and backplane view of the building*

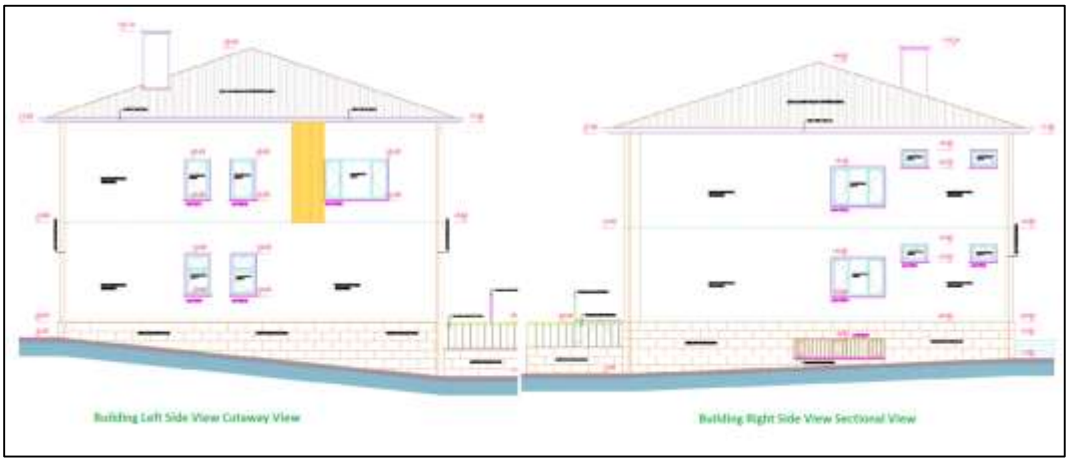

Figure 5. *Building viewed from left and right*

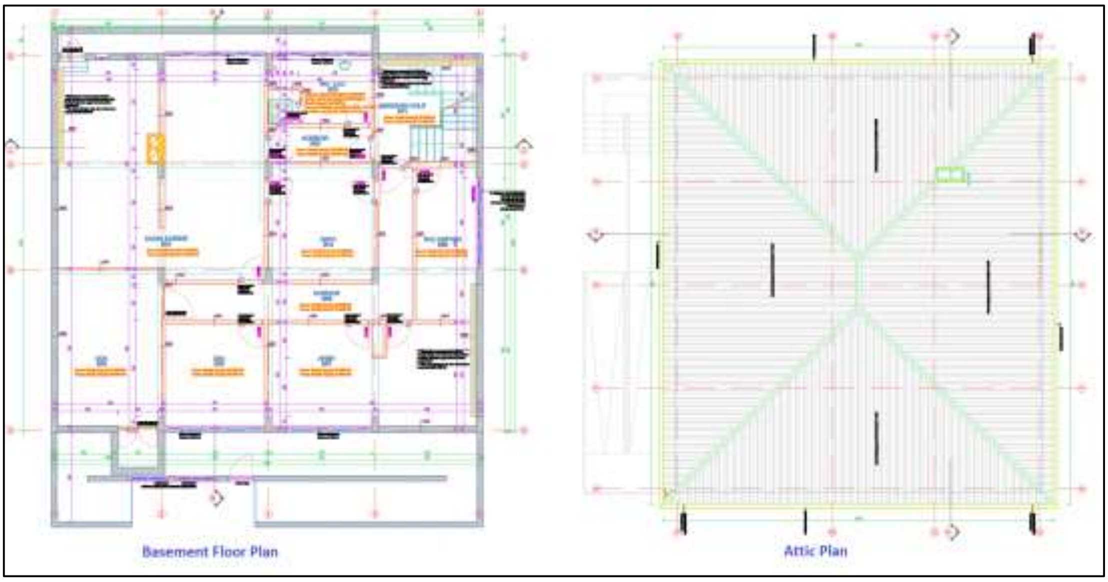

Figure 6. *Building foundation and roof floor architectural project view*

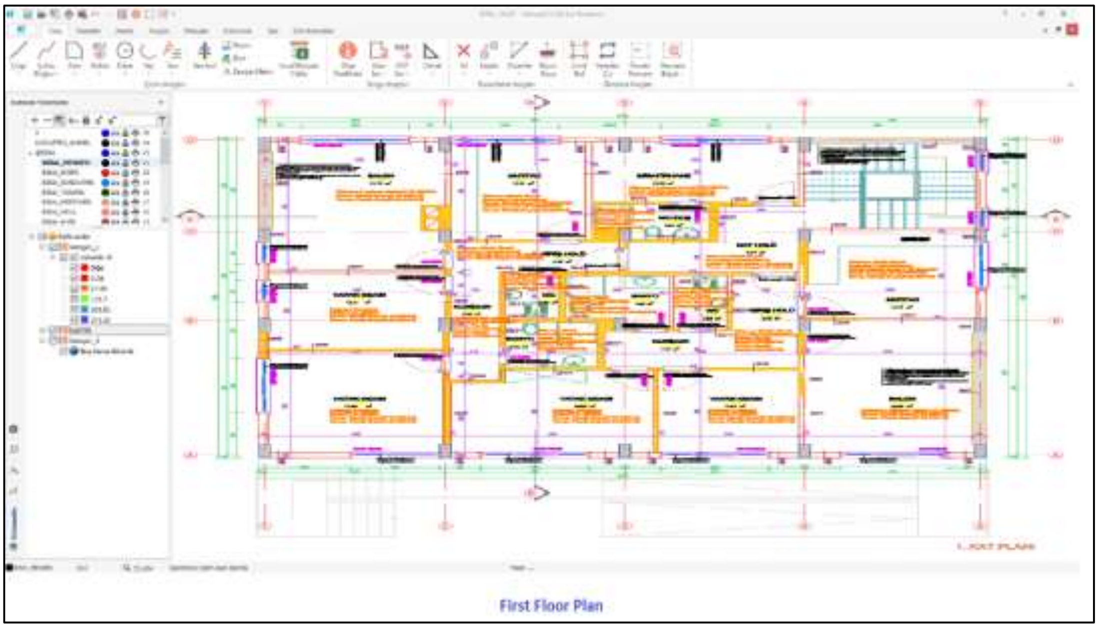

Figure 7. *Building first-floor ground plan view*

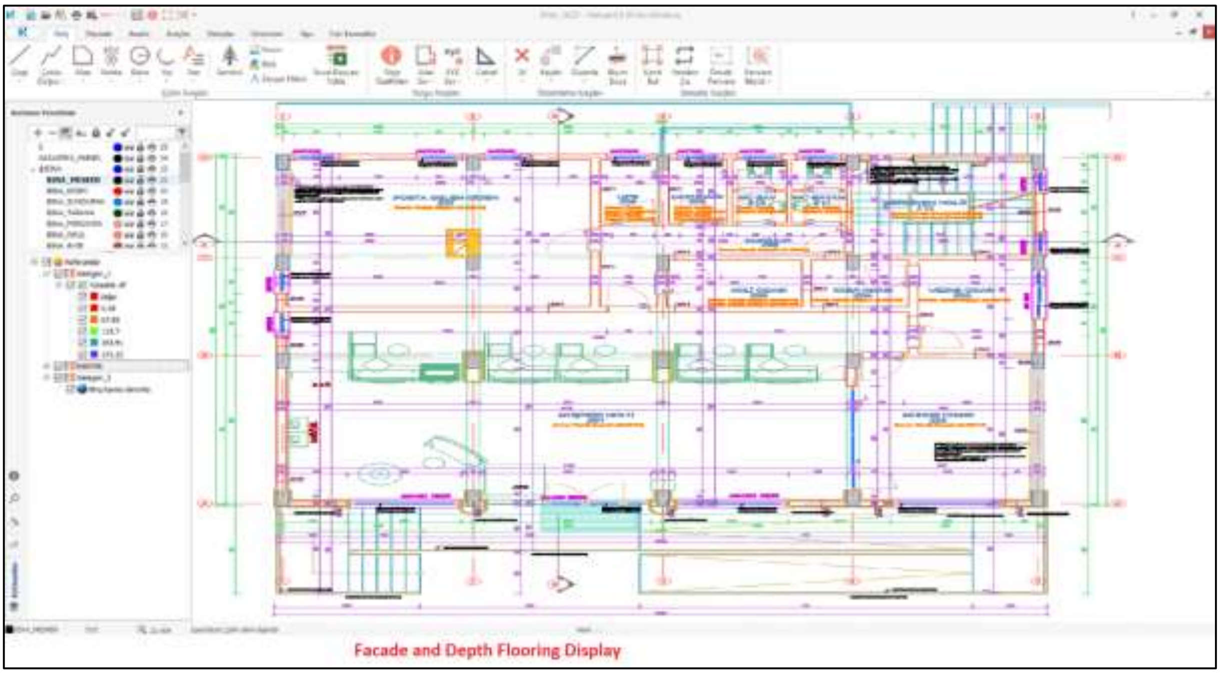

Figure 8. *Facade and depth view of the parcel on the ground*

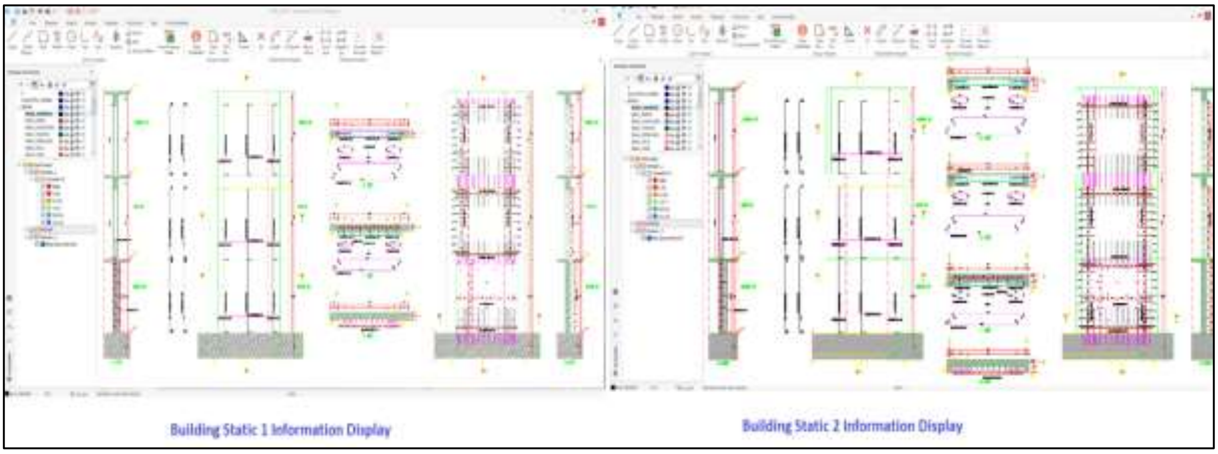

Figure 9. *Building 1st and 2nd Floor static structure project view*

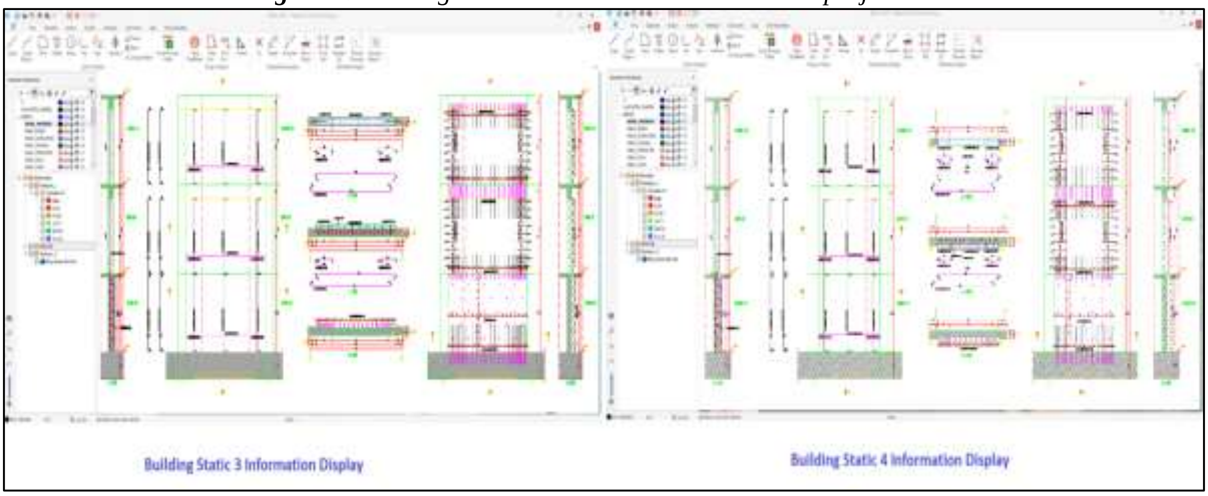

Figure 10. *Building 3rd and 4th Floor static structure project view*

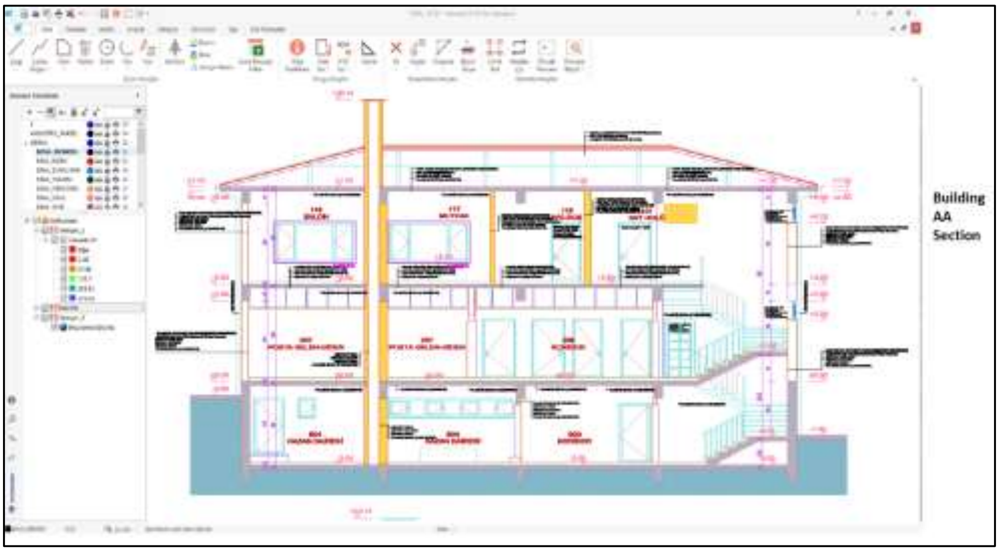

Figure 11. *A sectional AA image of a Cad 2D building*

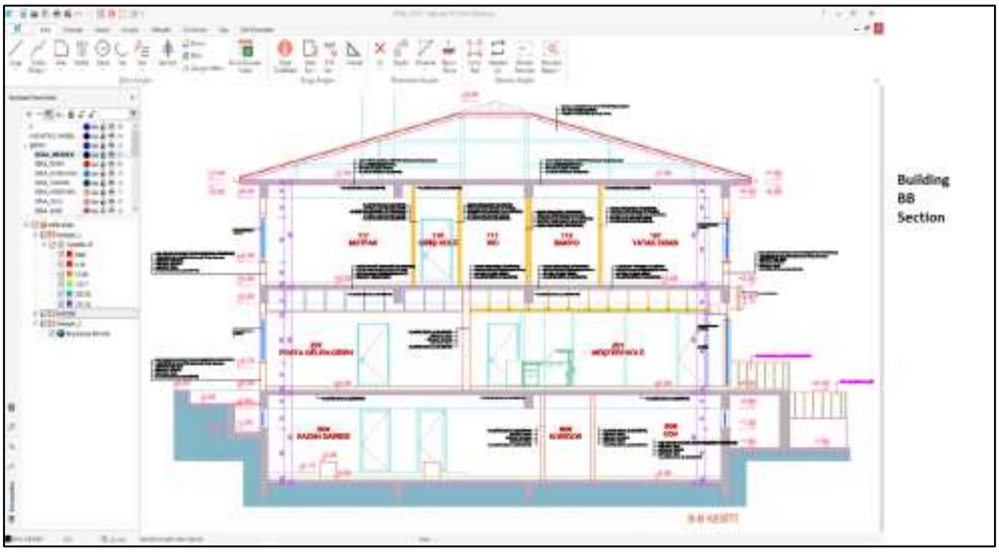

Figure 12. *A sectional BB image of a Cad 2D building*

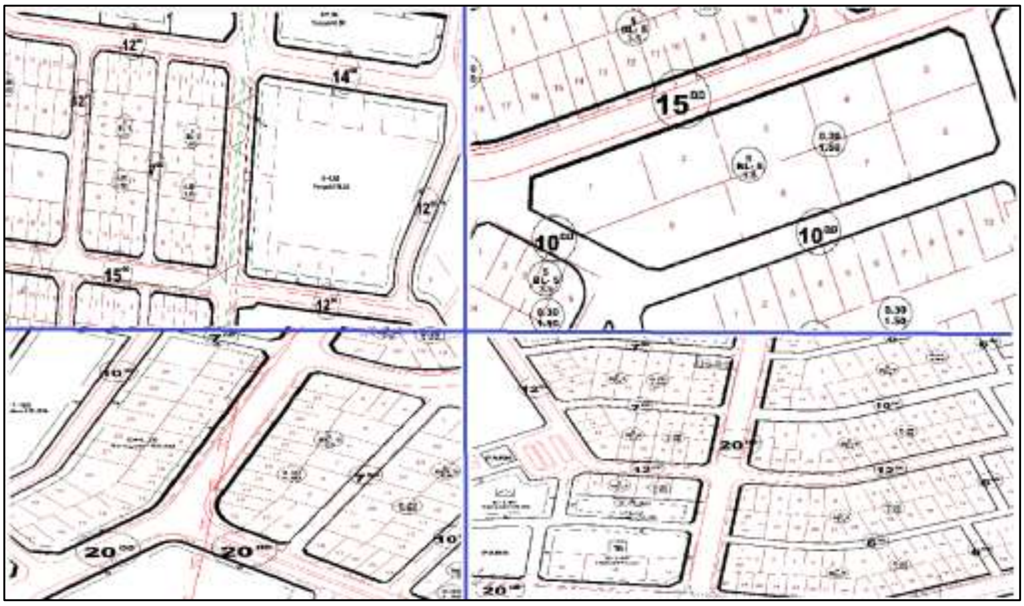

Figure 13. *2D zoning plan view*

The images shown between Figure 2 - Figure 13 are a 2D architectural project, static structure, site plan, independent division plan, ground and basic section building, and development plan with island identity features in the development plan. Typically, when reading only from this project, it is highly probable that holistic inputs and outputs will be overlooked due to the planar tone perspective. Because each process step is independent and the relationship network can only be followed manually as a single-point order, the possibility of making mistakes increases. Archiving, drawing distances of parcels, facade, and depth measurement tracking will be dependent on the person; however, a building like a zipper will be made, and all project stages will turn into a series of errors with a mistake. Therefore, the BIM model will be created by transferring all data to the digital system and comparing the 3D calculations in the CAD environment with the on-site calculations under one roof.

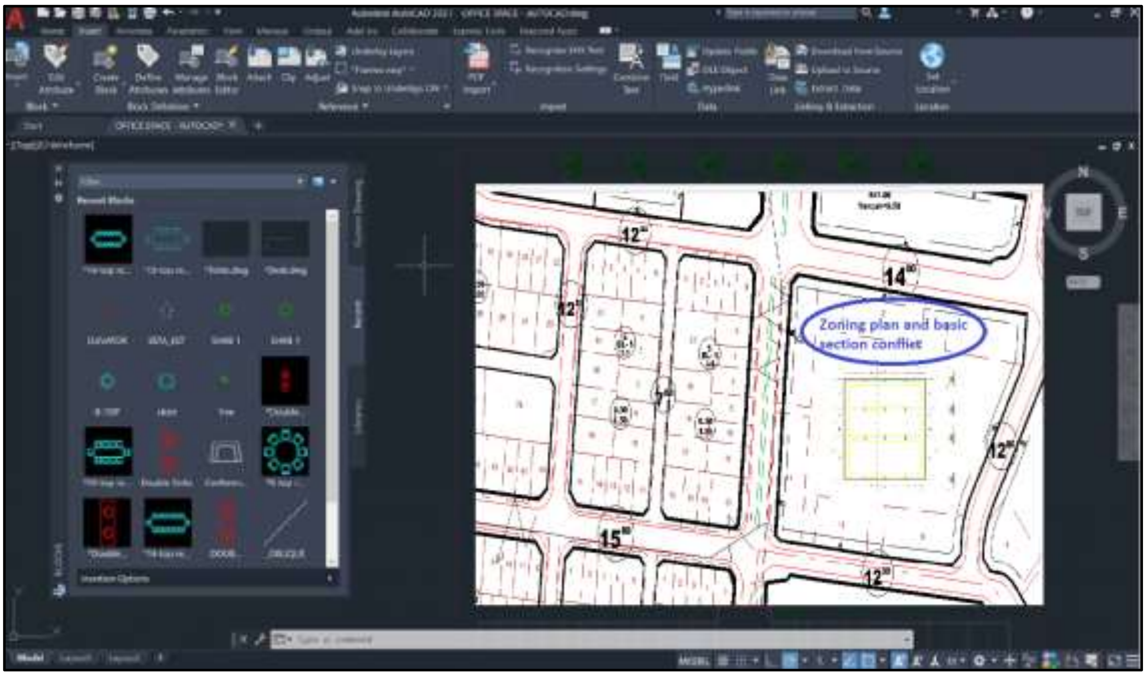

Figure 14. *Building ground project and parcel view placed on 3D zoning plan*

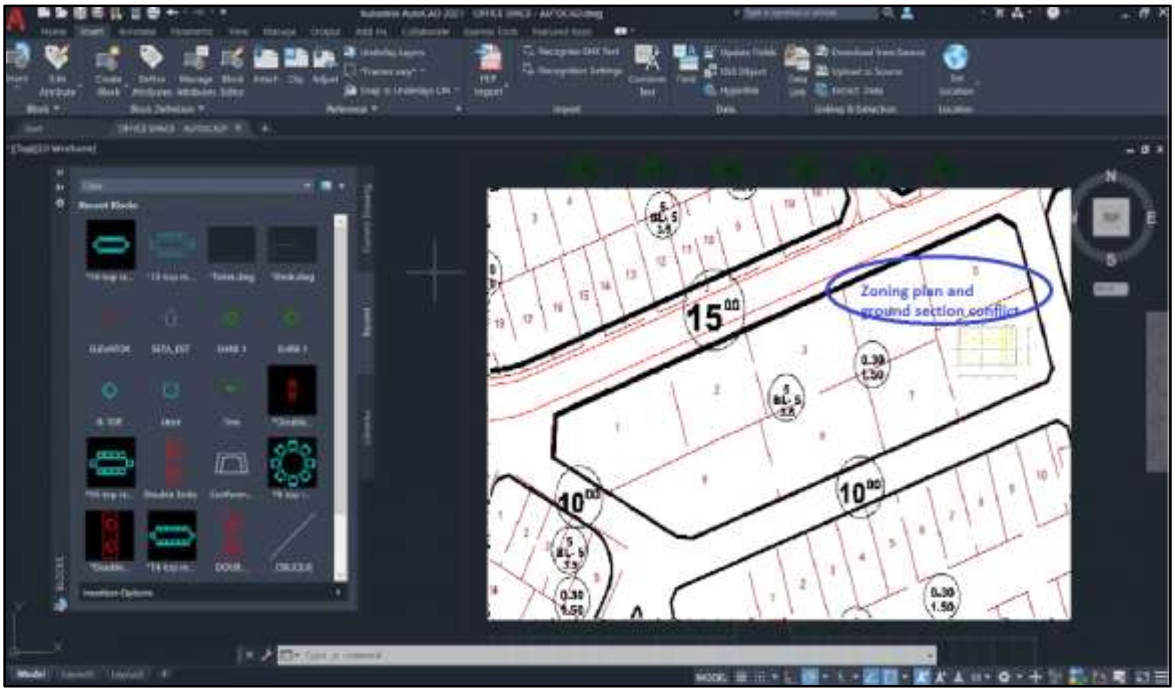

Figure 15. *Building ground facade depth and parcel view placed on the 3D zoning plan*

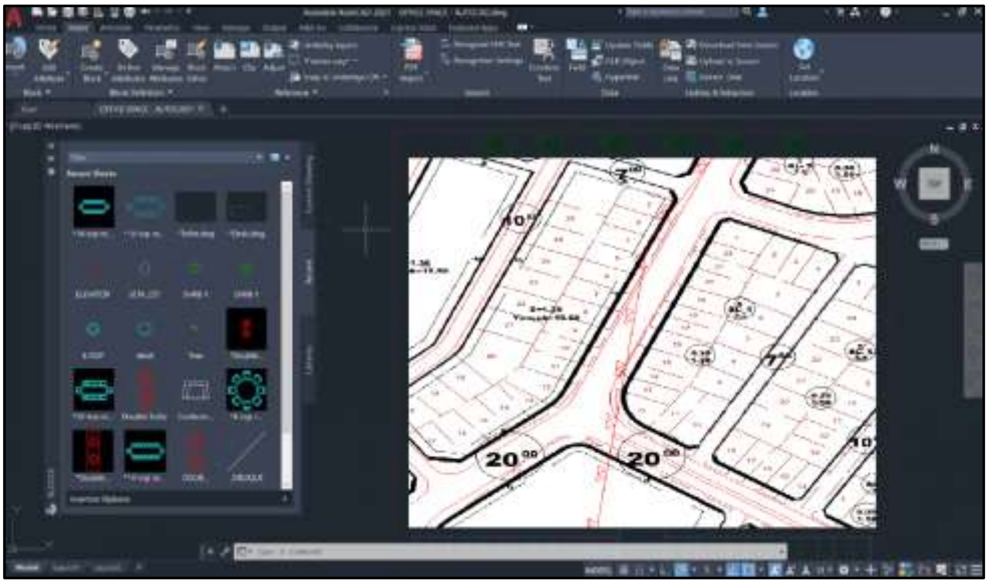

Figure 16. *3D zoning island and precedent features loading image*

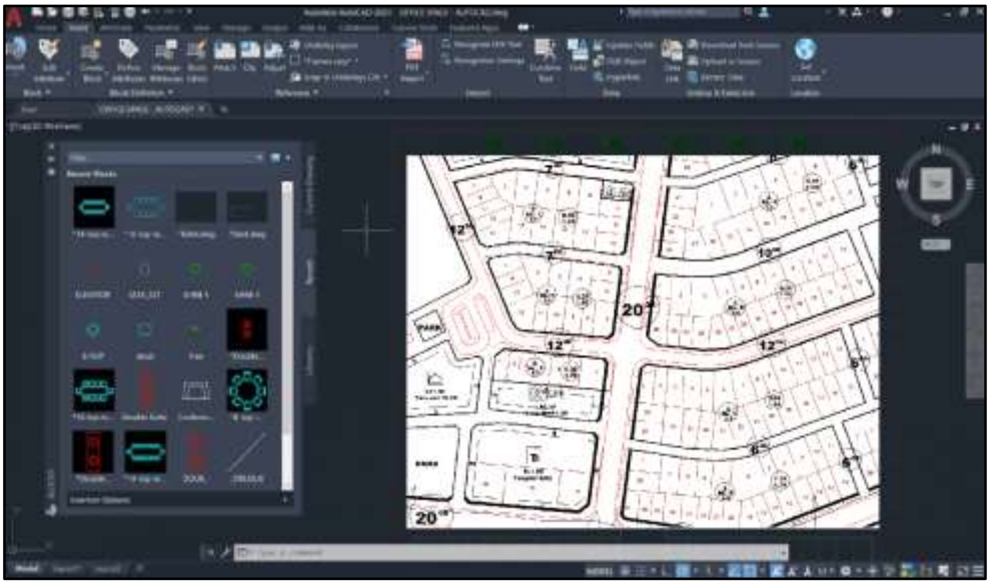

Figure 17. *General plan section view*

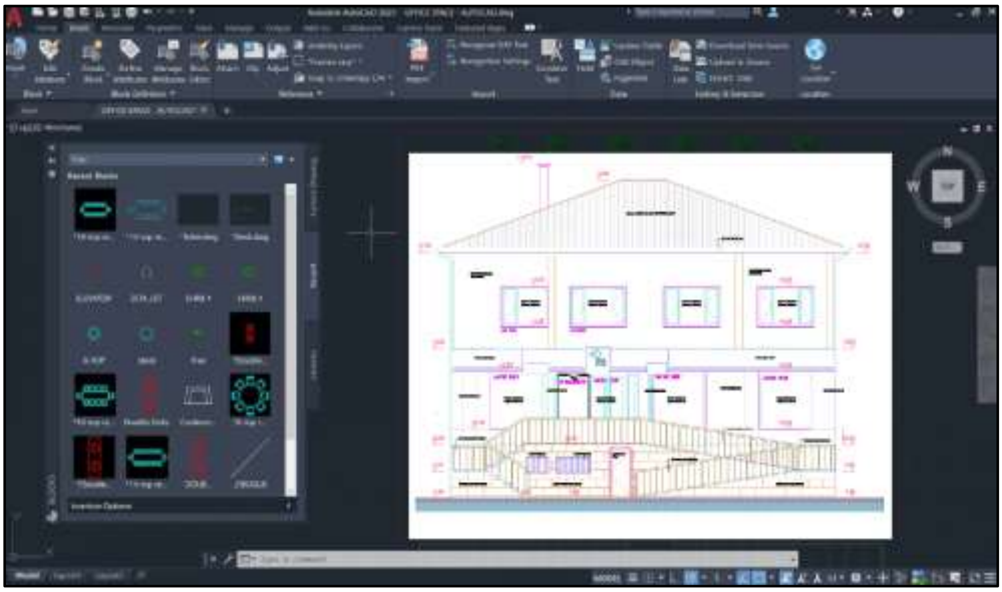

Figure 18. *3D building AA image*

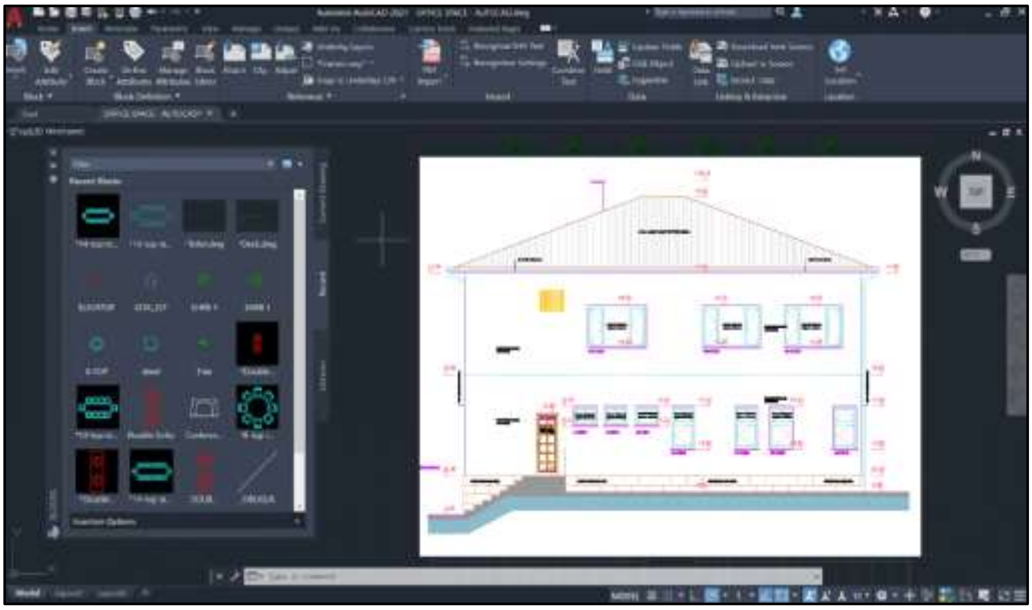

Figure 19. *3D building BB image*

In the images shown between Figure 14 - Figure 19, the 2-dimensional sections of the zoning parcel and building projects in all aspects were placed on the Autodesk base and rotated 3600 in the X-Y plane to create a model in the form of a model. As a result of following each step that was done or will be done completely, the images of the information system formation were obtained. The foundation project between the parcel and the building steps will be determined according to the zoning status, the building height according to the plan H ratio, and the construction foundation surface area per floor will be determined according to the floor area coefficient ratio limited by the plan.

In Table 1, if the building stock model is taken as the basis in the sense of urbanism over two floors, the cost required for an average construction site starts at the beginning of the construction of a building in the parcel size. The installation amount required will be calculated in this way: the analysis of the final account information received from the relevant institutions and the market, which will emerge at the end of the project, and the values entered with BIM before the project starts. In other words, the unknown cost increase after the start of the work according to the traditional method will be minimized. This can contribute to the perfection of the planning process.

Table 1. *Average material type and equivalent per floor (BIM construction model calculation)*

Average Material Type and Equivalent per Floor				**Building**			
Serial No.	**Pos. No.**	**Name of the Pose**	**Unit of Pose**	**Unit Price (Specifying Year)**	**Unit Price Year**	**Amount**	**Price ($)**
1	1	Garden Type (Including Cabin Production and Assembly, Cabin Electrical Internal Installation, and Electrical UPS Table Works). Preparation of Place for Cabin Assembly, Energy Supply Grounding, UPS, and Air Conditioning	Piece	30.000.00 $	2024	1.00	30.000.00 $
2	2	Garden Type Cabin Over 100 Km Transportation Cost (Distance Over 100 Km Between Cabin Manufacturer Company Production Site and Installation Location)	Meters	5.40 $	2024	729.00	3.936.60 $
3	3	Garden Type Cabin Installation (Installation, Scale, and Adjustment Procedures, Making It Ready for Use by Making Energy and Data Connections, Including Crane) (In Case the Device is at the Workplace)	Piece	1.104.00 $	2024	1.00	1.104.00 $
4	4	Coffee Table Production	Piece	190.00 $	2024	1.00	190.00 $

5	5	3 Kva Uninterruptible Power Supply	Piece	1.000.00 $	2024	1.00	1.000.00 $
6	6	Air Conditioner 12000 BTU	Piece	1.500.00 $	2024	1.00	1.500.00 $
7	7	Isolation Transformer (3 Kva)	Piece	500.00 $	2024	1.00	500.00 $
8	8	Astronomical Time Clock Used in Lighting Control	Piece	180.00 $	2024	1.00	180.00 $
9	9	2x10mm^2 N2XH 1 Kv Underground Cables and Column and Feeder Line Installation (In case of excavation, payment will be made from the excavation fee.)	Metric Tonne (Mt)	15.00 $	2024	60.00	900.00 $
10	10	Grounding Rod (1,75 Mt)	Piece	140.00 $	2024	2.00	280.00 $
11	11	Cable Protection Pipes Q50 Pvc Pipe	Mt	4.50 $	2024	40.00	180.00 $
12	12	Plastic Insulated Conductor 1x16mm^2 Section (Ho7Z,07Z1)	Mt	10.00 $	2024	38.00	380.00 $
13	13	Making a Steel Bottom Platform for a Garden Type Cabin (H: 10 cm. Including Steel Coating)	Piece	412.50 $	2024	1.00	412.50 $
14	14	Crane Cost	Piece	100.00 $	2024	1.00	100.00 $
15	15	Electricity Subscription Transactions	Piece	1.100.00 $	2024	1.00	1.100.00 $
16	16	Electrical Panel (As per Project)	Piece	200.00 $	2024	1.00	200.00 $
17	17	Step	Piece	600.00 $	2024	1.00	600.00 $
18	18	Digging Soft Slugs by Hand	M^3	100.00 $	2024	1.60	160.00 $
19	19	Aluminum Coating with Chest	M^2	52.50 $	2024	1.70	89.25 $
/	/	/	/	/	/	/	42.812.35 $

Table 2. *Approximate building project completion BIM cost analysis calculation*

Serial No.	Pos. No.	Definition	Unit	Amount	Unit Price	Price $	Percentage	Total Percentage
1	04.769 /10	EPDM rubber, neoprene, or the insulation and glass seals and wicks	KG	15,00	4,25	63,75	0,023771	0,023771
2	18.181	Demolition of masonry construction without explosives or mortar	M^3	6,666	34,79	231,91	0,086472	0,086472
3	18.183	Explosive-free cement mortar masonry, Khorasan construction demolition	M^3	20,88	74,54	1.556,40	0,580336	0,580336
4	18.185	Non-explosive, non-ferrous concrete construction demolition	M^3	6,06	154,04	933,48	0,348067	0,348067
5	18.191	Border Removal	Mt	41,60	2,49	103,58	0,038622	0,038622
6	18.195	Dismantling of all kinds of wooden doors, windows, and glass windows	M^2	34,02	9,28	315,71	0,117719	0,117719
7	18.198 /01	Removal of all kinds of rain gutters, such as sheet metal, PVC, zinc, etc.	Mt	66,70	3,41	227,45	0,084809	0,084809
8	18.198 /02	Dismantling of rain pipes, such as sheet metal, PVC, zinc, etc.	Mt	68,76	3,41	234,47	0,087427	0,087427
9	18.198 /10	Removal of galvanized sheet, aluminum, glass fiber reinforced, etc. roof covering	M^2	270,10	6,69	1.806,97	0,673766	0,673766
10	18.198 /11	Removal of marble, travertine, terrazzo tiles, and andesite coatings of all thicknesses	M^2	133,498	9,81	1.309,62	0,488319	0,488319
11	18.198 /12	Removal of ceramic, tile, etc. coatings	M^2	39,71	11,09	440,38	0,164205	0,164205
12	18.198 /18	Remove wooden and PVC skirting boards, etc.	Mt	107,50	2,29	246,18	0,091793	0,091793
13	18.198 /21	Removal of windowsills, parapets, and copings from marble, travertine, and andesite slabs	M^2	11,976	13,86	165,99	0,061893	0,061893
14	18.198 /22	Removal of sills, parapets, and copings from cast mosaic	M^2	7,482	22,75	170,22	0,06347	0,06347

15	18.198 /29	Dismantling of all kinds of iron (doors, windows, glass windows, railings, fences, sheet metal door frames, etc.)	KG	1.723,101	2,41	4.152,67	1,54840899 99999999	1,54840899 99999999
16	18.241	Roofing the wooden roof with 0.50 mm galvanized corrugated sheet metal	M^2	275,457	37,38	10.296,58	3,83929199 99999999	3,83929199 99999999
17	18.246 /7	1 layer waterproofing under the roof with 3 mm thick elastic base poly felt stone poly bit covering on the wooden roof	M^2	275,457	22,50	6.197,78	2,31097000 00000002	2,31097000 00000002
18	21.011	Flat surface concrete and reinforced concrete formwork	M^2	175,26	29,38	5.149,14	1,91996300 00000001	1,91996300 00000001
19	21.054	Wooden formwork scaffolding (maximum 4 m)	M^3	99,22	4,76	472,29	0,176103	0,176103
20	21.057	Wooden formwork scaffolding (height 4.01-6 m)	M^3	24,36	10,65	259,43	0,096734	0,096734
21	22.009 /3A	A double-sided plywood-pressed door leaf with laminated sheet coating is to be installed instead of being made	M^2	3,96	212,08	839,84	0,313152	0,313152
22	23.111	Making and replacing all kinds of iron doors and windows	KG	3,00	11,29	33,87	0,012629	0,012629
23	27.525 /1A	Perlite plaster and satin plaster coating can be applied to surfaces such as concrete, brick walls, etc.	M^2	131,24	35,91	4.712,83	1,75727600 00000001	1,75727600 00000001
24	27.528 /1A	Plaster primer (finishing) (in repair works)	M^2	531,454	4,00	2.125,82	0,792656	0,792656
25	27.565	Making flat mosaic floor covering	M^2	47,896	39,56	1.894,77	0,706504	0,706504
26	MSB.8 51/1	Making Sheet Metal Rain Downpipe	Mt	68,76	51,59	3.547,33	1,32269499 99999999	1,32269499 99999999
27	P-007/A	Supply and Installation of Insulating Glass Unit Consisting of 3+3 mm. Laminated+12 mm. HB+4 mm. Flat Glass	M^2	1,152	125,00	144,00	0,053693	0,053693
28	P-028/C	Stair Step Covering with Andesite Plates (B=3, R=2 cm)	Mt	21,60	57,26	1.236,82	0,461174	0,461174
29	P-030/C-MK	Wall Cladding with 2 cm Thick Andesite Slabs	M^2	20,66	96,42	1.992,04	0,742773	0,742773
30	P-033/A	Dismantling of Aluminum and PVC Manufacturing	M^2	8,045	9,05	72,81	0,027149	0,027149
31	P-035/A	Applying Two Layers of Plastic Whitewash to Old Whitewashed Surfaces	M^2	643,41	8,95	5.758,52	2,14718300 00000001	2,14718300 00000001
32	P-036/A	Glass Removal	M^2	8,045	8,03	64,60	0,024087	0,024087
33	P-039	Painting Painted Iron Fabrication with Two Coats of Oil Paint	M^2	15,84	19,42	307,61	0,114699	0,114699
34	P-074	Rod Anchoring with Injection Resin (Drilling holes horizontally and vertically in concrete up to 60cm, making rod anchors, and filling the holes with injection resin)	Piece	171,00	82,81	14.160,51	5,28003800 00000002	5,28003800 00000002
35	P-074/A	Rod Anchoring with Injection Resin (Drilling holes horizontally and vertically in concrete up to 30cm, making rod anchors, and filling the holes with injection resin)	Piece	301,00	47,66	14.345,66	5,349075	5,349075
36	P-088	Making Plaster Skirt, Chimney Edge, Roof Inspection Cover, and Roof Lantern Bottom with 0.70 mm Flat Aluminum Sheet	Mt	12,00	31,04	372,48	0,138887	0,138887
37	P-106/C	Making coping with a 4 cm thick andesite plate	M^2	2,336	149,46	349,14	0,130184	0,130184

38	P-115/b	Making reinforced (14-Point Locking Multi System Door Lock) Door Wing and Frame (10' Wall 90/210)	Piece	1,00	2.000,00	2.000,00	0,745741	0,745741
39	P-130/d	Aluminum Joinery Wide Type Door Lock	Piece	1,00	81,25	81,25	0,030296	0,030296
40	P-130/e	Aluminum Joinery Door Handles and Mirrors	Piece	1,00	50,00	50,00	0,018644	0,018644
41	P-130/g	Aluminum Joinery Door Bottom Brush	Mt	0,95	15,00	14,25	0,005313	0,005313
42	Y.16.050/03	Pouring concrete (including concrete transportation) in the c 16/20 compressive strength class, produced in the concrete plant or purchased and pressed with a concrete pump	M^3	8,64	155,85	1.346,54	0,502085	0,502085
43	Y.16.050/15	Pouring concrete (including concrete transportation) in the C 25/30 compressive strength class, produced in the concrete plant or purchased and pressed with a concrete pump	M^3	7,209	175,15	1.262,66	0,470809	0,470809
44	Y.16.059/1A	Pouring concrete (including concrete transportation) in the c 30/37 compressive strength class, produced or purchased in the concrete plant and pressed with a concrete pump	M^3	28,09	170,26	4.782,60	1,783291	1,783291
45	Y.18.110/01C04	Building a wall with 10 cm thick aerated concrete wall blocks without equipment (with aerated concrete glue) (g2 class) (2.50 n/mm² and 400 kg/m³)	M^2	15,695	34,43	540,38	0,201492	0,201492
46	Y.18.111/01	Building an 11.5 cm thick wall with lime sandstone of (37.5x11.5x19 cm) size (glue application)	M^2	22,22	28,00	622,16	0,231985	0,231985
47	Y.19.055/045	External thermal insulation on external walls with 7 cm thick carbon black - graphite-based expanded polystyrene sheets (EPS - 16 kg/m^3 density) and thermal insulation plaster on top (sheathing)	M^2	189,628	47,99	9.100,25	3,3932159999999998	3,3932159999999998
48	Y.19.055/046	External thermal insulation on external walls with 8 cm thick carbon black - graphite-based expanded polystyrene sheets (EPS - 16 kg/m^3 density) and thermal insulation plaster on top (sheathing)	M^2	364,975	49,71	18.142,91	6,764958	6,764958
49	Y.21.001/03	Making flat surface reinforced concrete formwork with plywood	M^2	46,60	39,63	1.846,76	0,688603	0,688603
50	Y.21.101/06	OSB/3 coating on the roof	M^2	275,457	28,43	7.831,24	2,920039	2,920039
51	Y.21.290/01	Making and replacing skirting boards from wood	Mt	118,22	9,84	1.163,28	0,433753	0,433753
52	Y.22.001/01	Making and installing solid wooden inner door frames and molding	M^2	22,44	119,39	2.679,11	0,998961	0,998961
53	Y.23.014	Ø 8- Ø 12 mm ribbed concrete steel bar, cutting, bending, and placing the bars	Tonne	2,82	2.552,31	7.197,51	2,6837399999999998	2,6837399999999998
54	Y.23.015	Ø 14- Ø 28 mm ribbed concrete steel bar, cutting, bending, and placing the bars.	Tonne	4,51	2.503,25	11.289,66	4,2095830000000003	4,2095830000000003
55	Y.23.155	Making and placing a bending door frame from 2.00 mm thick hot rolled sheet metal	KG	2,652	9,45	25,06	0,009344	0,009344
56	Y.23.176	Making and placing various ironworks from flat and profile irons	KG	1.889,009	7,95	15.017,62	5,5996290000000002	5,5996290000000002
57	Y.23.231	Flooring with diamond-patterned sheet metal and placing it in place (on existing beams, partitions, stairs, and carriers)	KG	1.013,54	6,64	6.729,91	2,5093860000000001	2,5093860000000001

58	Y.23.241	Manufacturing and installing plastic joinery (manufacturing all kinds of doors, windows, coatings, and similar from hard PVC joinery profiles)	KG	31,68	10,74	340,24	0,126866	0,126866
59	Y.23.244/F	Manufacturing and installation of natural-matte and anodized heat-insulated aluminum joinery	KG	28,425	24,01	682,48	0,254477	0,254477
60	Y.24.065	Making a seamless gutter from 0.50 mm thick, hot dip galvanized, painted flat sheet metal and installing it in place (Sheet width is 30 cm in total)	Mt	66,70	18,39	1.226,61	0,457367	0,457367
61	Y.25.002/01	Applying two layers of paint to iron surfaces against corrosion	M²	11,11	11,43	126,99	0,047351	0,047351
62	Y.25.002/03	Applying two coats of solvent-based epoxy paint to iron surfaces	M²	65,731	22,73	1.494,07	0,557095	0,557095
63	Y.25.003/05	Applying two coats of water-based matte paint to old painted surfaces by applying primer (interior)	M²	188,31	17,51	3.297,31	1,2294700000000001	1,2294700000000001
64	Y.25.003/16	Applying two coats of water-based matte paint to satin plaster and plasterboard surfaces by applying primer (interior)	M²	1.077,288	12,10	13.035,18	4,860436	4,860436
65	Y.25.004/04	Applying silicone-based water-based paint to exposed concrete, plastered or old painted surfaces by applying primer (exterior)	M²	77,184	21,64	1.670,26	0,622791	0,622791
66	Y.25.004/05	Applying a silicone-based grained/textured coating to exposed concrete, plastered or old painted surfaces by applying primer (exterior)	M²	22,56	23,64	533,32	0,198859	0,198859
67	Y.26.005/402	Floor covering with first quality, colored ceramic floor tiles with 3 mm joint spacing in nominal dimensions of (30 x 30 cm) or (33 x 33 cm), with all kinds of patterns and surface features (with tile adhesive)	M²	2,933	35,60	104,41	0,038931	0,038931
68	Y.26.006/407	Wall covering with first-quality, colored ceramic wall tiles with 3 mm joint gaps in nominal dimensions of (20 x 50 cm) or (25 x 50 cm) or (30 x 45 cm) or (33 x 45 cm), with all kinds of patterns and surface features (with tile adhesive)	M²	43,444	38,40	1.668,25	0,622041	0,622041
69	Y.26.017/032	Floor covering with 8 cm high normal cement steam-cured concrete paving stones (in all sizes, colors, and patterns)	M²	52,438	36,75	1.927,10	0,718559	0,718559
70	Y.26.017/065	50 x 20 x 10 cm normal cement steam-cured concrete curb laying (beveled, any color)	Mt	38,56	15,34	591,51	0,220557	0,220557
71	Y.26.017/125	30 x 10 x free length cm white cement steam cured concrete gutter stone laying (all colors)	Mt	19,38	20,93	405,62	0,151244	0,151244
72	Y.26.020/042A	Making external windowsill with 3 cm thick colored marble slab (3cmx30-40-50cmxfree size) (honed or polished)	M²	11,097	176,70	1.960,84	0,73114	0,73114
73	Y.27.501/01	Plastering with 250/350 kg cement dosed with coarse and fine mortar (exterior plaster)	M²	96,48	28,08	2.709,16	1,0101659999999999	1,0101659999999999
74	Y.27.501/03	Plastering with 250/350 kg lime/cement mixture of coarse and fine mortar (ceiling plaster)	M²	175,613	26,04	4.572,96	1,705122	1,705122
75	Y.27.578	Making mosaic-coated concrete coping on masonry walls of all widths (normal cement)	M²	14,472	153,44	2.220,58	0,827989	0,827989
76	Y.27.581	Making a leveling layer with a 200 kg cement dose	M²	33,96	13,09	444,54	0,165756	0,165756
/	/	/	/	/	**Total**	**217.027,23**	**/**	**80,92**

In Table 2, the approximate cost analysis will be completed in line with the measurement units of the items required for the frame structure at the beginning of the project, which will have a minimum of two floors. The BIM model can show how much money will be spent on each item.

4. Conclusion

By integrating BIM into the planning process, architects and planners can more effectively coordinate buildings' spatial and structural elements with the specific characteristics of the land on which they are situated. In addition, the relationship between buildings and their parcels is vital for the efficacy of zoning. The following points outline the key considerations and suggestions for integrating BIM into the town planning process to enhance efficiency and promote sustainability.

- Topographical Considerations in Zoning and Urbanization: During town planning, all essential topographical features—such as slope, aspect, and geological structure—are evaluated. These parameters serve as foundational elements for developing building systems, ensuring that the natural landscape is thoughtfully integrated with town planning frameworks. BIM facilitates this evaluation by enabling planners to visualize and analyze terrain data, leading to designs that harmonize with the environment [28,29].

- Parcel Formation within Zoning Regulations: The process of parcel creation, guided by zoning and cadastral laws, organizes all pertinent geospatial data. This approach facilitates compliance with regulatory requirements and supports orderly town development in line with planning codes. By utilizing BIM, planners can simulate various zoning scenarios, optimizing parcel layouts to enhance functionality and aesthetics while adhering to legal constraints [30].

- Data Storage and Movement Tracking Based on Parcel Boundaries: Parcel boundary-based data storage and movement tracking provide a precise, organized spatial link between the building and its corresponding land parcel, significantly improving overall project accuracy and accountability. BIM allows for the dynamic updating of this data throughout the project lifecycle, ensuring that any changes in design or use are accurately reflected and managed, thereby reducing the risk of errors and omissions [30,31].

- Sustainability through Integrated Project Continuity: BIM promotes long-term sustainability by ensuring the seamless integration of all project components throughout the building's lifecycle [31,32]. Continuous interaction among systems maximizes resource efficiency and supports the sustainable management of building projects. By providing a holistic project view, BIM enables stakeholders to make informed decisions considering environmental impacts, resource consumption, and maintenance needs, ultimately fostering a more sustainable town environment [28,29,31,32].

In summary, integrating BIM into town planning transforms traditional methodologies by streamlining processes and enhancing the correlation between buildings and their parcels. BIM empowers planners and architects to analyze the interactions between architectural designs and land characteristics, supporting informed decision-making [33]. As urbanization accelerates, its real-time data sharing and scenario simulation capabilities facilitate efficient and environmentally responsible developments, ultimately contributing to the sustainable creation of livable town spaces that meet human needs.

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References

[1] Taştekin, O. (2019). An investigation on the management of tender processes by using building

information modeling in international construction projects [Master's Thesis, İstanbul Teknik Üniversitesi]. Türkiye Thesis Center (Council of Higher Education). Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/ (Thesis No. 559131)

[2] Kartoğlu, G. (2016). Building information modelling as a computational design method [Master's Thesis, Yıldız Teknik Üniversitesi]. Türkiye Thesis Center (Council of Higher Education). Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/ (Thesis No. 432144)

[3] Muratoğlu, H. (2015). Effects of using BIM on disputes arised from design process [Master's Thesis, İstanbul Teknik Üniversitesi]. Türkiye Thesis Center (Council of Higher Education). Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/ (Thesis No. 397864)

[4] Sacks, R., Eastman, C., Lee, G., & Teicholz, P. (2018). *BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers, 3rd Edition*. John Wiley & Sons, Inc., Hoboken, New Jersey. http://doi.org/10.1002/9781119287568

[5] Süer, F. Z. (2022). Multidimensional evaluation of external wall application details in mass housing projects; analysis at Ankara province scale [Master's Thesis, Gazi Üniversitesi]. Türkiye Thesis Center (Council of Higher Education). Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/ (Thesis No. 751800)

[6] Shin, B., & Kim, S. (2022). CO_2 emission and construction cost reduction effect in cases of recycled aggregate utilized for nonstructural building materials in South Korea. *Journal of Cleaner Production*, *360*, 131962. https://doi.org/10.1016/j.jclepro.2022.131962

[7] Taygun, G. T. (2005). A model for life cycle assessment of building materials [Doctoral Dissertation, Yıldız Teknik Üniversitesi]. Türkiye Thesis Center (Council of Higher Education). Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/ (Thesis No. 198931)

[8] Belany, P., Hrabovsky, P., & Kolkova, Z. (2021). Combination of lighting retrofit and life cycle cost analysis for energy efficiency improvement in buildings. *Energy Reports*, *7*, 2470-2483. https://doi.org/10.1016/j.egyr.2021.04.044

[9] Çetin, M. (2020). Analyzing collaboration barriers and improvement pathways in bim-based teamwork of architects and structural engineers [Master's Thesis, Başkent Üniversitesi]. Türkiye Thesis Center (Council of Higher Education). Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/ (Thesis No. 659508)

[10] Pektaş, Ş. T. (2014). The Layered Dependency Structure Matrix for Managing Collaborative Design Processes. *Open House International*, *39*(1), 26-35. http://doi.org/10.1108/OHI-01-2014-B0004

[11] Glick, S., & Guggemos, A. A. (2009). IPD and BIM: Benefits and Opportunities for Regulatory Agencies. In *Proceedings of the 45th Associated Schools of Construction National Conference* (pp. 1-8). Associated Schools of Construction. Retrieved from http://ascpro0.ascweb.org/archives/2009/CPGT172002009.pdf

[12] Demircan, K. (2021). BIM'e geçiş süreçlerinde anlaşmazlık ve uyuşmazlıkların incelenmesi [Master's Thesis, Kocaeli Üniversitesi]. Türkiye Thesis Center (Council of Higher Education). Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/ (Thesis No. 669048)

[13] Afsari, K. (2012). Building Information Modelling in Concept Design Stage [Master's Thesis, University of Salford]. Retrieved from http://doi.org/10.13140/RG.2.1.2240.1521

[14] Turan, M. (2021). An investigation on the opportunities of BIM (building information modeling) in the conceptual architectural design process [Master's Thesis, Gazi Üniversitesi]. Türkiye Thesis Center (Council of Higher Education). Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/ (Thesis No. 728141)

[15] Bebanı, Z. (2022). UAV and BIM technology performance in infrastructure projects [Master's Thesis, Tokat Gaziosmanpaşa Üniversitesi]. Türkiye Thesis Center (Council of Higher Education). Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/ (Thesis No. 757157)

[16] Azhar, S., Khalfan, M., & Maqsood, T. (2012) Building Information Modelling (BIM): Now and Beyond. *Construction Economic and Building*, *12*, 15-28. https://doi.org/10.5130/ajceb.v12i4.3032

[17] Boydak, H. (2020). Simulation assessment of green concept outputs in energy efficiency of hospital buildings: Elazig example [Master's Thesis, Fırat Üniversitesi]. Türkiye Thesis Center (Council of Higher Education). Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/ (Thesis No. 674667)

[18] Yapı Bilgi Modelleme: Gereksinim ve Birlikte Çalışabilirlik. *Mimarist*, *14*(49), 10-12.

[19] Akciger, A. (2021). Generating the final bim with automatic extraction method in final projects [Master's Thesis, İstanbul Teknik Üniversitesi]. Türkiye Thesis Center (Council of Higher Education). Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/ (Thesis No. 677473)

[20] Süer, B. (2022). A proposal of an office lighting design in bim [Master's Thesis, İstanbul Kültür Üniversitesi]. Türkiye Thesis Center (Council of Higher Education). Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/ (Thesis No. 714675)

[21] Ren, Y., Skibniewski, M. J., & Jiang, S. (2012). Building information modeling integrated with electronic commerce material procurement and supplier performance management system. *Journal of Civil Engineering and Management*, *18*(5), 642-654. https://doi.org/10.3846/13923730.2012.719835

[22] Kymmell, W. (2008). *Building Information Modeling: Planning and Managing Construction Projects with 4D CAD and Simulations (McGraw-Hill*

Construction Series), 1st Edition. The McGraw-Hill Companies, Inc., New York.

[23] Clayton, M. J., Johnson, R. E., Vanegas, J., Ozener, O. O., Nome, C. A., & Culp, C. E. (2007). *Downstream of Design: Lifespan Costs and Benefits of Building Information Modeling*. Retrieved from http://doi.org/10.13140/RG.2.1.1032.0245

[24] İlhan, B., & Yaman, H. (2015). BIM and Sustainable Construction Integration: An IFC-Based Model. *MEGARON / Yıldız Technical University Faculty of Architecture E-Journal*, *10*(3), 440-448. http://doi.org/10.5505/MEGARON.2015.09719

[25] Li, X., Wu, P., Shen, G. Q., Wang, X., & Teng, Y. (2017). Mapping the knowledge domains of Building Information Modeling (BIM): A bibliometric approach. *Automation in Construction*, *84*, 195-206. https://doi.org/10.1016/j.autcon.2017.09.011

[26] Krygiel, E., & Nies, B. (2008). *Green BIM: Successful Sustainable Design with Building Information Modeling*. Wiley Publishing, Inc., Indianapolis, Indiana. Retrieved from https://www.wiley.com/en-us/Green+BIM%3A+Successful+Sustainable+Design+with+Building+Information+Modeling-p-9780470239605

[27] Shourangiz, E., Mohamad, M. I., Mohamad, M. S., Banihashemi, S. S., Bakhtiari, M., & Torabi, M. (2011). Flexibility of BIM towards Design Change. In *2011 2nd International Conference on Construction and Project Management* (pp. 79-83). International Association of Computer Science and Information Technology (IACSIT) Press. Retrieved from https://www.academia.edu/2643184/Flexibility_of_BIM_towards_Design_Change

[28] Nikologianni, A., Mayouf, M., & Gullino, S. (2022). Building Information Modelling (BIM) and the impact on landscape: A systematic review of evolvements, shortfalls and future opportunities. *Cleaner Production Letters*, *3*, 100016. https://doi.org/10.1016/j.clpl.2022.100016

[29] Cheng, Q., Tayeh, B. A., Abu Aisheh, Y. I., Alaloul, W. S., & Aldahdooh, Z. A. (2024). Leveraging BIM for Sustainable Construction: Benefits, Barriers, and Best Practices. *Sustainability*, *16*(17), 7654. https://doi.org/10.3390/su16177654

[30] Tran, S. V. T., Lee, D., Pham, H. C., Dang, L. H., Park, C., & Lee, U. K. (2024). Leveraging BIM for Enhanced Camera Allocation Planning at Construction Job Sites: A Voxel-Based Site Coverage and Overlapping Analysis. *Buildings*, *14*(6), 1880. https://doi.org/10.3390/buildings14061880

[31] Pan, X., Mateen Khan, A., Eldin, S. M., Aslam, F., Kashif Ur Rehman, S., & Jameel, M. (2024). BIM adoption in sustainability, energy modelling and implementing using ISO 19650: A review. *Ain Shams Engineering Journal*, *15*(1), 102252. https://doi.org/10.1016/j.asej.2023.102252

[32] Akbari, S., Sheikhkhoshkar, M., Pour Rahimian, F., El Haouzi, H. B., Najafi, M., & Talebi, S. (2024). Sustainability and building information modelling: Integration, research gaps, and future directions. *Automation in Construction*, *163*, 105420. https://doi.org/10.1016/j.autcon.2024.105420

[33] Lai, H., Deng, X., & Chang, T. P. (2019). BIM-Based Platform for Collaborative Building Design and Project Management. *Journal of Computing in Civil Engineering*, *33*(3), 5019001. http://doi.org/10.1061/(ASCE)CP.1943-5487.0000830