



Investigating the Impact of Changing the Usage Type of Existing Structure Using BIM

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Abstract

Many real estate owners change the building in terms of the type of usage in response to changes in economic conditions and the requirements of the surrounding environment to get the best potential financial return. To investigate the possibilities of changing the real estate's usage, the owners of these existing structures turned to feasibility study experts for assistance in making the optimum alternatives. So, they need an integrated model between VE and BIM, especially applicable to an existing structure, to determine the optimum usage type for the existing structure. Value Engineering (VE) and Building Information Modeling (BIM) must be connected to profit from both outputs simultaneously. Previous studies only investigated the VE alternatives during the design phase; when they decided to reduce project costs by using construction materials alternatives, they ignored existing structure alternatives significantly when changing the usage type. This study attempts to provide an integrated model between VE and BIM that can be applied to the existing structure to assist in determining the best alternative in terms of the type of usage for such existing structures by conducting BIM methodology such as a feasibility study, including BIM software such as Revit and Primavera. A feasibility study that contains the bank rate of interest. As a result, the maximum financial return is obtained based on predetermined criteria and in compliance with decision-making requirements.

Keywords: Building Information Modeling (BIM); Value Engineering (VE); Optimal Solution; Feasibility Study; Integrated Model.

1. Introduction

The real estate owners sought the assistance of an economic expert to help them decide the best options for changing the construction usage. Most feasibility study experts employ the BIM technique in their studies, where it can decrease calculation time and failure costs. Building Information Modeling (BIM) is a digital system in which all essential information is stored, used, and controlled by all stakeholders, starting with the design and ending with the constructed building. Where BIM is a technology that enables the creation of a structure with the help of many stakeholders, a construction-wide culture shift is required to achieve a unified commitment to BIM [1].

Building Information Modeling (BIM) and Value Engineering (VE) hybrids were developed to get the most out of both. The previous integrated models failed because they were limited only to the building VE alternatives at the design phase and did not include VE alternatives for the existing structure. This study presents a comprehensive model for guiding decision-makers to the optimum VE alternative for existing structures using BIM tools as a feasibility study, including BIM software such as Revit and Primavera. The feasibility studies with the banks' interest ratio, the real estate

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owners' ability to make some modifications during the development of the alternative, and the time required to implement the alternative and achieve goals were all used in this study. Components of the integrated model technique are depicted in Figure 1.



Figure 1. The components of the integrated model

1.1. Value Engineering Methodology

Value engineering in building projects is an efficient technique to reduce project costs. In the past, many value models were created and employed in building projects [2]. Value engineering is a powerful problem-solving tool that can reduce costs while maintaining or improving performance and quality requirements [3]. Value engineering can improve decision-making, leading to an optimal expenditure of owner funds while meeting required function and quality levels. The success of the VE process is due to its ability to identify opportunities to remove unnecessary costs while assuring quality, reliability, performance, and other critical factors that meet or exceed customers' expectations [4].

Value approaches may be used more than once during the project's life cycle. Early use of a value approach aids in getting the project out on the proper foot, and subsequent applications aid in refining the project's direction when new or changing information becomes available. The longer a Value Study is carried out in the project development process, the more probable implementation costs will rise. A value approach can be used as a rapid response study to solve an issue or as part of a more considerable organizational effort to boost innovation and enhance performance. A company's quality initiatives, new product development activities, manufacturing processes, and architectural and engineering design may all benefit from value approaches [5]. Value engineering is a creative and structured way of increasing the value of a system. The most crucial component of a VE task plan is idea creation. Although the specialists in a value engineering team might analyze a variety of alternatives that could replace the original concept, most ideas are generated based on their expertise and experience [6].

A multidisciplinary team will use the VE study to increase the value of any project. Save International [7] establishes six consecutive steps for successful VE research. Pre-workshop stage, workshop stage, and post-workshop stage are the three stages. Figure 2 depicts the Save International VE study process, which includes stages and phases.

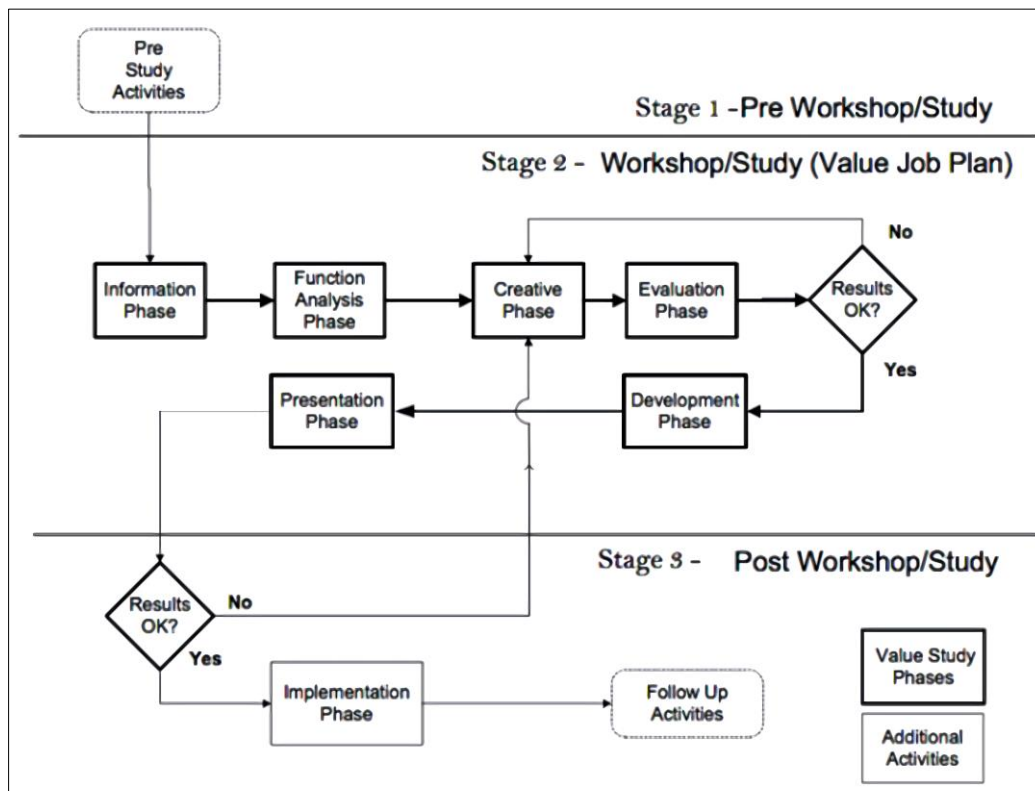


Figure 2. Value study process flow diagram [7]

This study's scope is limited to the workshop level (stage 2), which is the most technically demanding. Stage 2 of the VE research includes the following phases:

- Information Phase;
- Creativity Phase;
- Development Phase;
- Function Phase;
- Evaluation Phase;
- Presentation Phase.

The study included all six phases of a VE investigation; however, the study will focus on the Development Aspect, which is the most critical phase of any VE study.

1.2. Building Information Modeling Methodology

Building Information Modeling (BIM) is a virtual design and construction process that spans the whole building lifecycle. It's a place where project participants may share information and communicate. Building Information Modeling, in other terms, is the process of creating a Building Information Model. Building Information Models may create high-quality 3D visualizations of a structure. The feasibility study specialists do not realize the total potential value of the Building Information Model if they utilize the model better to explain the BIM idea in 3D to the owner and do not use the built-up information in the Building Information Model [8].

Building information modeling, or BIM, is a paradigm change in how buildings and other infrastructure are designed, engineered, built, and managed [9]. It differs significantly from the paradigm that has governed the architecture/engineering/construction (AEC) sector since the Renaissance. BIM platforms: a) use multi-dimensional (3D, 4D, etc.) representations of buildings; b) model buildings as compositions of digital objects that are faithful to the form, function, and behavior of the physical building elements they represent; c) serve as digital prototypes that allow simulation and analysis of building functional performance. With BIM technology's expanded capabilities, new design and building methods have fully evolved to utilize these capabilities [10].

With BIM technology's expanded capabilities, new design and building methods have fully evolved to utilize these capabilities. As a result, BIM incorporates both computer and business operations. Four essential characteristics distinguish BIM technology and procedures:

- They convey form, function, and behavior in an object-oriented manner.
- They can create and test digital construction prototypes.
- They make it possible to integrate the efforts of all those participating in a building project.
- They offer a relaxed atmosphere and facilitate the use of "building technology" [10].

The VE team utilizes the three-dimensional (3D) representation to comprehend the design and building components better. Information extraction and design change, essential VE activities, are simple to do in BIM. Previous research on the integration of VE and BIM has been limited, and no empirical proof exists of this integration's perceived benefits. VE workshops to assess a project or design take time and require much information and data from many project stakeholders. Typically, suggested changes to a project or structure cannot be tested immediately and must first be approved by the client (owner) [11].

1.3. VE and BIM Integrated Model

There are a few studies in the literature about BIM and VE integration. Dabade [12] recommended VE for the shop drawing generating process using a BIM-based workflow. They focused on how this strategy may increase productivity by applying it to a construction element (i.e., a window). Wei and Chen [13] use BIM and VE to enhance the design of green buildings. The study employed simulation to design various building envelope solutions for optimal energy usage.

The study did not, however, explain how VE is used to improve the design or select a viable replacement. Park et al. [14] focused on the brainstorming phase of a value engineering workshop and created a BIM-based prototype to help with idea development and retrieval. The BIM-based idea bank can help VE sessions run more efficiently. According to this literature review, there are still certain constraints in integrating the BIM and VE fields.

All the Previous research employed simulation to get the data and focused on minor components of the structure or a phase of the VE investigation. As a result, further practical studies based on an entire project are needed to evaluate VE and BIM integration adequately.

As indicated in the flowchart in Figure 3, the value approach is applied in an all-encompassing model via a consequence procedure known as the "Job Plan" [15]. This Job Plan aims to guide the revision group through the process of identifying and focusing on the significant project goals to generate new, value-adding ideas. A value study is often broken down into three stages:

- The Pre-Workshop Phase is the first step in the workshop process (Preparation Stage). The decision-purpose maker at this stage is to define the inquiry's primary objectives and potential themes, assemble an analytical team, and create a strategic strategy [16].
- Workshop Job Plan (Implementation of six phases), this stage aims to discover and resolve issues that develop as a consequence of the job's functions. The six steps are information, function, creativity, assessment, development, and presentation [17].
- Post-Workshop Stage (Follow-up to the workshop), its purpose is to ensure that workshop participants' permitted value study change ideas are carried out [17].

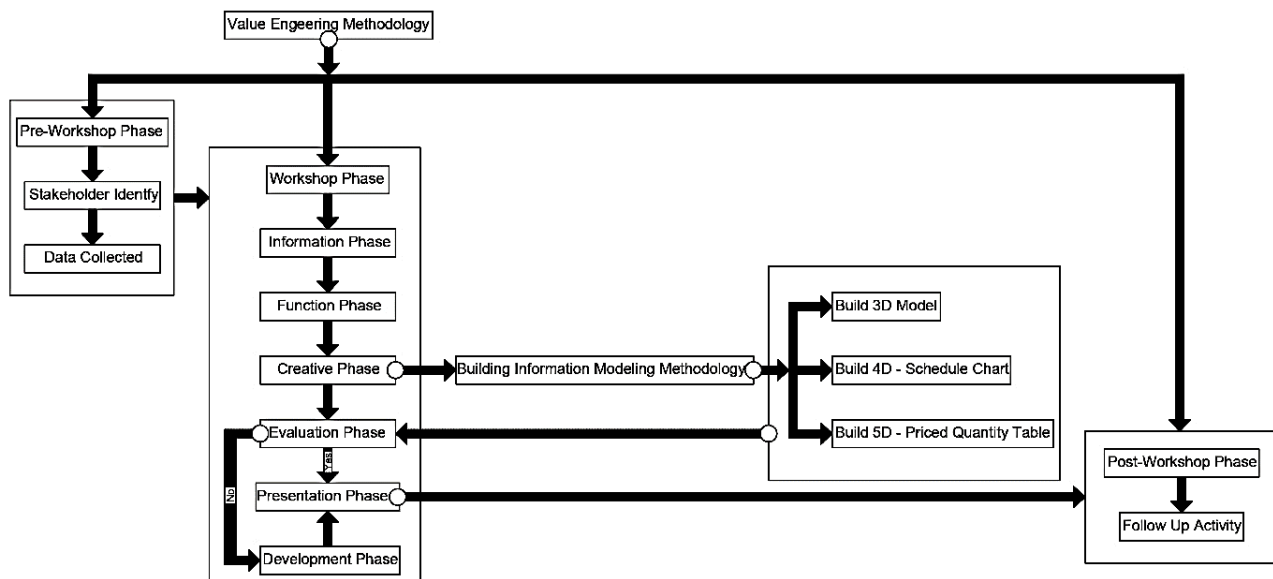


Figure 3. An integrated model flowchart

1.4. Feasibility Study

Project managers use feasibility studies to examine a project's or commercial endeavor's viability by identifying the aspects that can contribute to its success. The feasibility studies analysis also illustrates the possible return on investment and any threats to the venture's success [18]. A feasibility study is a comprehensive examination of what is required to execute the planned project. A description of the new product or business, a market study, the necessary technology, and labor, as well as sources of finance and capital, may all be included in the report. Financial predictions, the chance of success, and, finally, a go-or-no-go decision will all be included in the report [19, 20].

2. Research Methodology

Based on the impact of BIM in exhibiting VE possibilities like 4D (time) and 5D (cost). The result will be an integrated model that will let real estate owners choose the optimal VE choice depending on specific parameters. In this study, the Net Present Value (NPV) of Investment was calculated using the bank interest ratio, which was one of the feasibility study's findings.

2.1. An Integrated Model Mechanism

As indicated in the flowchart in Figure 4, The BIM methodology includes drawing 3D alternatives models with software BIM tools, extracting data from the 3D-BIM model, survey quantity, cost estimation, scheduling, NPV, and cash flow, which are all outputs of feasibility studies, and determining the Criteria, which are an essential component in the process of evaluating different alternatives for judging alternatives. A 3D model, schedule tables (4D), and survey quantity tables (5D) are built using the software BIM program Revit 2021.

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Value Engineering Methodology			Methodology	Software Tools	Framework Model Steps
Pre-Workshop Phase	Work Phase	Post-Workshop Phase			
1- Stakeholder Identify	-	-	BIM	Excel - MS Office	1- Identify the Stakeholder - Set up a value engineering team
2- Data Collected	-	-	BIM	Excel - MS Office	2- Conduct project Information
	1- Information Phase	-	BIM	Excel - MS Office Excel - MS Office	3- Suggested the proposed alternatives Determined the cost and quality
	2- Function Phase	-	BIM	Revit	4- Drawing the Alternative (3D Models) 5- Take Initial Approval for Suggested Alternatives
	3- Creative Phase	-	BIM - Feasibility Study	Primavera AHP	6- Create the Alternatives (4D Model - 5D Model) 7- Conducted a feasibility study with cash flow
	4- Evaluation Phase	-	BIM - Feasibility Study	Excel - MS Office	8- Calculated the net present value (NPV) of each alternative based on the cash flow
	5- Presentation Phase	-	BIM	PowerPoint -MS Office	9- The VE team presented the VE Report
		1- Follow Up Activity			10- The optimal decision was implemented

Figure 4. An integrated model flowchart

2.2. Research Limitations

The study's spatial scope has been restricted to projects created and implemented in Egypt so that the effect of changing the location has been neutralized, and its negative or positive results have been removed. The initiatives under investigation have been confined to those conceived and implemented between 1970 and 1990. This period was chosen because it featured periods.

2.3. Case Study

In this study, an integrated model was utilized in a case study to illustrate its capabilities and to emphasize the model's properties. The case study is used to build a model for BIM integration with VE to help with decision-making when examining options and deciding on the project's existing structure; the model is based on a database created using BIM software. The model is meant to aid real estate owners in selecting the most appropriate utilization type of existing structure throughout the design and feasibility study phases by showing design, cost, and time performance on a BIM model. It provides a visual aid and alternate information and allows for the criteria analysis.

The building consists of five floors after the ground floor. The administrative headquarters of Maadi Company for development and reconstruction subsidiary of the public business sector ministry, which is a public organization, was selected. The various data for the case study were collected, such as architectural drawings of the project, site location (see Figures 5 to 8.), coordinates, the total construction area, and the case study documents. Table 1 illustrates the project's description.



Figure 5. The venue for the case study on the global map



Figure 6. The venue for the case study at the local map



Figure 5. The architectural drawings ground floor perspective for the case study



Figure 6. The architectural drawings are typical floor perspectives for the case study

Table 1. Information about the case study

Location	Ninth District, Extension of El Nasr St, Behind National Investment Bank, New Maadi, Cairo, Egypt. https://goo.gl/maps/MzLgjMMCbbHTVdkD9
Latitude and Longitude	The building is in an existing urban area in the Maadi district at latitude 29°58'35.31"N and longitude 31°17'7.44"E. It rises above sea level 46.0 meters.
Total Built-Up Area	1,852.99-meter square.
Building Components	Six floors (five typical floors and the ground floor).
Land Area	2,285.37-meter square.
The price of land, including the building on it	2,440 \$ / meter square.
Price of vacant land	3,254 \$ / meter square.

3. Results and Discussion

Steps in applying the integrated model to a case study are:

- A value engineering team comprises financial members, technologists, and administrators formed by the property owner to conduct a feasibility study.
- A value engineering team and feasibility study specialist collect the property data and determine the bank interest ratio.
- Suggested the proposed alternatives with a 5-year lifecycle as shown in Table 2.

Table 2. Alternatives for the case study

No.	Alternative
1	Selling the structure after Converting Usage to Medical Centre Building - Outpatient Clinics.
2	Selling the structure after Converting Usage To educational structure - international school.

- Architectural drawings and views for each alternative (3D - models) were created using Revit 2021, as shown in Figures 9 to 16.

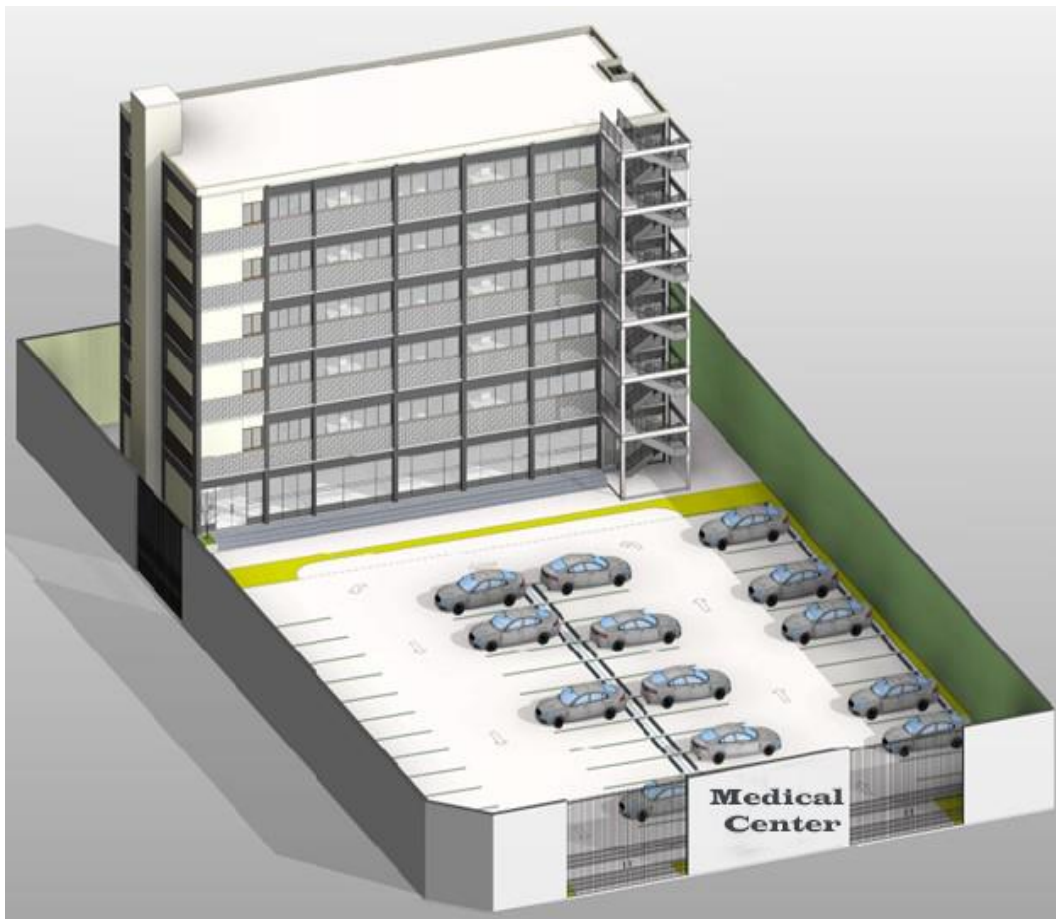


Figure 7. Alternative No.1 perspective

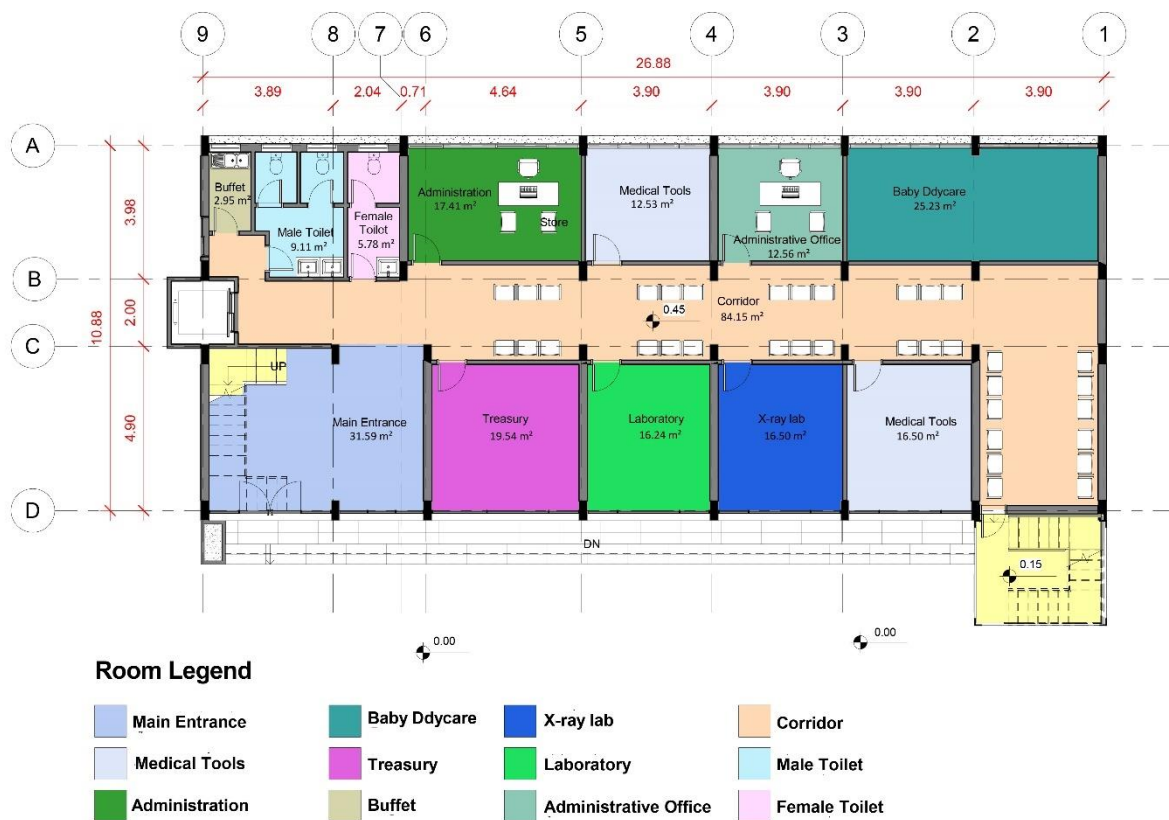


Figure 8. Alternative No.1 ground floor perspective



Figure 9. Alternative No.1 typical floor perspective



Figure 10. Alternative No.2 perspective



Figure 11. Alternative No.2 ground floor perspective



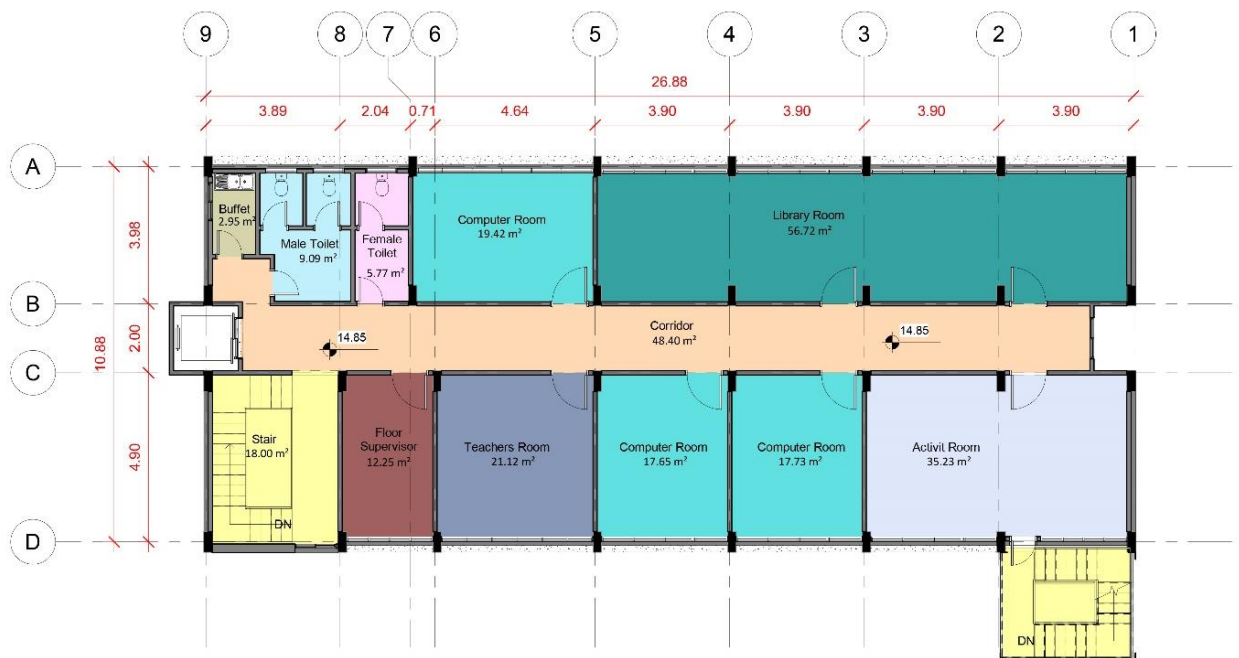
Figure 12. Alternative No.2 first floor perspective



Room Legend

- | | | | |
|--|---|--|--|
| Activity Room | Floor Supervisor | Stair | Male Toilet |
| Glass | Buffet | Corridor | Female Toilet |

Figure 13. Alternative No.2 typical floors (2nd to 4th) perspective



Room Legend

- | | | | |
|--|---|--|--|
| Library Room | Floor Supervisor | Stair | Female Toilet |
| Activity Room | Computer Room | Corridor | Male Toilet |
| Teachers Room | Buffet | | |

Figure 14. Alternative No.2 fifth floor perspective

- The real estate owner was shown and approved the 3D - models of each alternative.
- Calculated the Survey quantities of each approved alternative by the Revit Program 2021 and priced the elements of the Survey quantities using market values for the year 2021, as shown in Table 3.

Table 3. Alternatives for the case study

No.	Alternative	Priced survey quantity
1	Selling the structure after Converting Usage to Medical Centre Building - Outpatient Clinics.	\$ 262,245
2	Selling the structure after Converting Usage To an educational structure – an international school.	\$ 248,303

- Conducted a feasibility study with cash flow according to the market condition for each alternative.

Alternative No. 1 is to sell the structure after converting the usage into a medical center building - outpatient clinics, which contains medical clinics with an area of 1,853 m², and a suggested selling price of \$1,670/m². Thus, the total presented selling price for all clinic medical center units of the building is \$3,094,493. Alternative No.1 implementation finishing cost is \$262,245 depending on the alternative quantity of surveying, administrative expenses 1.5% of the implementation finishing cost, the implementation supervision cost 2.5% of the implementation finishing cost, and selling commission and marketing expenses 5% of the total proposed price of sale as shown in Table 4.

Table 4. Data analysis of alternatives No.1

Clause	Item	Value	Notes
Data	No. of floor	6	(Ground +5 typical) floor
	Medical clinics areas	1853 m ²	m ²
	Meter price of medical clinics	\$ 1,670	\$
	The total price of medical clinics	\$ 3,094,493	\$
Cost Estimation	Construction cost	\$ 262,245	\$
	Administration expenses	\$ 3,934	1.5% of construction cost
	Supervising the implementation	\$ 6,556	2.5% of construction cost
	Selling commission marketing expenses	\$ 154,725	5% of the selling price
	Total Cost	\$ 427,459	\$
	VPV	\$ 1,752,752	From cash flow

Figure 17 shows that the alternative No. 1 implementation will take just the first year of the alternative lifecycle (five years). According to the sales strategy, the alternative units (medical clinics) will sell throw three years, with 30% of the units selling in the first year, 40% in the second year, and 30% in the third year. According to the Central Bank of Egypt (CBE) interest rate (where the case study existed) is equal to 12% in January 2022The unit selling; mechanism is as follows: the unit will be received in the third year of the alternative lifetime, with 60% of the total medical clinics unit price paid, and the remainder of the unit price paid over two years at a rate of 20% each year.

\$ 427,459						Cost of Construction without Land Price	
Duration Life						Period	
Total	5th Year	4th Year	3rd Year	2nd Year	1st Year	Duration of construction	1
100%	0%	0%	0%	0%	100%	schedule Costruction	2
\$ 427,459	0	0	0	0	427,459	Cost depend on schedule Costruction	3
\$ 3,094,493						Total Revenue	4
100%	0%	0%	30%	40%	30%	Sales distributed over three years	5
100%	20%	20%	25%	25%	10%	1st year payment rates	6
100%	20%	20%	30%	30%	0%	2nd year payment rates	7
100%	20%	20%	60%	0%	0%	3rd year payment rates	8
\$ 3,094,493	618,899	618,899	1,160,435	603,426	92,835	Revenue per year	9
\$ 2,667,034	618,899	618,899	1,160,435	603,426	-334,624	Annual surplus/deficit	10

Financial indicators including the price of the land

Fifth Year	Fourth Year	Third Year	Second Year	First year	Period	1
\$ 618,899	\$ 618,899	\$ 1,160,435	\$ 603,426	\$ (334,624)	Cash Flow	2
\$ 1,752,752	\$ 1,401,572	\$ 1,008,251	\$ 182,276	\$ (298,772)	NPV	3
12.00%					Interest Ratio	

Figure 15. Alternative No.1 cash flow

Alternative No. 2 is to Sell the structure after Converting Usage To an educational system. This international school contains school rooms with an area of 1,853 m² and a suggested selling price of \$1,330/m². Thus, an international school's total presented selling price is \$2,464,477. Alternative no.2 implementation finishing cost is \$248,303 depending on the alternative quantity of surveying, administrative expenses 1.5% of the implementation finishing cost, the implementation supervision cost 2.5% of the implementation finishing cost, and selling commission and marketing expenses 5% of the total proposed price of sale as shown in Table 5.

Table 5. Data analysis of alternatives No.2

Clause	Item	Value	Notes
Data	No. of floor	6	(Ground +5 typical) floor
	School rooms areas	1853 m ²	m ²
	Meter price of the school rooms	\$ 1,330	\$
	The total price of medical clinics	\$ 2,464,477	\$
Cost Estimation	Construction cost	\$ 248,303	\$
	Administration expenses	\$ 3,725	1.5% of construction cost
	Supervising the implementation	\$ 6,208	2.5% of construction cost
	Selling commission marketing expenses	\$ 123,224	5% of the selling price
	Total Cost	\$ 427,459	\$
	VPV	\$ 1,632,497	From cash flow

Figure 18 shows that the alternative No. 2 implementation will take just the first year of the alternative lifecycle (five years). According to the sales strategy, the alternative will be to sell as one deal and install for three years with equal payment. According to the Central Bank of Egypt (CBE) interest rate (where the case study existed) is equal to 12% in January 2022.

\$ 381,459						Cost of Construction without Land Price	
Duration Life						Period	
Total	5th Year	4th Year	3rd Year	2nd Year	1st Year	Duration of construction	1
100%	0%	0%	0%	0%	100%	schedule Construction	2
\$ 381,459.06	0	0	0	0	381,459	Cost depend on schedule Costruction	3
\$ 2,464,477						Total Revenue	
100%	0%	0%	33%	33%	33%	Sales distributed over one year	5
100%	0%	0%	0%	0%	100%	1st year payment rates	6
100%	0%	0%	0%	100%	0%	2nd year payment rates	7
100%	0%	0%	100%	0%	0%	3rd year payment rates	8
100%	0%	100%	0%	0%	0%	4th year payment rates	9
100%	100%	0%	0%	0%	0%	5th year payment rates	10
\$ 2,464,477	0	0	821,492	821,492	821,492	Revenue per year	11
\$ 2,083,018	0	0	821,492	821,492	440,033	Annual surplus/deficit	12

Financial indicators including the price of the land

Fifth Year	Fourth Year	Third Year	Second Year	First year	Period	1
\$ -	\$ -	\$ 821,492	\$ 821,492	\$ 440,033	Cash Flow	2
\$ 1,632,497	\$ 1,632,497	\$ 1,632,497	\$ 1,047,775	\$ 392,887	NPV	3
				12.0%	Interest Ratio	

Figure 16. Alternative No.2 cash flow

- Calculated the net present value (NPV) of each alternative based on the cash flow, which was made in the previous step, according to the Central Bank of Egypt (CBE) interest rate (where the case study existed) equal to 12% in January 2022. Figure 19 shows an alternative NPV comparison chart through the project's life cycle (5 years).
- The VE team presented the VE Report to the real estate owner, who chose the best alternative with the highest NPV.
- The optimal decision was implemented.

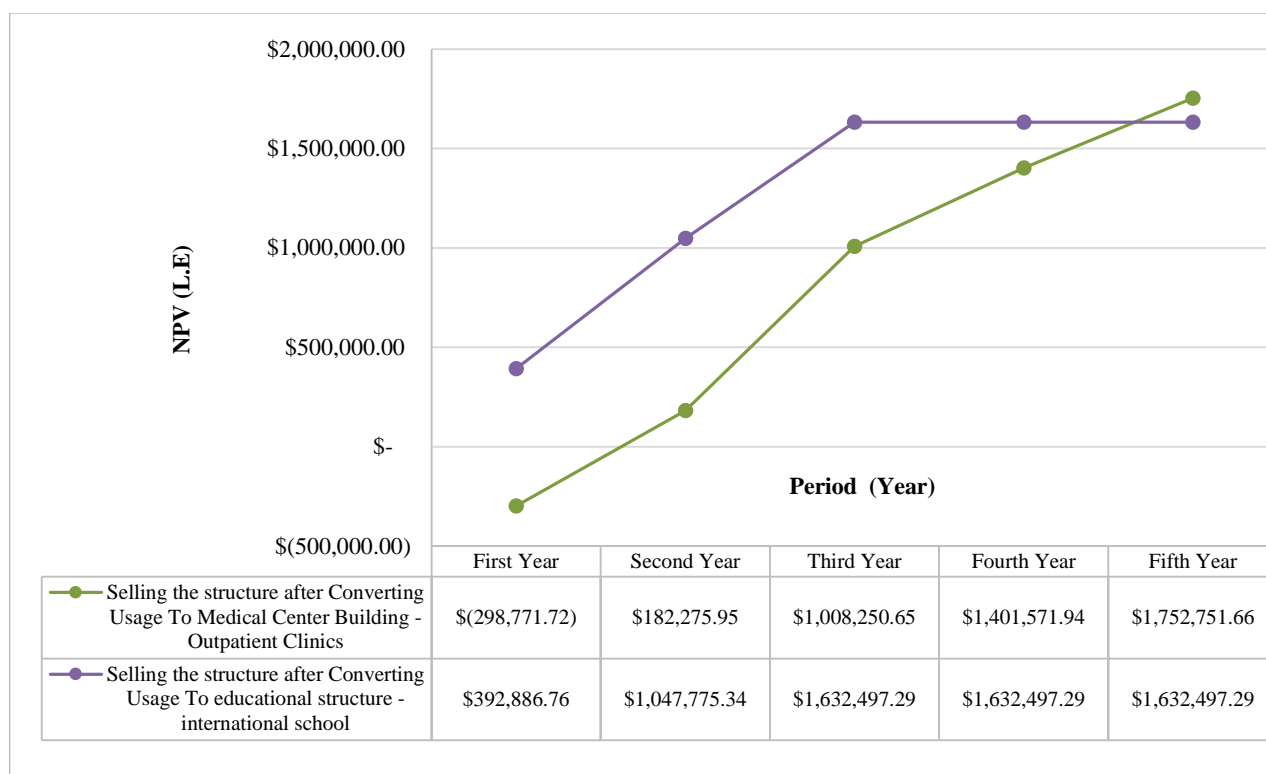


Figure 17. Alternatives NPV comparison chart throws Life cycle

Alternative No.1: selling the structure after Converting Usage to Medical Center Building - Outpatient Clinics based on a 12 percent bank interest rate.

In the first year, for \$ 427,459, alternative No. 1 was implemented to change the usage kind of the existing real estate from an administrative to a Medical Center Building - Outpatient Clinics. Also, 30% of the outpatient clinic's unit was sold, and 10% of its prices were collected, which equal \$ 29,835 as revenue. The annual surplus/deficit is \$ -334,624. Therefore, the NPV is \$ -298,772. In the second year, 40% of the outpatient clinic's unit in alternative No. 1 was sold, and 30% of its prices were collected additional 25% of the unit price sold in the first year, which equals \$ 603,426 as revenue. The annual surplus/deficit is \$ 603,426. Therefore, the NPV is \$ 182,276. In the third year, 30% of the outpatient clinic's unit in alternative No. 1 was sold, and 60% of its prices were collected additional 25% of the unit price was sold in the first year, and 30% of the unit price sold in the second year which equals \$ 1,160,435 as revenue. The annual surplus/deficit is \$ 1,008,426. Therefore, the NPV is \$ 1,008,251. In the fourth year, 100% of the outpatient clinic's unit in alternative No. 1 was sold at a price that equals \$ 618,899 as revenue. The annual surplus/deficit is \$ 618,899. Therefore, the NPV is \$ 1,401,572. In the fifth year, 100% of the outpatient clinic's unit in alternative No. 1 was sold at a price that equals \$ 618,899 as revenue. The annual surplus/deficit is \$ 618,899. Therefore, the NPV is \$ 1,752,752.

Alternative No.2: selling the structure after Converting Usage to an educational structure – an international school based on a 12 percent bank interest rate.

In the first year, for \$ 381,459, alternative No. 2 was implemented to change the usage kind of the existing real estate from an administrative to an educational structure – an international school. Also, 33% of the school structure was paid, which equals \$ 821,492 as revenue. The annual surplus/deficit is \$ 440,033. Therefore, the NPV is \$ 392,887. In the second year, 33% of the school structure in alternative No. 2 was paid, which equals \$ 821,492 as revenue. The annual surplus/deficit is \$ 821,492. Therefore, the NPV is \$ 1,047,775. In the third year, 33% of the school structure in alternative No. 2 was paid, which equals \$ 821,492 as revenue. The annual surplus/deficit is \$ 821,492. Therefore, the NPV is \$ 1,632,497. In the fourth and fifth years, 100% of the school structure in alternative No. 2 was paid last year; the annual surplus/deficit is \$ zero. Therefore, the NPV is \$ 1,632,497.

The NPV in alternative No.2 started with a negative value and then gradually increased until the fifth year of the lifecycle (last year), which equals \$ 1,752,752. On the other hand, the NPV in the previous three years of alternative No.2 lifecycle was the same, equaling \$ 1,632,497.

4. Conclusions

Many real estate owners change the building in terms of the type of usage in response to changes in economic conditions and the requirements of the surrounding environment to get the best potential financial return. This study presents an integrated model to face the challenges of real estate owners, members of the value engineering team, and stakeholders regarding selecting the optimum alternative—the optimum alternative suits all the existing structure owners' requirements when changing the usage type. By providing an integrated model in support of VE alternatives, the model is created by integrating the BIM technique into the various phases of the VE job plan and assessing alternatives based on conducting BIM methodology such as a feasibility study, including BIM software such as Revit and Primavera. A feasibility study that includes the bank's rate of interest. As a result, the maximum financial return is obtained based on predetermined criteria and in compliance with decision-making requirements. The value engineering team examined the benefits of the available alternative according to the real estate owners' requirements based on the specified criteria. Appraising alternatives begins with extracting data from the 3D-BIM model, followed by survey quantity, cost estimation, NPV, and cash flow, all of which are feasibility study outcomes. The criteria, which are an essential part of assessing distinct options for judging alternatives, are then determined.

An integrated model was examined in a case study to show how it might be used and what it could do, as well as to emphasize the framework's features. The purpose of the operation is to demonstrate the advantages of utilizing the model and its ability to choose the best option. According to the findings, this integrated model, which includes feasibility studies and comparison tables, might be adopted in the future while considering time and location restrictions. More studies are being conducted to enhance the requirements based on current real estate's time and location variables and expand BIM's dimensions.

Despite the benefits the model provides for the VE team members and enhances the creative phase and evaluation phase of the VE job plan, future work can be done to improve the implementation of the model and enrich the proposed methodology. Some of the recommendations that can enhance research in general are listed below:

- The spatial and period scope is increased in future research, where an integrated model of existing structures that were implemented between 1970 and 1990 is proposed;
- The life cycle cost is included in the calculations of the feasibility study of future research;
- Several BIM tools (software) are used to determine which of them is accurate in 4D - 5D Calculation;
- Various criteria are used in addition to feasibility studies as sustainability to achieve wide areas of application in an integrated model.

5. List of Abbreviations

BIM:	Building Information Modeling	VE	Value Engineering
NPV	Net Present Value	L.E	The Egyptian pound currency
CBE	Central Bank of Egypt		

6. Declarations

6.1. Author Contributions

Conceptualization, H.M.M.; methodology, H.M.M.; software, H.M.M.; validation, H.M.M., A.A.F., and A.H.N.; formal analysis, H.M.M.; writing—original draft preparation, H.M.M.; writing—review and editing, H.M.M., A.A.F., and A.H.N.; supervision, A.A.F. and A.H.N. All authors have read and agreed to the published version of the manuscript.

6.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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6.5. Conflicts of Interest

The authors declare no conflict of interest.

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