ICCEPM 2022
The 9th International Conference on Construction Engineering and Project Management
Jun. 20-23, 2022, Las Vegas, NV, USA

Construction Cost Segregation Process using Building Information Modeling

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Abstract: Cost segregation helps reduce tax liabilities by reclassifying real property to personal property and accelerates tax depreciation of a property. A typical cost segregation study requires much time and high costs. This study proposed a BIM integrated cost segregation process that can be applied to any commercial building project. The proposed BIM-based cost segregation process was verified in a new commercial construction project. It approved that this approach can: (1) increase the cash flow for the owner and provide assistance to tax-paying enterprises; (2) enable the contractor to use it as an added value in the bidding process; (3) realize data sharing in a common platform to improve the cost segregation study efficiency and reduce costs and errors; (4) contribute to the asset management in the life cycle of buildings while filling in the blank of cost segregation process. Future studies will focus on the automation of cost segregation and asset management in building construction's life cycle.

Key words: cost segregation, BIM, depreciation, cost saving

1. INTRODUCTION

Cost segregation is a comprehensive engineering analysis of a commercial property that significantly accelerates the IRS (Internal Revenue Service) allowed depreciation of the property [1]. Standard depreciation of a building occurs equally over 27.5 years for residential property and 39 years for nonresidential use property [2]. However, with cost segregation studies, building components can be depreciated over 5, 7, 10, 15-year periods [3][4]. Cost segregation has the following advantages over the traditional straight-line depreciation [4][5][6]: (1) It generates an immediate increase in cash flow through accelerated depreciation deductions. (2) It provides an easy opportunity to claim "catch up" depreciation on previously misclassified assets. (3) It reduces income taxes and can also reduce real estate property taxes. (4) It provides an independent third-

party analysis that will withstand IRS review. Cost segregation can be completed any time after the purchase, remodel, or construction of property [7]. The benefits of a cost segregation study to project owners can be significant, and the information necessary to produce a cost segregation report should be found in a detailed estimate [8].

Traditionally, cost segregation starts with a construction engineer analyzing construction drawings, identifying property units, performing detailed quantity take-offs, adjusting take-off prices by considering actual, identified subcontractor costs, and allocating the architectural fees, engineering fees, and general conditions. In general, a study by a construction engineer is more reliable than one conducted by someone with no engineering or construction background [5]. However, the possession of specific construction knowledge is not the only criterion. Experience in cost estimating and allocation and understanding of the applicable law are other essential criteria [9]. Cost segregation is produced for a fee that ranges based on building type and size. Bigelow et al. (2016) found that cost segregation studies start around $3,000 for small projects through the conversations with a cost segregation provider and a Certified Public Accountant (CPA) [5]. In order to make cost segregation process more efficient and accurate, Building Information Modeling (BIM) is introduced.

BIM is based on the most advanced 3D digital design solutions to the visual digital architectural models for designers, architects, and engineers [10][11]. In the past decades, there has been a growing interest of the construction sector in using BIM due to many benefits and resource savings during the design, planning, and construction of new buildings [12][13][14]. Li et al. (2020) proposed a budget control method for port construction projects based on BIM technology to fully alleviate the practical economic pressure of port construction projects and establish a relatively reasonable cost control environment [15]. Lin et al. (2017) constructed a framework for developing a productivity and safety monitoring system using BIM [16]. It uses BIM to integrate buildable design, prevent hazards, and safety assessment to mitigate risks and overcome design defects.

Noller (2003) reported that cost segregation studies are typically unused by general contractors' but represent an opportunity for them to strengthen relationships with clients and provide a competitive edge in bidding [17]. The introduction of BIM technology can bridge the shortcoming of traditional cost segregation, making construction project management more convenient and practical. This study attempts to develop a cost segregation process using the BIM technique.

This study developed a BIM integrated cost segregation process that can be applied to any commercial building project. This paper carried out a user scenario walk-through of a new facility under construction to perform cost segregation with BIM. The walk-through showed the feasibility of using BIM for developing a cost segregation system. The proposed process was approved to realize data sharing in a common platform to participate in many units, improving engineering quality, saving time, and reducing costs and errors. It can increase the owner's cash flow, assist tax-paying enterprises, and enable the contractor to use it as an added value in the bidding process to gain an advantage.

2. METHODS

The flow chart of this study is shown in Figure 1.

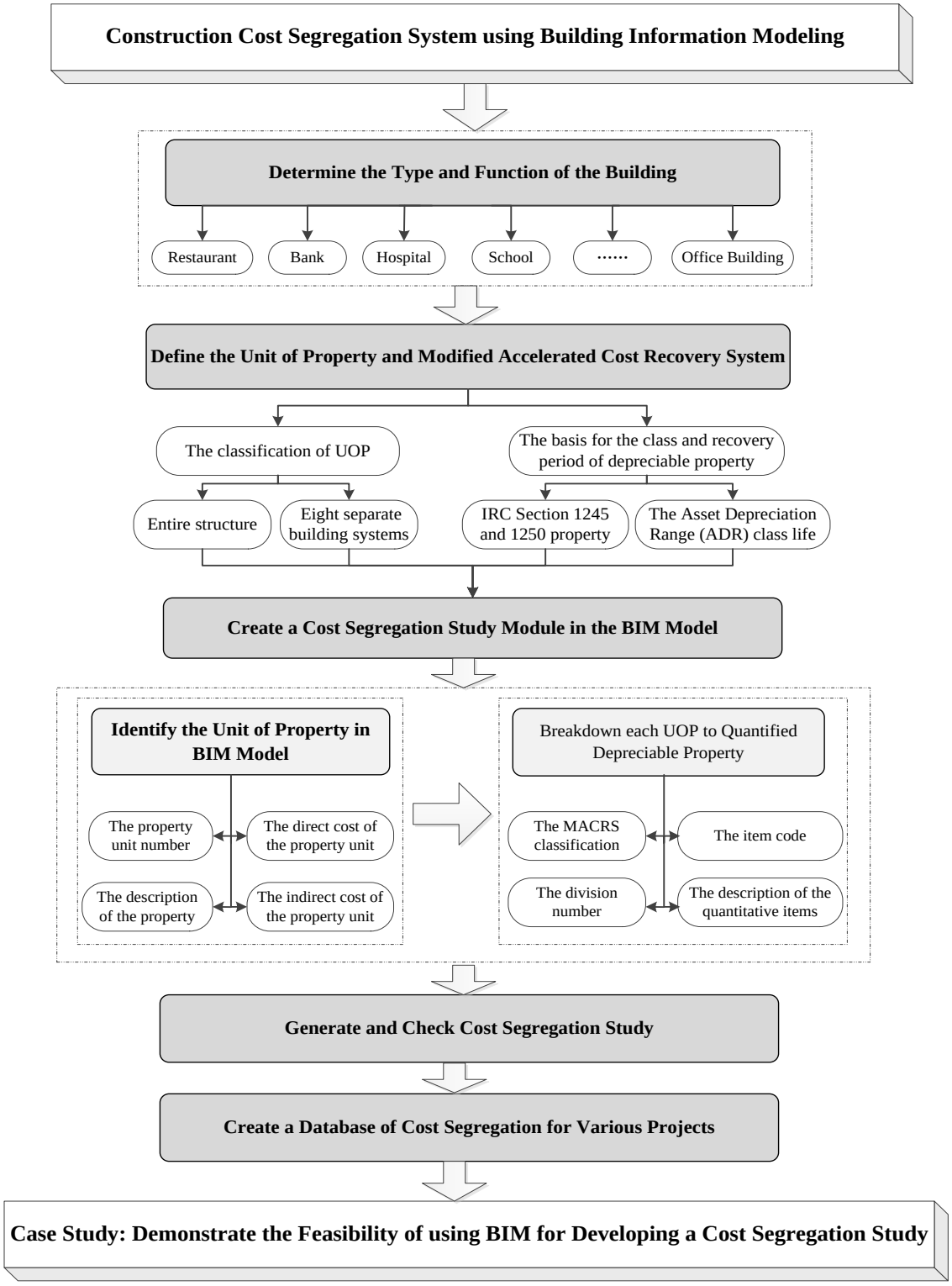

Figure 1. BIM-based cost segregation framework

2.1. Determine the type and function of the property

This study focuses on commercial construction, which can be categorized into the restaurant, bank, hospital, school, office building, department store, etc. They all have the same depreciable

component as a general classification, and each type of property has its characteristics. It is essential to determine the property's type and function to assign the associated cost segregation module to the property.

2.2. Determine the Unit of Property (UOP) and Modified Accelerated Cost Recovery System (MACRS) Class

The IRS released repair regulations relating to the standards for capitalization of specific expenses associated with tangible personal property. The repair regulations redefined the Unit of Property (UOP) to assist taxpayers with the compliance requirements of the new rules by separately identifying the building cost into the cost of the building structure and each specifically defined building system. The entire building and its structural components as a whole are a single UOP.

In addition, the following eight building systems are separate UOPs. An improvement to any one of these systems must be depreciated: (1) Heating, ventilation, and air conditioning systems: This includes motors, compressors, boilers, furnaces, chillers, pipes, ducts, and radiators. (2) Plumbing systems: This includes pipes, drains, valves, sinks, bathtubs, toilets, water, and sanitary sewer collection equipment, and site utility equipment used to distribute water and waste. (3) Electrical systems: This includes wiring, outlets, junction boxes, lighting fixtures and connectors, and site utility equipment used to distribute electricity. (4) All escalators. (5) All elevators. (6) Fire-protection and alarm systems: These includes sensing devices, computer controls, sprinkler heads, sprinkler mains, associated piping or plumbing, pumps, visual and audible alarms, alarm control panels, heat and smoke detectors, fire escapes, fire doors, emergency exit lighting and signage, and fire fighting equipment, such as extinguishers and hoses. (7) Security systems: These include window and door locks, security cameras, recorders, monitors, motion detectors, security lighting, alarm systems, entry and access systems, related junction boxes, associated wiring and conduit. (8) Gas distribution system includes pipes and equipment used to distribute gas to and from the property line and between buildings.

Modified Accelerated Cost Recovery System (MACRS) is mandatory for most tangible depreciable property placed in service after December 31, 1986. Under MACRS, the cost of the eligible property is recovered over a 3, 5, 7, 10, 15, 20, 27.5, 31.5, or 39.0 year period. The classes of depreciable property are defined in terms of Internal Revenue Code Section 1245 and 1250 property and the Asset Depreciation Range (ADR) class life as of January 1, 1986. Specifically, the name of depreciable property is determined mainly according to Section 1245 and 1250 property provisions. Section 1245 property is depreciable property that is either (1) personal property (tangible and intangible) or (2) other tangible property (not including a building or its structural components) used as an integral part of (a) manufacturing, (b) production, (c) extraction, or (d) the furnishing of transportation, communications, electrical energy, gas, water, or sewage disposal services. Section 1245 property also includes single-purpose agricultural and horticultural structures and storage facilities used to distribute petroleum and its primary products.

2.3. Create a cost segregation module in the BIM Model

A cost segregation module is developed in the Revit to perform a cost segregation study. According to the MACRS class, schedules of 3, 5, 7, 10, 15, 20, 27.5, 31.5, and 39-year class depreciation are established. Quantifiable depreciable property components are identified and described by the Internal Revenue Code Section 1245 and 1250 property in the Revit. To calculate the yearly depreciation value under each UOP, this study activates and defines shared parameters about cost segregation common to all building types. Shared parameters are attributes of each family, including Property Unit Number, Division, Description, Quantity, Unit of Measure, E/A (Estimated/Actual Cost), Direct Cost, Indirect Cost, Total Cost, Class Life, and MACRS (n,

n=1,2,3……Class Life). The shared parameters data are used to calculate the amount of cost depreciation deduction for the annual year under each UOP according to the calculation formula of cost depreciation. Then MACRS (n) can be obtained by setting the calculation formula according to the required data values. Finally, a cost segregation study report will be generated. The benefits of cost segregation are derived by comparing cost segregation and without cost segregation.

3. CASE STUDY

This research adopted a new construction with a 3,516 square feet one-story bank branch as the case project to demonstrate the feasibility of using the proposed cost segregation process. The bank is the property that goes with 39 years of depreciation. However, certain specific items are qualified for 3, 5, 7, 10, 15, 20, 27.5, and 31.5 years accelerated depreciation. First, the BIM model of the bank was created in Revit, as shown in Figure 2.

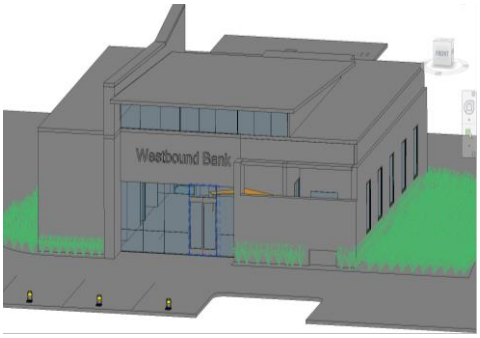

Figure 2. BIM model of the bank

Second, property units are defined and identified based on their use, physical characteristics, and other criteria. Detailed quantity take-offs are developed during the engineering analysis from the contract documents, including the construction drawings, specifications, and other pertinent information. Based on the building components, 34 UOPs have been identified, and a schedule was created for each UOP, as shown in Figure 3.

According to the building components, only 39yr, 15yr, 7yr, and 5yr property classes are identified. An example of each class is shown in Figure 4 to Figure 7. Building components are listed and identified in the Revit. For example, in Figure 5, UOP 100 is site improvements. Excavation, concrete work, bollards, curb and gutter, etc., are within the UOP and will be depreciated under 15yr class, instead of 39 years.

UNIT OF PROPERTY (UOP)	DESCRIPTION	UNIT OF PROPERTY (UOP)	DESCRIPTION	UNIT OF PROPERTY (UOP)	DESCRIPTION
100	SITE IMPROVEMENTS	3160	DOORS & WINDOWS	6000	DOMESTIC HVAC SYSTEM
110	PAVING & SURFACING	3210	INT. OBSERV. GLASS PNLS	6540	COMPUTER EQUIPMENT A/C
200	CURB/SIDEWALKS	3700	CARPETING	7000	DOMESTIC ELECTRICAL SYSTEM
540	STORM DRAINAGE SYSTEM	3870	CABINETS/COUNTERS/MILLWORK	7020	BANK EQUIPMENT ELECTRICAL
910	SITE LIGHTING	4120	BATHROOM ACCESSORIES/EQUIPMENT	7050	BREAKROOM EQUIPMENT ELECTRICAL
1380	IDENTITY SIGNS	4160	FIRE EXTINGUISHERS/CABINETS	7290	ACCENT/DÉCOR LIGHT FIXTURES
1430	LANDSCAPING/IRRIGATION	4240	BANK EQUIPMENT	7390	TASK LIGHTING
2010	SUBSTRUCTURE	4515	APPLIANCE	7540	COMPUTER EQUIPMENT ELECTRICAL
2040	DRIVE-THRU EQP SUPPORT	4560	WINDOW TREATMENTS	7600	SIGN ELECTRICAL
2150	SUPERSTRUCTURE/BLDG ENCL.	5000	DOMESTIC PLUMBING SYSTEM	7670	COMMUNICATION SYSTEM
3000	INTERIOR CONSTRUCTION	5050	BREAKROOM EQUIPMENT PLUMBING	7780	SECURITY LTG & DETECTION
				7830	TELEVISION SYSTEM

Figure 3. Unit of property (UOP)

Item Number	Contract Number	Property Unit	Description	A/E	Final Contract	Project Indirects	Asset Total Cost
Building Number: 1			**BANK**				
5	3	2010	CONCRETE	A	100,166	18,885	119,051
58	2	2010	BLDG EXCAVATION(14064CF)	A	32,320	6,093	38,413
Property Unit :		**2010**	**SUBSTRUCTURE**		**132,486**	**24,978**	**157,463**

Figure 4. Example of 39 yr property class – UOP 2010 Substructure

Item Number	Contract Number	Property Unit	Description	A/E	Final Contract	Project Indirects	Asset Total Cost
Building Number: 1			**BANK**				
44	2	100	SITE EXCAVATION(23794CF)	A	55,031	10,375	65,406
45	3	100	CONC WHEEL STOP/SITE	E	52	10	62
47	3	100	CONC BASE/SITE HC PARKING SIGN	E	77	15	92
48	5	100	4" PIPE BOLLARDS/SITE	E	2,500	471	2,971
49	3	100	CONC BASE/SITE BOLLARDS	E	262	49	312
50	5	100	STL 4" PIPE RAIL 8"H CURB/SITE	E	1,667	314	1,981
Property Unit :		**100**	**SITE IMPROVEMENTS**		**59,589**	**11,234**	**70,823**

Figure 5. Example of 15 yr property class – UOP 100 Site Improvements

Item Number	Contract Number	Property Unit	Description	A/E	Final Contract	Project Indirects	Asset Total Cost
Building Number: 1			**BANK**				
71	2	7670	SITE 4" TELE LN TO BLDG	E	877	165	1,043
72	2	7670	TRENCH & BEDDING/SITE TELE LN	E	792	149	941
107	16	7670	TELE BOARD	E	151	29	180
Property Unit :		**7670**	**COMMUNICATION SYSTEM**		**1,821**	**343**	**2,164**

Figure 6. Example of 7 yr property class – UOP 7670 Communication System

Finally, the depreciation value of each will be calculated based on the MACRS, as shown in Figure 8. Based upon the analysis, the following assets of the bank property were identified as Section 1245 property and land improvements. These results are summarized as shown in Table 1.

Item Number	Contract Number	Property Unit	Description	A/E	Final Contract	Project Indirects	Asset Total Cost
Building Number: 1			**BANK**				
34	21	7540	INTERNET INSTALL	A	2,273	0	2,273
39	21	7540	BRANCH SET-UP IN CORE SYS	A	16,534	0	16,534
101	16	7540	DATA/TELE OUTLET	E	7,498	1,414	8,912
102	16	7540	DUP RECEPT/COMPUTER EQP	E	2,184	412	2,596
103	16	7540	QUAD RECEPT/COMPUTER EQP	E	377	71	448
104	16	7540	FLR BOX(2DUP & 2 D/T)/CONF RM	E	1,097	207	1,304
105	16	7540	WIREMOLD/LOBBY FOR PWR & DATA	E	479	90	569
106	16	7540	ELEC CONN/DATA RM SPLIT SYS	E	86	16	102
118	21	7540	ELECTRONIC CABLING	A	15,771	0	15,771
Property Unit :		**7540**	**COMPUTER EQUIPMENT ELECTRICAL**		**46,298**	**2,210**	**48,508**

Figure 7. Example of 5 yr property class – UOP 7540 Computer Equipment Electrical

Table 1. Cost segregation summary

5-Year Personal Property	$260,686
7-Year Personal Property	2,164
15-Year Land Improvements	263,180
39-Year Real Property	973,562
Total Project Cost Reviewed	$1,499,592

Year	Depreciation Value	Year	Depreciation Value	Year	Depreciation Value	Year	Depreciation Value
1	$90,600	11	$40,517	21	$24,963	31	$24,963
2	$133,956	12	$40,491	22	$24,963	32	$24,963
3	$97,905	13	$40,517	23	$24,963	33	$24,963
4	$75,524	14	$40,491	24	$24,963	34	$24,963
5	$73,440	15	$40,517	25	$24,963	35	$24,963
6	$56,563	16	$32,727	26	$24,963	36	$24,963
7	$40,635	17	$24,963	27	$24,963	37	$24,963
8	$40,563	18	$24,963	28	$24,963	38	$24,963
9	$40,517	19	$24,963	29	$24,963	39	$15,382
10	$40,491	20	$24,963	30	$24,963		

Figure 8. Cost Segregation in 39 years

4. CONCLUSIONS

The cost segregation system involves reducing tax liabilities by reclassifying real property to personal property and accelerating tax depreciation of a property. In order to overcome the shortcomings of traditional cost segregation, this paper proposed a new cost segregation process based on BIM to help maximize the cash flow of companies and individuals. It realizes the integration, optimization, and sharing of cost segregation data for multi-source construction assets for the owner. Also, it enables contractors to use it as an added value in the bidding process. Future studies will focus on the automation of cost segregation systems and asset management in the life cycle of building construction.

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