Ministry of Higher Education
and Scientific Research
University of Diyala
College of Engineering

Integration Of Virtual Prototyping And Building Information Modelling To Optimize The Construction Site Planning And Management

A Thesis Submitted to the Council of College of Engineering University of Diyala in Partial Fulfillment of the Requirements for the Degree of Master of Science in Civil Engineering

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2019 A.D IRAQ 1441 A.


بِسْمِ اللّٰهِ الرَّحْمَنِ الرَّحِيم
وَمَا تَوْفِيقِي إِلاَّ بِاللّهِ عَلَيْهِ
تَوَكَّلْتُ وَإِلَيْهِ أَنِيب﴿٨٨﴾
صَدَق اللّٰهَ الْعَظِيْم
سورة هود

DEDICATION

I dedicate this research to;

My Dear Father;
His words of inspiration and encouragement in pursuit of excellence.

***My Affectionate Mother*;**
Whose prayers and love took me to zenith of glory and transform my dreams into reality.

***My Husband*;**
For his Love, endless support and encouragement

My Brothers and Sister;
Who have always encouraged and supported me for further study.

The Researcher

ACKNOWLEDGEMENTS

Thanks to God firstly and lastly...

I would like to express my great gratitude and appreciation to everyone who helped me in performing this study:

To my supervisor Dr. Abbas Mahde Abd for the continuous support of my research, for his patience, motivation, and immense knowledge. His guidance helped me all the time of conducting research and writing this thesis;

To the Department of Civil Engineering, College of Engineering Diyala university represented by the Head Dr. Hafedh Ibrahim Naji and all the academics and staff;

To the Deanship of the College of Engineering for assisting in overcoming the difficulties.

To all engineers working in Engineering Affairs Department in University of Diyala who helped me by their notices and information;

Finally, thanks to all who gave me moral support at the time I need it.

ABSTRACT

Integration Of Virtual Prototyping And Building Information Modeling To Optimize The Construction Site Planning And Management

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BIM technology (Building Information Modeling) is one of the most important technologies in the construction industry and it increases the performance during project life cycle. As a result of the development of the construction industry, such technology has to be used, increasing design efficiency and improving construction work while providing more time and cost.

The aim of this research is to study the possibility of using building information modeling BIM to improve the efficiency of site planning and manage the buildings spaces. So, fourteen buildings were modeled as a case study that includes the Faculty of Medicine with three scientific departments, the deanship ,the library, and Faculty of Veterinary Medicine including four scientific departments and the deanship, faculty of Science and include four scientific departments.

In order to achieve this research, the literature and previous researches used this technique in this area have been reviewed, as well as the collection of data by interviewing a group of engineers collecting existed documents and drawings of the projects, and taking pictures of the buildings.

By analyzing case studies and generating the data for real area by using BIM technology and comparing it with the international standards for space management on campus, there was a significant difference with requirement. And it was found that there is no listed international standard

that used in the design of these spaces, and there was a shortage of suitability for students, staff and teaching staff. In the case of factual departments (A1,D1,H2,H3,H4) there are a shortage in the spaces for student in lecture hall and laborotary .This shorage is notes in a big percent in Medicein Collage were the diffrence in number of student is about (104,53,24) in lecture hall and (80,51,24) in laborotary.This encourage to recommend the use of BIM technology in the early stage of the project to reduce the design error in space management and the efficiency of this technology as it's easy to obtain information and data.

The integration of the BIM model with the environment of the virtual site resulted in improving the site utilization and analysis. This integration helped in finding the functions of each space with the construction site, comparing this data with the standard requirement proposing some recommendations to manage the use of the project site more efficiently.

The researcher also recommends using this technique in planning the construction site where it is possible to obtain three dimensional virtual models to visualize the shape of the construction site including buildings, roads, parkings, green areasm before the implementation and study the effect of natural light and misguidance on the site at different times from the day that helps to obtain the optimum direction of the buildings. BIM technique was used efficiently in calculating the heating and cooling load , the annual carbon emissions, Fuel consumption use, and Electricity use for building constructions.

Finally, although there are obstacles to the use of BIM practices due to the reasons for the lack of the qualified personnel in this field, The imminent future will witness the use of large scale BIM system in the construction industry.

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LIST of ABBREVIATIONS

Abbreviations	Explanation
2D	Two Dimension
3D	Third Dimension
4D	Fourth Dimension
5D	Fifth Dimension
6D	Sixth Dimension
7D	7D BIM 6D BIM + Facility Management Features
AEC	Computer Aided Design
B	Laboratory
BDS	Building Description System
BEP	BIM Execution Plan
BIM	Building Information Modeling
C	Office Room
CO	Computer Room
CAD	Architecture, Engineering and Construction
CIFE	Center for Integrated Facilities Engineering
COBIE	Construction Operation Building Information Exchange
F	Staff Room
FM	Faclites Management
WPI	Worcester Polytechnic Institute
HVAC	Drawing Exchange Format
I	Library
IFC	Industry Foundation Classes
IFD	International Framework for Dictionaries
K	Storage Room
L	Lecture Hall
LOD	Level Of Detail
MEP	Mechanical , Electrical\and Plumping
NIBS	National Institute Of Building Sciences

O	Office Room In Deanship
R	Reading Room
S	Service Room
V	Free Room
A1	Factual Department Of Medecien College
A2	Deanship |Of Medicine College
A3	Library Of Medicine College
D1	Factual Department Of Veterinary Medicine College
D2	Deanship Veterinary Medicine College
H	College of Sciences

Chapter One

Introduction

1.1 Background

As a result of the continuous development of the construction industry, it was necessary to find modern techniques to keep pace with this development. The use of BIM technology in this area has been developed in terms of planning, designing and constructing buildings. BIM,hence should provide a level of solution in terms of site planning and space management inside buildings.

To ensure that, the college or university campus that have all level of efficiency and comfort for the use of these buildings in term of optimal use of space management within these building.

It is necessary to design these buildings by approaching to obtain these factors and the use of BIM technology that fulfills these requirements.

This chapter,in this domain will present the problem and justifications of research, aims and objectives, Limitations and scope, methodology and organization. This chapter also will explain the previous studies and researches related to this study.

1.2 Problem and Justifications of Research

a) Some problems in the construction project planning there are many different professionals working together or in parallel to the different parts of the project (site plan, visibility study, structure, services, design, distribution… etc.) following a fragmented method of management. Each of these parts must be based on a common “idea” and follow the same criteria of others, they are the key parts of information that,all

together,allow the possibility to create the project. If information is not accurate and exact enough next stages will be affected by it.

b) BIM could make more efficient stages in order to avoid many of the most typical mistakes when they work separately. At this point, budget planning, estimation and schedule plans are key aspects to the project success.

c) It is essential to know whether BIM tools are effective in site planning and space management or not.

d) There is a shortage in spaces for some parts of buldings in a case studies (lecture hall,labortory and teaching staff room) and these parts not suitable for useres.

1.3 Objectives of The Study

The main objectives of this study are:

a) Investigating the potential of BIM adoption in construction projects as site planning and management tool.
b) Finding the percentage of site spaces and functions relative to the total area of the whole campus.
c) Exploiting the BIM benefits in project energy analysis.
d) Analyzing the actual internal spaces of the buildings using the Revit software with the international standard of space management within the campus.

1.4 Research Limitations

This study is restricted to the following:

1. Spatial limitations:

This study concentrates on the site of University of Diyala, in the Iraqi construction sector

2. Temporal limitations:

A limited period of time (2018-2019) is determined to develop the BIM or use the BIM in site planning and management.

1.5 Research Methodology

Theoretical approach

a) This work will be focused on the theoretical analysis of scientific literature. It will start from the general concept of BIM as a new collaborative process, and then will continue with its analysis as an "n-D" tool.

b) General concept of Building Information Modelling as a tool and process will be used to manage information in different areas of the site planning.

Experimental analysis

a) Make a comparison between general site planning and BIM site planning. This quantitative analysis for a case study of the already existed project, based on the automatic process of extracting information from BIM models.

b) Case studies were modeled by Revit software according to BIM to calculate their actual area and compare with the international standard.

c) Make a survey to obtain real data from the construction sector to compare how BIM is implemented in site planning and space

management. In addition,it is sigficance to know which advantages or disadvantages this technology offers to the construction sector. Figure (1.1) represents the methodology used in the research.

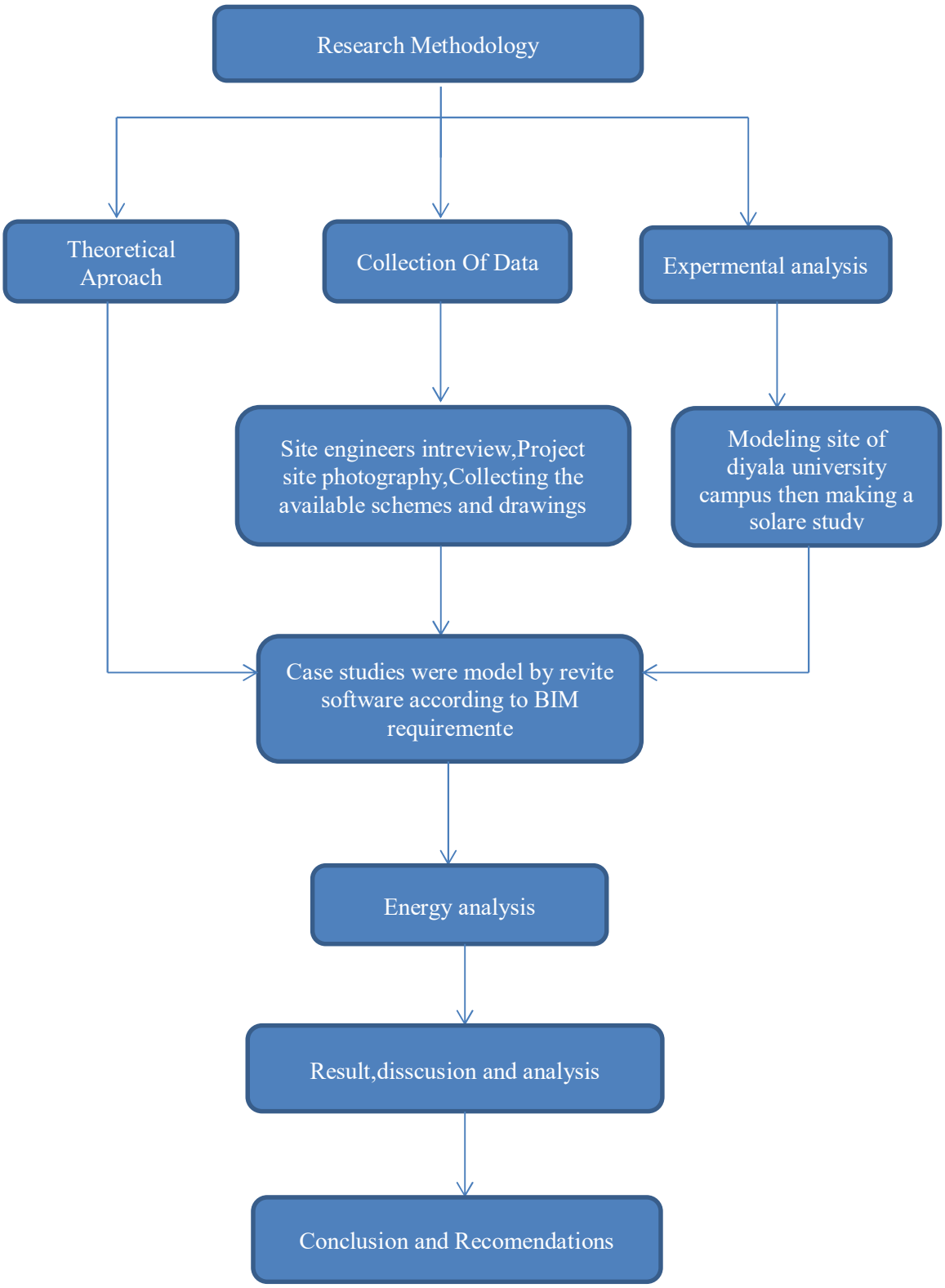

Figure (1.1) Research Methodology (Researcher)

1.6 Structure Of The Thesis

Based on the aforementioned, the below structure has been adopted as follows and shown in figure (1.2) below:

- Chapter One: Introduction

  This chapter contains the study introduction, Problem statement, study aims and objectives, study methodology, Limitations and scope, and previous studies that focus on the use of BIM in space management and site planning.

- Chapter Two: Literature Review

  This chapter includes the definition of master plan ,The roles and effects of campus master plans**,** an introduction in to BIM, The requirement for BIM**,** The technical value and business value of BIM, BIM programming ,maturity levels of BIM, planning for success BIM,idea of BIM in project management ,The facilities management (FM) process ,importance of BIM, The value of BIM for (FM) ,BIM execution plan (BEP),site displaying devices ,BIM adoption benefits.

- Chapter three: case Studies , Site Planning And Energy Enalysis

  This chapter discusses the use of Revit software according to BIM in space management inside building and makes virtual prototyping of the site of Diyala University campus.

- Chapter Four: Results and Discussion

  This chapter includes the analysis of results calculated by Revit software and compared them with standards then the suggestions were given.

- Chapter Five :Conclusion And Recommendation

  This chapter contains the conclusion of this study and some recommendations for future work.

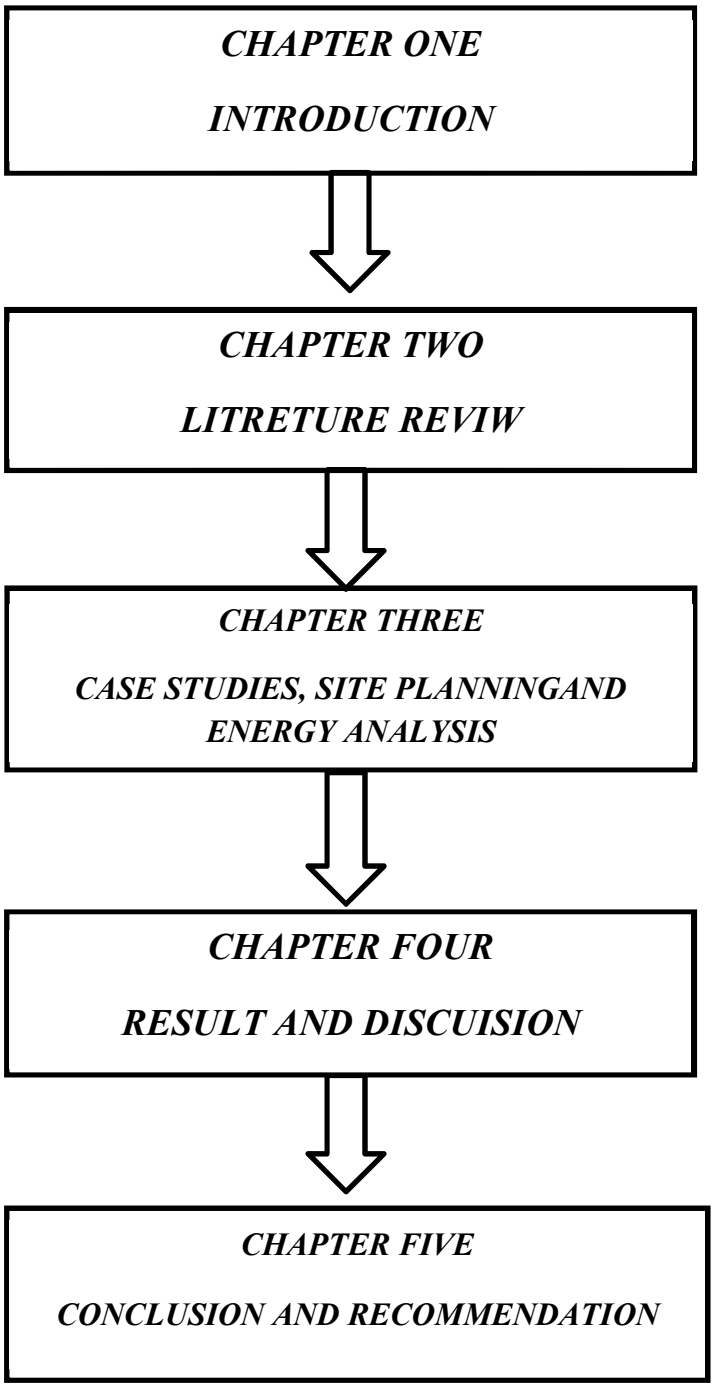

Figure (1.2) Structure Of The Thesis (Researcher)

1.7 Previous Studies

Table 1.1 Reviews of Previous Studies

Previous studies		
Year	RESEARCHER	The work
2010	Christopher.J.keegan	The aim of this study to investigate the advantages of utilizing Building Information Modeling (BIM) in the conveyance of redesign extends just as its conceivable use in space usage the executives. This investigation endeavored to distinguish open doors for BIM to enhance the procedure that colleges and establishments, specifically, right now use for their remodels and space uses the executives. as part of this research study A case study was done on a building on the WPI campus, Salisbury Laboratories .This research project gathered data from the WPI offices the executives division explicitly and from overviews of different establishments to more readily comprehend the present issues related with redesigns and space arranging and to endeavor to approve the utilization of BIM as a suitable arrangement the study could recognize a few advantages of using BIM in the conveyance of remodel ventures, incorporating expanded proficiency in the structure stage and age of reasonable gauges and staging gets ready for the proprietor. The important advantage found by the investigation in the usage of BIM was the capacity for spatial perceptions and the simplicity of adjusting the plan in a steady and effective manner.
2014	Jarrel.B.whitman	The aim of this research is to find the best practices for site utilization planning and to detect the ability of BIM to enhance of the planning of the use of site. The data was collected by the questionnaire and 241 responses were received.

2017	Wadhah.A.hatem and Nagham.N.abbas	The objective of this research is to detect the possibility of applying BIM in the Iraqi construction projects. Including the benefit and challenging in addition to identifying the factors that stimulate the adoption of this technology. The quantitative approach was adopted by means of the questionnaire and was reinforced by personal interviews with construction project specialists. The result showed that the knowledge of this technology is low in the geometric medium. As for the benefit of BIM , results showed that this technology saves time and cost significantly in the project providing a high quality system in documentation ,detection of errors and conflicts, cooperation among members of the project team. The challenges are the weak government efforts to support this technology, lack of number of experts, lack of education and training.
	Alaa.S. khamees	The objective of this research is to examine the possibility of adopting BIM in technique in documentation due to the loss of project documents, spare orders and unreliability. The result of this study was determined by the ability of the technique to give distinct result in the treatment of the completed buildings through the rehabilitation and development of the buildings that were established previously. The real and speculative calculus of these cases was determined and the accuracy between the actual and BIM and the actual was 93.5% for the case study 1 and 96.9% for the case study 2.
2018	Muhammed.M.sadeq	The aim of this research is to study the possibility of using the BIM in the middle east. And the difficult faced by the users of this technology and the most important advantage of this technology to support the concept of sustainability through the questionnaire developed by using the internet and choose Al-Qasim green University as a case study to test the capabilities of the integration of BIM with analysis tool sustainability to enhance the economic aspect of design through the adoption of LCC cost analysis to select the best alternatives for design construction.
Current study (2019)		
This research explores the benifets of using BIM in site planning and space management throug making a virtual prototype of diyala university campus .this study found that the green area cositute 40% of the total area of the site and the area of park G1 is about (13743m2) and for park G2 is about (10220) there is a shortage in parking area is about (2964m2) for park G1 and (588m2) for G2 therefor the researcher suggest to make a multy-story park .		

1.8 Summry

This chapter presents a brief introduction to BIM, description of the problem and justification of study, description of the aim and objectives of the research, the limitations of research, the methodology of research in brief, the structure of the thesis, research originality, and finally review of previous studies which included a comparison with the current study.