**T.C.**
**ISTANBUL GEDİK UNIVERSITY**
**INSTITUTE OF GRADUATE STUDIES**

# DESIGN AND CONSTRUCTION OF SUSTAINABLE STRUCTURE BUILDING IN TERMS OF PROJECT MANAGEMENT

**MASTER THESIS**

**Nihad Jarullah ABDULLAH**

**Engineering Management Master in English Program**

**MAY 2021**

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**Thesis Advisor: Asst. Prof. Dr. Mert TOLON**

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**İSTANBUL GEDİK ÜNİVERSİTESİ**
**LİSANSÜSTÜ EĞİTİM ENSTİTÜSÜ MÜDÜRLÜĞÜ**

## Yüksek Lisans Tez Onay Belgesi

Enstitümüz, Engineering Management Department İngilizce Tezli Yüksek Lisans Programı (181281019) numaralı öğrencisi Nihad Jarullah ABDULLAH'in "Design and Construction of Sustainable Structure Building In Terms of Project Management adlı tez çalışması Enstitümüz Yönetim Kurulunun 21.05.2021 tarihli kararıyla oluşturulan jüri tarafından *Oy Birliği* ile Yüksek Lisans tezi olarak *Kabul* edilmiştir.

| **Öğretim Üyesi Adı Soyadı** | **İmzası** |
|---|---|

**Tez Savunma Tarihi:**

**1) Tez Danışmanı:** …….

**2) Jüri Üyesi:** …….

**3) Jüri Üyesi:** …….

***to the feet of my parents…***

## DECLARATION

I, Nihad Abdullah, do hereby declare that this thesis titled as “Design and Construction of Sustainable Structure Building In Terms of Project Management” is original work done by me for the award of the masters degree in the faculty of Engineering Management. I also declare that this thesis or any part of it has not been submitted and presented for any other degree or research paper in any other university or institution.(…../ …../…..)

Nihad Jarullah ABDULLAH

## PREFACE

In the name of Allah, the Merciful And peace and blessings be upon the Messenger of God, our master Muhammad, his family and companions, and whoever followed him with kindness until Day of Judgment.

I want to express my profound thanks, appreciation, and respect to the esteemed professor Asst. Prof. Dr. Mert Tolon, who was the best help for me during my studies in the courses and writing this thesis, provided me with advice and guidance to present this humble work.

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MAY 2021 Nihad Jarullah ABDULLAH

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**ABBREVIATIONS**

| | |
|---|---|
| **A.C.O.S.S.** | : Australian Council for Social Services |
| **A.E.C** | : Architecture, Engineering and Construction |
| **B.M.S** | : Building Management System |
| **B.R.E.E.M.** | : Building Research Establishment Environmental Assessment Method |
| **BIM** | : Building Information Modelling |
| **C.F.D.I** | : Computer Fluid Dynamic |
| **C.O.P** | : Coefficient of Performance |
| **CaGBC** | : Canada Green Building Council |
| **CWD** | : Construction Waste Demolition |
| **G.N.P** | : Gross National Product |
| **GHG** | : Greenhouse Gas Emissions |
| **HVAC** | : Heating, Ventilation, Electrical and Air Conditioning |
| **I.P.D.** | : Integrated Project Delivery |
| **ISF** | : The Institute for Sustainable Futures |
| **IUCN** | : Iinter National Union for Consorvation of Natuure |
| **L.C.A.** | : Life Cycle Assessment |
| **L.C.C.** | : Life Cycle Cost |
| **Leed** | : Leader Ship in Energy and Environmental Design |
| **LEED** | : Leadership in Energy and Design |
| **M.E.P.** | : Mechanical, Electrical and Plumbing |
| **N.G.O** | : Non-Governmental Organization |
| **O.E.C.D.** | : Organization for Economical Operation |
| **U.S.G.B.C.** | : United States Green Building Council |
| **UNEP** | : United Nation Environment Programme |
| **V.F.D.** | : Variable Air Volume |
| **V.R.F.** | : Variable Refrigerant System |
| **VAV** | : Variable Air Volume |
| **VDC** | : Virtual Design and Construction |
| **W.C.E.D.** | : Western Cape Education Department |
| **W.W.F** | : Worldwide Fund of Nature |
| **3D** | : Third Dimension (Depth, Height) |
| **4D** | : Fourth Dimension( Time) |
| **5D** | : Fifth Dimension(Cost) |
| **6D** | : Sixth Dimension(Environment And Energy Consumption) |
| **7D** | : Seventh Dimension( Building Information Modelling / Facility Management) |

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**DESIGN AND CONSTRUCTION OF SUSTAINABLE STRUCTURE BUILDING IN TERMS OF PROJECT MANAGEMENT**

## ABSTRACT

A strong movement is emerging to protect the natural ecosystem, conservation of natural capital, and reduce pollution in the atmosphere. The emphasis has been on the city, which is the area that uses the most resources, so sustainable architecture has been an essential part of new ventures. Such assumptions threaten the climate and economies of different industries while giving rise to innovative architecture and delivery methods. It helps to create productive facilities by reducing detrimental effects on the community. "Sustainability" was defined for the first time through the Brundtland Report posted in 1989 by way of the United Nations of the World Commission on Environment and Development, located inside the middle of several studies and practices.

Sustainability maintains the quality of life by adjusting to the environment utilizing natural resources for the longest possible period leading to life-long conservation. Moreover, the idea of sustainability involves a community of essential mechanisms that provide livelihoods of all sorts, helping them preserve their generations' prosperity and establish growth expectations over time.

The development of environmentally friendly buildings and smart homes results from legislation that focuses on sustainability. The commitment of responsibility for natural capital and water degradation in the building industry Think environmentally conscious, get a better home: Sustainability-design homes include state-of-the-art solutions in existing structures. For this kind of design, people who have interests in the project, including engineers, architects, component vendors, administration, and use managers, all participate in Separating risks and assets from the assets, picking the right technologies for the enterprise, and sourcing them from inside or from outside the company are critical in carrying out a long-term plan. Corporations that invest in R&D for power and worldwide sustainability can thrive in the Era of strategy. Lately, the construction employer has grown to be more interested in designing environmentally friendly buildings (such as sustainable homes) that offer overall performance and save money due to less maintenance. Building information modelling technology(BIM) provides designers with the ability to provide exclusive design options, choose power strategies, and build infrastructure through simulated lighting, electricity consumption assessment, sustainable design requirements, and the Building Life Cycle Assessment (L.C.A.).

Various study methodologies were adopted, including literature review, layout device analysis, and structured questionnaire. Data collected were synthesized as a part of the research procedure.

It is not hidden all over the world is going on sustainable creation. The sustainable layout has emerged as a mainstream construction design aim in the latest years because of worldwide environmental concerns. Sustainable development is even more urgent in mild global climate change. This thesis targets to look at the

contributions that building information modelling (BIM) and challenge management could make to sustainable construction designs. This thesis is more like a guide for engineers to design sustainable building through answer these questions

- What is sustainability?
- What is BIM ?
- How to design?
- What programs should we use to design?
- What standard should we use?
- What are the advantages of BIM?.

Therefore, the research aims to discover the role of sustainable architectural design in Reducing and achieving impacts on the built environment the goal.

The research reported the following procedures: -

1. It builds a comprehensive theoretical framework for sustainability, sustainable architectural design, and sustainability strategies by studying some architectural literature that has dealt with the subject.

The discussion will be: how to take advantage of practical applications of BIM Serving to design environmentally friendly buildings; to show the possibility of addressing academic science and translating it into manageable steps that provide the designer with a more realistic field in the stages of imagination and more accurate in terms of architectural design outputs; which confirms BIM's ability to transcend the famous five dimensions to the sixth dimension and seventh dimension.

2. It is extracting indications that benefit the designer to reduce negative design impacts.

The seventh dimension is for a design that provides its users with a vast world of analysis and understanding of construction performance very early to make design decisions more clearly, transparently, and convincing decision-makers. It will be explored some of the concepts related to environmental factors that affect our daily lives and performance that may be missed by some specialists, especially those working outside the arc Life field, which architectural design emphasizes. It will try Presenting these concepts in a simplified manner and clarifying the benefit from their positive impact, avoiding their negative impact, and the ease of dealing with them through applications or software for the BIM.

This thesis's ultimate goals are to make the best way for civil engineering to design, manage, and execute these works. It also examines the critical role it plays in This vital sector (sustainable building). The main problem of this thesis is to reduce the negative impact on the built environment. There is a deficiency Cognitive Towards the role that sustainable design strategies play in minimizing these impacts.

**Keywords:** *Sustainability, BIM and sustainability, design of the sustainable structure.*

# PROJE YÖNETİMİ AÇISINDAN SÜRDÜRÜLEBİLİR YAPI BİNASI TASARIMI VE İNŞAATI

## ÖZET

Doğal çevreyi korumaya, doğal kaynakların tükenmesini azaltmaya ve atmosferdeki kirleticileri azaltmaya yönelik net bir eğilim ortaya çıktı. Dikkat, en çok enerji tüketen sektör olan kent sektörüne odaklandı, bu nedenle sürdürülebilir mimari konseptleri, modern mimari tasarımların ve projelerin ayrılmaz bir parçası haline geldi. Çeşitli Çağ sektörlerine gölge düşüren çevresel ve ekonomik zorlukları artıran ve bunları gelişmiş yöntem ve teknolojilerle planlama, tasarım ve uygulama yoluyla verimli bir şekilde karşılayan algılardır. Çevre üzerindeki olumsuz etkilerin azaltılmasına katkıda bulunur, böylece verimli, faydalı tesislerin kurulmasına katkıda bulunur.

"Sürdürülebilirlik" ilk kez 1989 yılında Birleşmiş Milletler Çevre ve Kalkınma Komisyonu tarafından yayınlanan Brundtland Raporu ile çeşitli çalışma ve uygulamaların ortasında yer alan tanımlanmıştır.

Sürdürülebilirlik, yaşam boyu korumaya götüren mümkün olan en uzun süre doğal kaynakları kullanarak çevreye uyum sağlayarak yaşam kalitesini korur. Dahası, sürdürülebilirlik fikri, her türden geçim kaynağı sağlayan, nesillerinin refahını korumalarına ve zaman içinde büyüme beklentileri oluşturmalarına yardımcı olan temel mekanizmalardan oluşan bir topluluğu içerir.

Eko-Binalar ve akıllı evler, sürdürülebilir çevre düzenlemelerinin sonucudur. İnşaat sektöründe doğal kaynakların tüketiminden ve çevre kirliliğinden sorumludur. Akıllı binalar olarak adlandırılan sürdürülebilir yapılar, sıradan binalarda sürekli yeni ve benzeri görülmemiş teknolojilerin kullanıldığı, kontrol sistemlerine sahip yüksek teknolojili evlerdir. Bu tür inşaatlar için mühendisler, mimarlar, ürün üreticileri, enerji danışmanları, görev yöneticileri, yöneticiler ve kullanıcılar dahil olmak üzere paydaşlar birlikte çalışır. Bu teknolojileri takip ederek yeteneklerle ilgili tehditleri ve yetenekleri belirlemek, kuruluş için uygun teknolojiyi seçmek ve bu teknolojileri bina stratejisini kontrol etmek için iç veya dış gruptan satın almak, sürdürülebilir bina ilkelerinin oluşturulmasında esastır. Stratejik Çağın kontrolünü kullanarak dünya çapında gelecek inşa etme kurumunda araştırma ve geliştirmeye yatırım yapan ve küresel pazarda rekabet edebilmek için enerjisini sürdürülebilir kılan şirketler, bir yer bulabilir ve dünya pazarında öne çıkan bir isim yapabilir. Son zamanlarda, inşaat işvereni, genel performans sunan ve daha az bakım nedeniyle tasarruf sağlayan çevre dostu binalar (sürdürülebilir evler gibi) tasarlamakla daha fazla ilgilenmeye başladı. Bina bilgi modelleme teknolojisi (BIM), tasarımcılara simülasyonlu aydınlatma, elektrik tüketimi değerlendirmesi, sürdürülebilir tasarım gereksinimleri ve Bina Yaşam Döngüsü Değerlendirmesi (L.C.A.) aracılığıyla özel tasarım seçenekleri sunma, güç stratejileri seçme ve altyapı oluşturma yeteneği sağlar.

Literatür taraması, düzen cihaz analizi ve yapılandırılmış anket dahil olmak üzere çeşitli çalışma metodolojileri benimsenmiştir. Toplanan veriler araştırma prosedürünün bir parçası olarak sentezlendi.

Sürdürülebilir yaratım için dünyanın her yerinde gizli değil. Sürdürülebilir düzen, dünya çapındaki çevresel kaygılar nedeniyle son yıllarda ana akım bir inşaat tasarım hedefi olarak ortaya çıktı. Sürdürülebilir kalkınma, ılıman küresel iklim değişikliğinde daha da acildir. Bu tez, bina bilgi modellemesinin (BIM) ve zorluk yönetiminin sürdürülebilir inşaat tasarımlarına yapabileceği katkılara bakmayı hedeflemektedir. Bu tez, mühendislerin bu soruları cevaplayarak sürdürülebilir bina tasarlamaları için bir rehber gibidir.

- Sürdürülebilirlik nedir?
- BIM nedir?.
- Nasıl tasarlanır?
- Tasarlamak için hangi programları kullanmalıyız?
- Hangi standardı kullanmalıyız?
- BIM'in avantajları nelerdir?

Bu nedenle araştırma, sürdürülebilir mimari tasarımın hedefin yapılı çevre üzerindeki etkilerin azaltılması ve başarılmasındaki rolünü keşfetmeyi amaçlamaktadır.

Araştırma aşağıdaki prosedürleri bildirdi: -

1. Konuyla ilgili bazı mimari literatürü inceleyerek sürdürülebilirlik, sürdürülebilir mimari tasarım ve sürdürülebilirlik stratejileri için kapsamlı bir teorik çerçeve oluşturur.

Tartışma şu şekilde olacaktır: Çevre dostu binalar tasarlamak için BIM Hizmetinin pratik uygulamalarından nasıl yararlanılacağı; tasarımcıya hayal gücü aşamalarında daha gerçekçi ve mimari tasarım çıktıları açısından daha doğru bir alan sağlayan akademik bilime hitap etme ve onu yönetilebilir adımlara dönüştürme olasılığını göstermek; Bu, BIM'in ünlü beş boyutu altıncı boyuta ve yedinci boyuta taşıma yeteneğini doğrular.

2. Tasarımcının olumsuz tasarım etkilerini azaltmasında fayda sağlayan göstergeleri çıkarır.

Yedinci boyut, tasarım kararlarını daha net, şeffaf ve ikna edici karar vericiler için çok erken bir zamanda kullanıcılarına geniş bir analiz dünyası ve inşaat performansı anlayışı sağlayan bir tasarım içindir. Mimari tasarımın vurguladığı arc Life alanı dışında çalışanlar başta olmak üzere bazı uzmanlar tarafından gözden kaçırılabilecek, günlük hayatımızı ve performansımızı etkileyen çevresel faktörlerle ilgili bazı kavramları inceleyeceğim. Bu kavramları basitleştirilmiş bir şekilde sunmaya ve olumlu etkilerinden elde ettikleri faydayı netleştirmeye, olumsuz etkilerinden kaçınmaya ve BIM için uygulamalar veya yazılımlar aracılığıyla bunlarla başa çıkmanın kolaylığını sağlamaya çalışacaktır.

Bu tezin nihai hedefleri, inşaat mühendisliğinin bu işleri tasarlaması, yönetmesi ve yürütmesi için en iyi yolu yapmaktır.

Ayrıca bu hayati sektörde (sürdürülebilir bina) oynadığı kritik rolü de inceler. Bu tezin temel sorunu, yapılı çevre üzerindeki olumsuz etkiyi azaltmaktır.

Sürdürülebilir tasarım stratejilerinin bu etkileri en aza indirmede oynadığı role doğru Bilişsel bir eksiklik vardır.

**Anahtar Kelimeler**: *Sürdürülebilirlik, BIM ve sürdürülebilirlik, Sürdürülebilir yapının tasarımı.*

## 1. INTRODUCTION

Structures and frameworks make high-quality commitments to several aspects of our lives, including commercial enterprise, training, health, and prosperity. They are likewise a fundamental piece of a stable economy. Be that as it could, as merely being liable for colossal quantities of ozone harming substance emanations, they also have a developing choice to move quickly intending to fundamental problems that have motivated the advancement of a broad scope of potential arrangements (John, G.; Clements et al. 2005). These include management frameworks, the shape of developments, mechanical upgrades, and adjustments in business practices. However, there is no generally agreed way to deal with the tendency to manage in action, and this proposal acquires a wide range of arrangements. One of the challenges confronting environmental sustainability is that the planet's resources are used up. The quantity of already open concern has arisen in the light of modern knowledge. In comparison, there has been significant growth in the collaboration and recommendations associated with a modest increase in the overall production of relevant artifacts and substances, board methodologies, and evaluation techniques—realistic action set in order, multiple players. Extraordinary compared to other recognized ones, given with the help of Norway's former Prime Minister, Gro Harlem Brundtland; she described economic development as follows:

"Advancement that addresses the prevailing issues without trading off the capability of people within the future to address their problems." (World Commission on Environment and Development, 1987).

Regardless of the alternative you choose, the economic implications would be profound. With organizations that help with the program, the enhancement component is one of the prevalent foreign clients of common property. Essentially, it leads to the new impractical method of developing the world economy. The sustainable building seeks to adapt the principles of sustainable improvement to the manufacturing enterprise. It involves the delivery of houses, structures, engineering assistance, and their immediate surroundings:

1. Increased use of resources through the use of fewer raw materials and much less energy, thus fewer pollutants and waste
2. Enhance the best of lifestyles and provide purchaser satisfaction.
3. There should be flexibility in choosing resources and changing them or using alternatives during the construction life stage.
4. Provide an appropriate economic and social environment and support it regularly.
5. In a possible timeframe to enhance construction efficiency and throughout the construction business's life, it is clear that the effect of the structure continues for a long time beyond the period of development of materials used in the construction industry—both of these considerations taken into consideration (Farzad Jalaei., 2015).

A building's efficiency in terms of operation and maintenance determined in the early planning and specification stages. Consequently, sustainable project proposals must consider the design, construction, and operation care and at the end of the demolition phase. As correctly as having direct effects on sustainability, homes' location and shape also have indirect impacts by influencing occupants' level of sustainable behaviour. Offices far away from shipping routes encourage automobile use in today's world, home windows that can't promote air conditioning, and poorly planned working environments cause decreases in properly-being, health, and productivity.

Building enterprise experts have started to awareness of controlling and adjusting ecological harm because of their exercises. Planners, originators, specialists, and others engaged with the structure process have a significant risk of decreasing environmental impact by executing maintainability desires at the shape development section of a structured challenge. Modern-day activities, systems, and techniques around greater widespread worldwide desires and critical destinations are feeble proceedings to miniaturized scale level (express challenge level) coordinated dynamic (Ugwu, O.O.; Kumaraswamy et al. 2006). Understandably, only on the smaller stages, support desires should be transformed into concrete, practical activities using a comprehensive method of dealing with emotional encouragement. Building Research Environmental Assessment Method (BREEAM), Actions for Environmental and Economic Sustainability (BEES), Leadership in Energy and Environmental Design (LEED), is continually being created and updated to complement modern practices in

making structures. The primary goal is to reduce the combined state's overall impact on human well-being and typical habitat.

In the direction of the most recent 20 years, records innovation has altered the plan and advent of movies and music, planes and toasters, devices, and events. In particular, the form of the produced items gained by the help of the software that promotes design and inspection of every possible quality of a gathering, from the body and walking to warm action and development, and the receiving of superior models in the assembly has rendered the gadgets increasingly talented and inspired. Modellers and experts are presently applying comparative devices to the building plan. These gadgets' most complicated conveys nonstop and brief enter on a miles extra considerable scope of attributes than standard form apparatuses. Overall, on the web presence, physical quantity and consistency have a disconcerting effect, and the rules of "elevate-new growth" were there but would most often not be evident. Redecorate a certain situation in your mind to remember what you'd learned. This manner of coping with building configuration is not much like utilizing everyday CAD programming that the commercial enterprise has another name for it: Building information modelling (BIM). As constructing improvement crosses with herbal worries and the increasing price of vitality, a developing discipline inside form configuration has risen - possible plan, the act of planning, constructing, and operating structures in a way that limits their ecological impact Purpose (Siti Hawa, 2005)

The sustainable layout has to be a mainstream construction layout purpose in recent years because of world environmental issues. Sustainable development is even more urgent in mild world climate change.

### 1.1 Study Topic

The Global Building Modeling Information Report (N.B.S., 2012) shows some exciting findings regarding the current situation, its features, innovative professionals' practices and roles to sustainability, new product selection not previously tried, energy calculations, skills assessment, and sustainability projects.

The questionnaire(of the study mentioned above) showed that even if more than 50% were aware of the importance of all three sustainability (environmental, economic, and social) and understood the sustainability policy, only a few of them would serve the

ecological assessment. Sustainability and building information modelling technology are mainly today—the clarification and understanding of sustainable planning's subsidiary methods. So far, there is no complete and systematic way to help specialists assess sustainability from the early stages of design and benefit from the results that it aspires to reach.

Despite the modern Era's efforts closest to sustainability, electricity's efficiency and the rate of charges corresponding to consumption are not significant. Requirements in the construction development process lead to the loss of opportunities to increase planning in energy-saving construction. The current Era (the Era of the sustainable building) must have a plan for energy saving.

Energy and performance and its evaluation are after the issuance of the architectural planning and construction documents. The loss of integration in the planning approach results in an ineffective way to retroactively edit the design to obtain consistent, comprehensive performance criteria. In this context (Bouchlaghem et al., 2005) indicated the importance of integrating all disciplines from the initial level to the planning document. Early picks are essential to benefit sustainability inside the resulting format outcome (Schlueter et al., 2009).

Understanding the sustainability criteria, especially in the project's initial planning stage, can be very beneficial because it allows customers to specify the green building certification specifications required to obtain a specific credit. The Leadership in Energy and Design (LEED) system is a thriving business selling sustainability in the A.E.C. industry due to government support and aggressive advertising and marketing of the United States Green Building Council(USGBC). (Peter O. Akadiri et .al 2012)

Similar to what Canda and her Affiliate Council (CaGBC) have done, according to (Eastman et al. (2008), BIM can develop an ecological model that can simulate reality and achieve our ambition. Indeed, BIM is now able to reduce the time and effort needed to start any project. The BIM application can undoubtedly address a significant sustainable construction (dealing with project complexity, simulation work, voice evaluation, and light). In the future, we look to BIM to be more comprehensive than it is now, where until now, the paragraph of power consumption of the building has not been added, knowing that technology is continually evolving. Environmental impacts and strength of each building element separately and the classification of green buildings are all present and applied in the BIM environment simultaneously as the

planning approach used. The fact that coordination between people and tools can cause a bone benefit in the stage of buildings' overall performance makes many situations Difficult to face. An integrated format approach, interdisciplinary collaboration, complex format analysis, careful material, and tool optimization are required to solve this problem (Nofera et al. 2010).

Many kinds of research have realized sustainable layout; we discovered that few studies come up with a whom to start to be a designer. This thesis contributes to sustainable design and BIM; it defined what you have to know the approximately sustainable layout, what requirements you must use, what programs you have to learn.

### 1.2 Hypothesis

The hypothesis is the two main subjects.

1. To find the relationship between sustainable design and the uses of BIM technology.
2. To find the possibility for civil engineers to design a building by using BIM in terms of a successful project management application.

### 1.3 Purpose of the Thesis

Although many definitions relate to sustainable buildings, the basic principles, theories, and goals are still the same, a stable economy, a harmless environment, and a general public culture that will enhance the modern and future touch of existence. Given the negative impact of construction on the boundaries surrounding it, green building materials need help in Promoting movement towards the sustainable building, which is the beginning of its activity, and most of the engineers and designers are inexperienced in it. Designers, owners, and engineers are allowed in the initial design stage, and they are allowed access to various types of data to assess sustainable planning. The main objective of this examination is to obtain the following sub-goals:

- Objective 1: Generating an integrated environment programmed to carry out ecological design with the help of building information modelling technology.
- Objective 2: Describe away to design sustainable buildings and what standards should use.

- Objective 3: To find the relation between sustainable design and BIM management regarding project management.

This thesis is an abbreviation of what the researcher learned through experience to become a designer, and below is the most critical point that this thesis aims to:

1. We define sustainability and its most essential elements: the most critical component and foundations for sustainable design.
2. Define information modelling and what programs used for design in general and sustainability programs in particular
3. Define that BIM is a management design system that extends to the end of a building's life, not during the design and construction phase but instead rises to the post-construction stage.
4. Introduce vernacular evaluation systems for sustainable buildings and what are the requirements for successful design.
5. The primary purpose is to explain how the civil engineer designs and implements his project by understanding the basics of sustainable design, programs must learn, and evaluation systems he uses.

In short, it shows how to put the first foot on a civil engineer on the design path.

### 1.4 Methodology

The workflow applied in these studies is as tracks: (Fig1.4)

1) A comprehensive literature assessment to discover BIM ideas and sustainable design.
2) Designed questionnaire for the expert in sustainable designers.

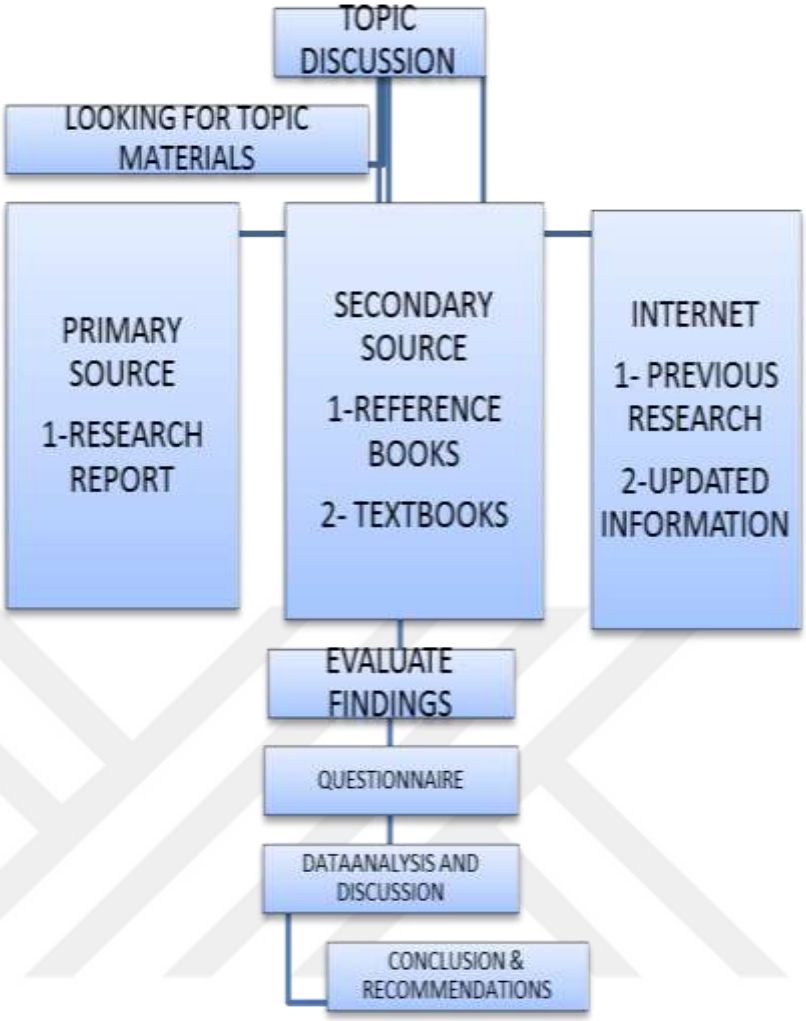


**Figure 1.1:** Thesis Methodology

### 1.5 Structure of the Thesis

In this part of the thesis, we will briefly explain the contents of the idea.

The first chapter includes introducing the thesis, the relationship between sustainable buildings, and building information modelling.

The reasons, objectives of the thesis will explain, and methods used to extract the final results.

In the second chapter, sustainability in the general and sustainable building was discussed, where sustainability touched. The essential sustainability components will explain, and each part is concerned. A historical overview of sustainability and its development stages are mentioned, and then sustainability is discussed in the building and the construction sector.

The sustainability principle in construction discussed; what are the criteria and evaluation systems used in construction? Moreover, what is the relationship of building information modelling systems to sustainability?.

How can design be based on applying sustainability principles through resource conservation, land conservation and energy, and water conservation (which are the foundations of the pillars of sustainability)?

The third chapter discusses the topic of building information modelling and its relationship to sustainability. We defied building information modelling in general and the date of creation of this technology and how it developed. Then it compared with the traditional building systems used and said some of its benefits.

In the fourth chapter, the method used to extract the results will be discussed, divided into two parts. The first section is literary reviews of sustainability as well as building and management information modelling. The second section is to conduct a questionnaire for construction workers as well as designers and civil engineers.

The fifth chapter will discuss the results obtained from the questionnaire, compare these results with previous literary reviews, and extract new products to develop engineers' work in this field.

The sixth chapter addresses some of the findings that have been reached based on the Coronavirus study. It also shares some of the latest advice that the testing team will want to see in the future. It also speaks about the future from going green and sustainable architecture, when everybody was in quarantine. This study would certainly be a chance to create more innovative designs to allow citizens who live in their homes more secure and healthier.

## 2. SUSTAINABILITY

This chapter focuses on the definition of sustainability and sustainable development and the international efforts made during the last half of the twentieth century to clarify the principles and premises for sustainability until it became a global demand advocated by developed countries and proud of the countries that adopted it.

The governments are obliged to do so because they preserve future generations' rights to live in an environment Safe and economical sound.

We will outline its primary goals as endorsed by the United Nations General Assembly. All countries of the world agreed on it and named it the Millennium Goals. We show the most important methods and mechanisms available to reach them, according to executive evidence. Sustainable development today is a road map to launch the peoples and nations in a united march, with deliberate steps with time limits and successive phases. It distinguishes it from the developmental models that preceded its neutrality and stripped it of the self-imposed ideologies (Brundtland 1987).

The most famous definition of sustainability is that The description, which is widespread and named by (Brundtland, Prime Minister of Norway), in United Nations In 1987:

"Sustainable development is a new pattern for development. Meet the present's needs without risking future generations' ability to fulfill according to their needs", and the report was entitled "Our Common Future."

It is famous that intense international efforts have taken place after this report, as those interested in the environment felt no longer concentrated on a country. Still, pollution has become a threat to humanity as a whole. International "UNESCO" and Roma Club moved to warn of the continued deterioration The depletion of natural.

The word sustainability origin goes back to Latin roots and its meaning (support from the bottom). It is a society built from the bottom by its inhabitants and present to the Greek concept (Lola Karbotli, 2014).

The concept of sustainability is the effective exploitation of the available resources and capabilities, whether human, material, or natural. It is environmentally and urbanely balanced to ensure continuity of sustainability without wasting future generations' gains (Faiq M.S. AL-Zwainy, 2019).

In the World Conference on Development, the environment and sustainability, A concept of sustainability represents "meeting the needs of people in the present without affecting future generations to meet their needs in the future." During the conference, the agreed definitions of sustainability were (BIM Arabia magazine 2017).

(Sustain) Support for life forms continues or remains, (Sustenance) Giving life or sustenance (giving food or nourishment), (Sustainable) It is an adjective describing something that gives support, comfort, and nourishment or has been provided with aid and thus remains that thing. It survives continuously or has prolonged. (Lola Karbotli, 2013).

There are four sustainable economic development goals for the members of the OECD to pursue: reducing poverty, improving human well-being, expanding economic growth, equalizing opportunity, and decent work, living wages, and further access to political participation (OECD). Services rely on us and not the community. The art of stopping is like fine art, except that it does not lend itself to contrast. Obedience to the law of nature is essential to have complementary programs in economic and environmental development strategies. (Asif, M et al. 2007)

Sustainable design, green architecture, sustainable construction, green building these concepts are all just methods. New forms of design and construction evoke problems that cast shadows on various sectors in this new Era during the current economic and social crisis. It also reduces costs, mainly operating and maintenance expenses. Contribute to providing a safe and comfortable urban environment. Thus, the motives for adopting the concept of sustainability in the sector.

With its dimensions (Sustainable Development), it does not differ from the motives that led to the emergence and adoption of the concept of sustainable development environmental, economic, and social overlapping. The term sustainable architecture describes the movement associated with architectural design interested in everything related to the environment. Sustainable architecture describes the real thing: we are

getting what we need from the universe. This realization forces us to respond with interest and regulation in using those resources (Hoúkara, 2007).

There are two principal issues of life: survival and the thing called entropy. Entropy is also the enemy trying to kill you because you have to work to do, which means you will never stop. However, survival is still trying to get it done, so you have to rest (Is the preservation of the ecological, economic and social systems formed in the urban environment, a process that involves dealing with Resources and technical direction to develop in harmony with the current and future needs of humanity). The country's schoolchildren are more open to literature than everyone else in the world's, and thus have the world's duty to become successful students, authors, musicians, and thinkers (Hoúkara, 2007; Oktay, 2005).

In the general concept, sustainability means using naturally available materials to ensure their continuity for the present time and future generations in a balanced manner so that the materials do not disappear from nature and deplete them. From this perspective, sustainability is a breakthrough way to preserve materials, ensure their durability, and reuse materials that have been previously used(Hoúkara, 2007). Sustainability objectives also exist generations in the subsequent century with the beneficial useful resource of shielding the herbal and built ecosystem, considering the conservation of natural resources (Osso et al., 1996).

### 2.1 Environmental Sustainability

It refers to the environmental ability to continue to work while trying to reach the least deterioration in the surrounding environment. The concept of sustainability will be achieved when planning the development process, not to harm natural capital as a minimum (Sev, 2009).

Climate change is considered one of the most critical issues that affect environmental sustainability due to the damage it causes from natural weather-related disasters and death tolls, and economic losses. The most important effects of climate change are low agricultural productivity and production of basic foodstuffs, and a difference in the water pressure ratio, increasing climate change. The sea level will rise with the acceleration of the ice cover’s disintegration, which increases pressure on forest ecosystems, the risks that cause human life to changes in temperature, and exposure to

natural disasters, which will affect food and air quality (Hugh Evans 2019). The following are among the most prominent goals that environmental sustainability seeks to achieve (Sisu.ut.ee.2019):

- Ensuring a healthy life for all people.
- It provides healthy water and a sustainable sanitation system.
- Saving energy
- Providing jobs for everyone and try to improve the economy
- Deal with climate change and try to reduce it.
- Preserve water sources and rationing from waste.
- They are combating desertification and reducing the biological use of materials.
- Raise awareness among people for the use of sustainable and recyclable materials.
- Promote sustainable industrialization and build sustainable infrastructure.

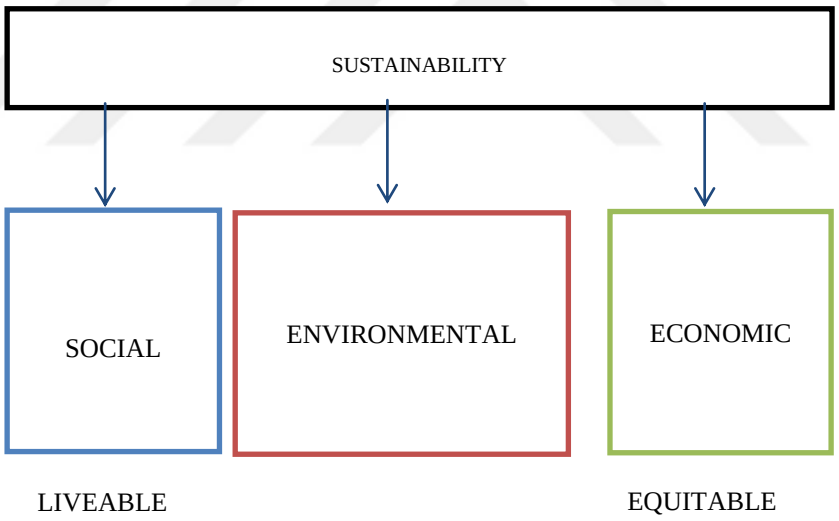


**Figure 2.1:** Pillars of Sustainability

## 2.2 Social Sustainability

Social sustainability is the most vital target of sustainable improvement that concentrates on some rights and freedom associated with being a human. The maximum outstanding one in each of the primary rights and liberties is equality and balance among generations. Resources can be shared with others to the next Era to keep their lifestyle and save their wealth. They will have help with a method of social

sustainability; (H.K.U. Architecture, 2002).

- Provide basic requirements that include work, home, fitness conditions, education, and cultural activities for all in the long term (strategically),
- Increase the quality of lifestyles.
- Reintegration of the disabled into society at the same time
- They will protect in proportion to the life of future technology (H.K.U. Architecture, 2002).

According to the Australian Council for Social Services (ACOSS): "Social sustainability occurs when formal and informal processes take place; Regulations; Structures; Relationships effectively support the ability of present and future generations to create healthy and living societies. Socially sustainable societies are fair, diverse, connected, democratic, and provide a good quality of life." (The Institute for Sustainable Futures (ISF., 2007).

I am curious about the creative term "Social Life", a UK-based social enterprise dedicated to location-specific creativity. According to this definition, social sustainability is about meeting people's needs rather than extracting resources. Space is intended to build culture, while the physical environment helps support it" (Sir Peter Hall, 2011).

These days, social sustainability has commonly been used to prevent global improvements that potential generations do not want to see. Distributive justice in this context Much Sustainable development is chiefly derived from the Brundtland Study. Access to necessities and alleviation cannot be separated from global justice issues, including gender roles and connections (S. Bauer, 2008).

Social Life has developed a Social Sustainability Framework that includes four dimensions: amenities, infrastructure, social and cultural life, sound and impact, and space for growth. In this way, social sustainability is an integral part of civil engineers' work and designers to provide amenities for the individual and society.

### 2.3 Economic Sustainability

In the modern-day modern monetary improvement model: it is a long way assumed that economic hobby would boom within the market via a boom in humans' buying electricity and the increase in Gross National Product (G.N.P.) will contribute to

individuals. As can be understood from its definition, this improvement version relies upon continuous production and intake. When it is miles considered from ecological respect, the previous version requires using existing resources as if they are infinite. Nevertheless, it is a long way that sources that may meet people's simple wants are confined. These assets have grown to be decreased each day without renewing the resources due to immoderate utilization. On the opportunity hand, again, it is miles clean that there are environmental issues due to wastes, which may be effects of this consumption frenzy (Toruno. et al., 2003). In a financial process, due to the truth, a production-intake balance needs to be set via thinking about ecological susceptibilities and social fair matters; monetary sustainability is one of the essential subjects of sustainable development. Sustainable economic improvement requires;

- Creation of new markets and vending opportunities,
- The decrease in price thru presenting performance with the resource of decreasing energy and useful resource enter in production, and
- Provision added value (H.K.U. Architecture, 2002).

In summary, monetary sustainability is the availability of regular public and private investment waft with green utilization and management of resources; assessment of overall economic performance with social criteria instead for organization profitableness (Hoúkara, 2007).

### 2.4 Development of Sustainable Strategies

The nine principles of sustainable growth methods are very helpful. (IUCN, 1991; UNEP 2011; W.W.F., 1991; Sev, 2009)

• Living together: Like all human beings live on one planet, everyone has the right to enjoy the good of this planet

• Improve human life.

• Protecting the right to life for human beings and other beings and preserving the right to diversity.

• Reducing the consumption of non-renewable resources.

• Changing human behaviour towards a world that understands the nature of the risk of overconsumption

• Forming global committees to create complementary formulas between production and development

• All societies should estimate the scale of the problem surrounding us by raising awareness, introducing sustainability, and preserving future generations' rights.

The reinforcements associated with the development sector are at the forefront when developing sustainable improvement techniques at present—the issue of development characterized by a critical position in both the economy and the employment sector. To follow the principle of equality and fairness is incredibly vital when using regions and resources. On the other hand, equality is useful and critical in respecting respect for the environment's resources, distribution, and fair use. (Pettifer, G. Gifford., 2004).

Besides mines, iron, cement, and aluminium used during building construction, and water and natural gas, and is ideal for commercial use, these resources are the most used resources from nature. Therefore, sustainable development should have emerged and emerged to preserve the environment and the economy, thus ensuring these resources' sustainability for future generations.

### 2.5 General Principles of Sustainability

The first principle is energy and water conservation: The decision to conserve energy includes careful planning, i.e., determining the specific climate conditions, building direction, and wall thickness And consciousness (Peter O. Akadiri. et .al, 2012).

The second principle: the life cycle of the building:

The building goes through three phases, which are the :

- Pre-construction aspect and includes materials returned in construction, materials with long life.
- Maintenance-related to the previous stage, which includes not using organic materials.
- The post-construction face reuse of the existing building and infrastructure.

The third principle: human design:

Includes preserving all existing topographical natural resources, urban design, and site planning, i.e., making use of Plans to reduce energy and water demands and achieve human comfort by sustaining health.

The scientists expect that until the year 2056, the international financial benefit will increase five times. The world population may have increased by more than 50%, and the consumption of resources may increase almost three times. The international industrial activity may extend to a minimum of three times (Matthews, E. Amann 24 May 2009). On the general level, we can say that the construction area is one of the most profitable industries that are resource-intensive. Comparing with the various sectors, construction using limited fuel assets have already raised problems about delivery difficulties, the depletion of electricity sources, and severe environmental impacts - ozone depletion, carbon dioxide emissions, heating, and weather change (Ilha, M.S.O.; Oliveira.2009). Any industrial piece's production consumes energy and consumes the completed building's operation, heating, lighting, power, and ventilation.

### 2.5.1 Sustainability in building construction

People need many systems to help their lives at some point in human progress. For example, the employee sitting in an uncomfortable office cannot perform his work correctly. The sustainable design provides tangible value to the individual and society, which causes many problems during the stages of its development and activity And its destruction.

On the other hand, the environmental exchange taking place in the building, which affects the nature of air and water in urban areas; according to (Vyas et al., 2014), 45% of energy is used worldwide and 1/2 of water by buildings, 23% of the effects of air and 1/2 of the ozone-depleting substances.

About 40% of water pollution and 40% of solid waste in urban areas are natural problems that occur almost through structures (Dixon, 2010). These terrible Problems that emerge from construction programs can be held low by adjusting specific requirements. Besides, the impact The most visible or measurable of the industry is on the ground, and its economic effects cause major imperfections as a result of the escalating use of the ordinary property for development work, solid waste, gas flows, and destruction harms nature (C.I.B. and UNEP-IETC, 2002).

These negative consequences can increase by using non-renewable resources, a decrease in natural diversity, demolishing forest areas, a shortage of rural resources, air, water, soil pollution, the extermination of the green regions abnormal weather

trade. As they are explained in a record (C.I.B. 2002), financial implications improve its hierarchical structure. Implementation can increase economic serviceability in any case. Corporations worldwide cannot deal with familiar societies within countries because globalization stops benefiting from importing import resources in all Domains on budget options within the country G.N.P. (Gross national product) diminishes. Likewise, improvement works are not economically robust as they cannot enhance environmental management because of the lack of ingenuity of resources and the overuse of these resources. The commercial project for construction can now build the nature of people with low incomes and provide relevant offers for them and provide social support through management to thwart the need in the public's eyes (C.I.B. and UNEP-IETC, 2002).

Another thing is the permanent arrangements for the problems presented through the creations of development work. The ability to support and economic development is not visible at present. It shows that engineering and practical development ideas that serve the methodology of dealing with difficulties by defining standards, methods, and strategies seem clear to find a solution to added environmental problems using regular building systems.

### 2.5.2 Sustainable architecture

Sustainable engineering is described as an assemblage of things that preserve nature while minimizing waste while making the most efficient use of resources. A trend that makes clients' well-being and removing familiar possessions unnecessary causes damage while still ensuring the same outcome (Gür, 2007). Energetic vitality, available water, and usable content are critical elements in growing the value of a project. Existence, water, and fabric and technological capabilities of being proved feasible are required for engineering ventures. Safety in terms of voltage or substance. This partnership, named through a decrease in unrenewable objects and construction of squandors, impedes the creation or influences shift (Kim and Rigdon, 1998). Besides the transformation phase, their contribution is often to the development process of creativity and physical play. The expenditure needed for handling title calls for both strategic and managerial choices and financial and resource-based efficiencies in the framework.

### 2.5.3 Sustainable construction

Cities are required to support human life and cultures. These facilities' environmental issues are huge during their building, service, and management, and eventually, they experience damage. Structures significantly affect the ecosystem because they use tons of electricity and money (Vyas et al., 2014). In 2010, 45 percent of the world's electricity and 50 percent of its water were used for houses. It involves air emissions, greenhouse gas production, water pollution, and solid waste in cities because of homes (Dixon, 2010). Environmental emissions induced by urban development dramatically minimized through the option of materials used. The most relevant impact of the industry is the climate (CIB & UNEP-IETC, 2002). Because of building practices and solid and liquid wastes in the construction sector, debris after construction activities and degradation activities negatively impact climate. These detrimental impacts can be summarized into the destruction of natural capital, declining ecological diversity, losing forest lands, air, water, and soil contamination.

In the current period, the building sector has essential significance to economic and political survival. Due to globalization, national organizations cannot contend with foreign organizations because they have become economic activity platforms. The building industry is not useful in financial terms but entirely eco-friendly because of generating many wastes. The building industry will significantly improve the standard of lives for low and low-income earners by merely offering work opportunities. Social security is accomplished by preventing suffering in the world (CIB & UNEP-IETC, 2002). Without lasting fixes, all the issues created by the building sector's growth, sustainability, and economic development are not treated as feasible. "Sustainable architecture" and "sustainable construction" principles that serve a systemic approach to the topic may respond to environmental issues created by buildings.

### 2.5.4 Architecture and sustainability

Human civilization depends on the processes of construction, construction, and continuous reconstruction to preserve its survival. Still, the planet's natural ability to support these processes began to decline due to the severe encroachment on the lands, the continuous destruction of natural environments, the acute depletion of resources, and the increasing consumption of various energy sources. Hence the importance of

achieving sustainable planning and urban design to achieve sustainability. As an alternative solution for designing and planning human urban settlements.

### 2.5.4.1 Urban design and sustainable development

Everyone realized that the main challenge facing the buildings sector is its ability to fulfill its obligations towards the developmental role to achieve comprehensive sustainability concepts. Environmental control over urban projects will be one of the essential competitive criteria in these sectors in the current century.

The drivers for sustainable urbanization have remained the same regardless of whether there is a concern for the quantity of natural resources, the state of the global economy, or people's well-being. The allocation of natural capital to rational projects while still considering social and ecological impacts also reduces waste and uses, reduces demand, and helps preserve the ecosystem (Fared al Keek, 2008).

It will illustrate the necessity of environmental considerations in the architecture, preparation, development, and management of all at once (Ali al -Sawat, 2005).

### 2.5.4.2 The concept of sustainable urban design

A book on the dimensions of urban design for public places(public places urban design) reviewed the idea of urban design as creating sites for people, including designing these places and achieving safety for society as the aesthetic aspect. It is also concerned with other matters, including social connection, movement, urban form, natural spaces, and treatments that ensure cities' success. Sustainable urban design is a term used in recent times. It stems from urban designers' attempt to deal sensitively with the earth's environment to preserve it healthy and fit human life in the present and future.

The concept of sustainable urban design is expressed in other ways, including (green architecture) and (environmental design) or design with the environment. All these expressions mean that urbanization belongs to the ground and is a friend to it, as it is consumed from its sources to the extent that it achieves a healthy environment for its residents and does not prejudice future generations' right to meet their needs. Therefore, sustainable urban design has become a goal for urban designers and producers interested in preserving the earth's environment in the present and future.

## 2.6 Design of A Sustainable Building

The construction institution is an essential detail of any budget, but it includes a widespread influence on the atmosphere under his mass. Creativity is one of the vital constituents of electricity, fabric, and aquatic, and it is a potent pollutant. In reaction to these effects, there is a rising meeting between companies devoted to comprehensive ecological presentation aims that require suitable tactics and procedures to create more environmental building activities (Abeysundara, 2009).

Concerning such an unlimited impact on manufacturing development, the sustainable construction methodology includes a high capacity to create appreciated sustainable development implications. Sustainability can be an extensive and multifaceted concept and has developed to be one of all significant construction institutions' significant problems. The idea of sustainability implies promoting a high quality of life, thereby allowing humans to remain in an extreme situation while improving social, monetary, and environmental conditions (Abidin, N.Z.2002). The purpose of the sustainability mission is to build, renew, operate, or reuse it ecologically and beneficially in the efficient use of resources (Azhar S, 2010) must achieve many positive goals: resource and energy efficiency, reduce carbon dioxide emissions and greenhouse gases, pollution, noise reduction, advanced interior air quality, harmony with the atmosphere. The perfect project should be less expensive and remain forever with low-cost maintenance, but it returns entirely to the world while being abandoned.

Designers, engineers, and planners involved in the construction process have an exclusive chance to reduce environmental impacts by applying sustainability goals to improve the construction project's appearance. Although awareness of sustainability initiatives, strategies, and technologies regarding general aspirations and broader strategic goals, they will be susceptible to addressing integrated decision-making at the micro-level (individualized tasks) (Ugwu, O.O.2006). Ironically, it is approximately miles at the precise stages that sustainability goals must translate into reasonable measures by employing comprehensive technology to facilitate the selection process. Despite new technology combined with the BREEAM method (BEES) and (LEED), It is always a part of the city and modernized to enrich modern-day performance in generating sustainable structures. The common goal is to reduce the surrounding areas' impact on human fitness and, thus, the standard atmosphere. Therefore this thesis reinforces the existing studies on the topic of sustainability.

Sustainability targets are imposed at the task level precisely within the construction manufacturing from a life-cycle perception. The plan adds to the manufacturing and sustainability study by clarifying the dimensions of the problems involved, starting with assessing the institution's environmental challenges. It sets future strategies and technologies to moderate creative activities' ecological impacts and facilitates construction development sustainability.

## 2.7 Ideologies of Sustainable Constructing

The scientist expected that until the year 2056, the international financial benefit would increase five times. The world population may have increased by more than 50%, and the consumption of resources may increase almost three times. The international industrial activity may extend to a minimum of three times (Matthews, E. Amann 24 May 2009). On the general level, we can say that the construction area is one of the most profitable industries that are resource-intensive.

The main problems related to the main sustainable construction topics are sorted and grouped in the table1. The sustainable building approach is under consideration because the easiest method for construction manufacturing to manoeuvre to achieve sustainable improvement enchanting obsessed with environmental, social, and economic issues, as shown in Table 2.5.

**Table 2.1:** Sustainability Issues

| TITLE | KEY THEME | PRINCIPLE ISSUES |
|---|---|---|
| Economic sustainability | 1- Maintaining high and stable levels of local economic growth and employment.<br>1.1 Improve project delivery.<br>2.1 Increase profitability and productivity | Improve productivity; Steady profit growth; Employee satisfaction; Supplier satisfaction; customer satisfaction; Shorter and more expected completion time.<br>Low-cost projects with increased cost predictability; Providing services that provide the best value to customers and focusing on developing clients' businesses. |

**Table 2.1:** Continue

| TITLE | KEY THEME | PRINCIPLE ISSUES |
|---|---|---|
| Environmental sustainability | 2- Effective protection of the Environment<br>2.1 Avoid contamination<br>2.2 Protection and promotion of biological diversity<br>2.3 Transportation planning<br>3- Prudent use of natural resources<br>3.1 Improving energy efficiency<br>3.2 Effective use of resources | Reduce pollutant emissions; Prevent nuisance from noise and dust through the excellent site and warehouse management; the Waste reduction and disposal; Improving the Environment; Protecting a sensitive ecosystem through acceptable building practices and supervision; Green transportation plan for commercial sites and activities.<br>Energy efficiency in warehouses and sites, reducing energy consumption in commercial activities, designing the whole life cost, using low-energy domestic supplies and materials, waste-free design, construction, avoiding waste, using recycled products, water, waste minimizing and managing |
| Social sustainability | 4- Social progress that recognizes the needs of each individual<br>4.1 Respect for employees<br>4.2 Working with resident communities and road users<br>4.3 Business Partnership | Provide adequate training and assessments, fair terms and conditions, provide equal opportunities, health safety, a favourable work environment, maintain ethical employee satisfaction, participate in decision-making, reduce traffic distribution and delays, build effective communication channels<br>contribute to the local economy through local employment Procurement, building long-term relationships with customers and suppliers, corporate citizenship, providing services that provide the best value to customers, and focusing on developing clients' businesses. |

Often, the automotive sector must minimize the harmful impacts of the environment (Ofori, G. et al. .1998). Sustainable building strategies extend to several ways to apply design programs that are done to mitigate environmental impact.

To avoid waste formation (Ruggieri., 2009) and to reuse waste material inside waste materials processing (Asokan, P. 2009) is favorable to society and ideal for the firm (Tseng, M.L2009) Hill and Bowen (2009) (Hill, R.C.1997). A reminder that sustainable construction initiates in the formation phase of a building and lasts throughout its life to finally disassemble and recycle resources to decrease the left-over flow associated with demolition.

Concerning popularity, the harmony that the breadth of the principle of sustainable construction reflects that relationship with a sustainable increase, popularity links economic, social, and environmental sustainability factors. These three pillars (and their related concepts) are volatile via strict and rapid principles geared to technology.

1. The draft assessments before the graduation of the proposed activities help integrate information related to the vital socio-economic, physical, and practical aspects of the decision-making system.
2. Decision-making Time participation in primary supervision (WCED. 1987).
3. Public-private collaborations must focuser on the multidisciplinary and stakeholder alliances between the civic and private sectors, manufacturers, advisors, and N.G.O.s. in an overly participating, cooperative, and consensual manner.
4. The popularity of the complication of the conception of sustainability to form an information-sharing team, often so that the mission goals are clear and decision-makers are happy with the implemented procedure.
5. Using the life cycle system with the condition to try not to forget all the criteria for sustainable structure at every phase of the task’s development (i.e., from preparation to project completion)
6. The system approach using to recognize the interconnection between the economy and the environment. Besides, the system approach is observed as an integrated design method.
7. Be careful when facing hesitation
8. Obedience with applicable legislation and regulations.
9. Unpaid commitment.

10. Managing support by setting goals, monitoring, evaluating, nutrition, reviewing, and self-law of growth. This technique is also used to advance the application to help access knowledge through communication.
11. The correlation between the environment and the development of these ideas will form a basis for achieving a sustainable construction that consists of environmental assessment throughout the design and planning stage of construction projects. Therefore, it will apply sustainable performs. There are also innovative approaches to manual the abuse to every degree of reverence, even across all disciplines. From this, we conclude an infinite series of principles and guidelines unique to the task or field, which may ensure that the choices made follow the path of sustainable development.

## 2.8 Sustainable Implementation

As part of a basis of policies and approaches to gain a sustainable future in the industrial production process, Asif et al. (Asif, M2007) propose the adoption of a multidisciplinary technology to defend many resources, including energy-saving and forward in the consumption of resources, reducing waste, trash, emission controller, etc. Numerous methods in terms of the current construction environment can be made less harmful to the ground by managing the construction process's construction process resources. It is well deprived of decreasing the useful output of the construction.

To create an improvement using an environmentally responsive structure, the entire life cycle of homes must be the framework they implemented. Literary reviews have identified three modern goals that should form a framework for sustainable building design (figure), taking into account sustainability ideas and issues (social, environmental, and economic) Previously described. These goals are

1. Material conservation
2. Price-performance.

1- 3.Plan for Social adaptation

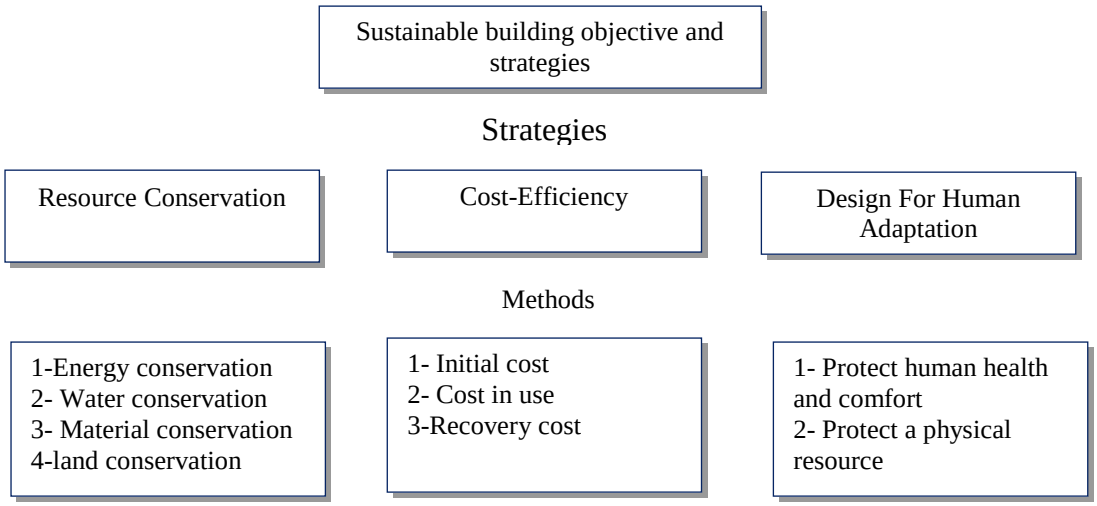


**Figure 2.2:** Framework For Implementing Sustainability

### 2.8.1 Resource conservation

Preserving resources in a way that ensures that future generations obtain their right from natural resources is an integral part of sustainability, and this concept has evolved and became an essential part of discussions related to sustainable development. (Haillday s 2007) noted that the usage of products used in nature ought to be handled with caution to save future generations' dreams to develop by Replacing less common materials or using renewable energy sources, society will preserve future generations' rights. Economically renewable strategies must then reduce energy use and avoid environmental degradation and natural resources' prudent usage. "Resource conservation" means achieving more with less. It is the management of the human use of natural resources to provide the maximum benefit to current generations while maintaining the capacity to meet future generations' needs (Wilson, A.; Uncapher et al. 1998).

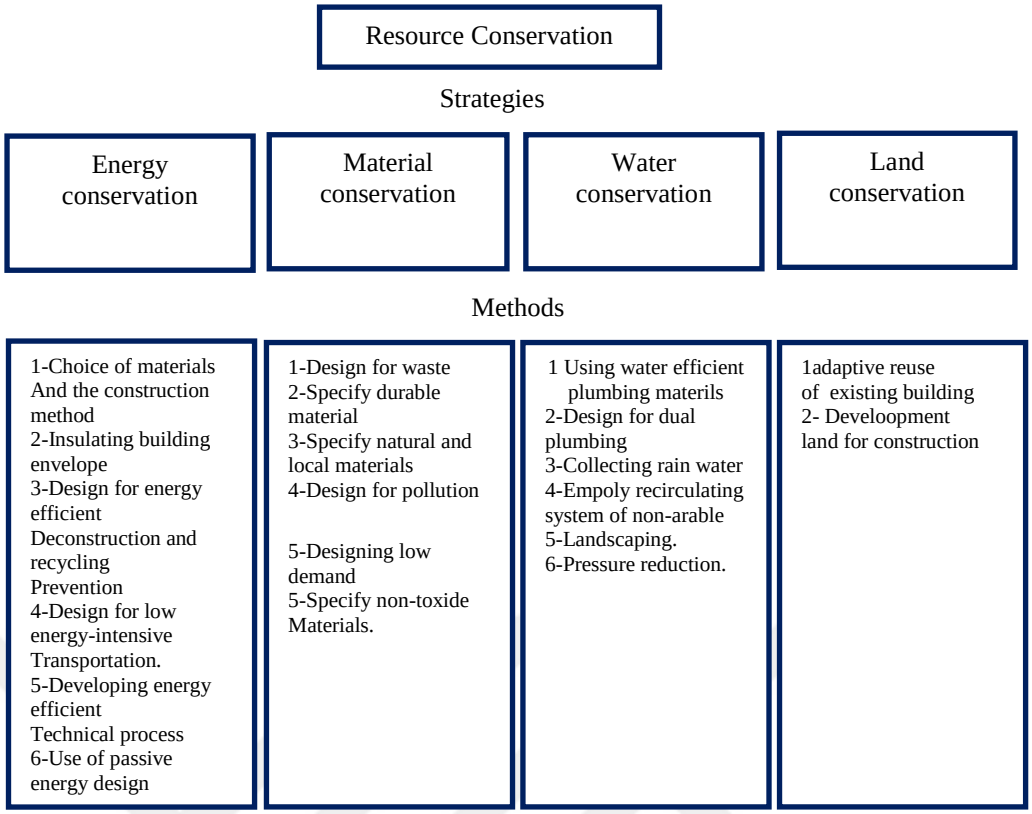


**Figure 2.3:** Framework for Implementing Sustainability

### 2.8.2 Energy conservation

Energy conservation means the efficiency of dealing with energy and reducing its consumption inside the dwellings while providing comfort to that house's users to give a more healthy living environment and reduce the building's impact on the environment. Design, such as site selection, building envelope efficiency, operating system efficiency, and local technology development in energy production. The structure is designed to consume the least amount of energy to make the lighting as natural as possible. You will allow full use of the sunshine and airflow when re-designed to lighten up the house (Schimschar, S. et al. 2011). Energy efficiency is one of the essential factors in green building design. Especially for Building Information Modeling(BIM) And to achieve energy efficiency, the following elements must be relied on:

1. Energy modeling, one of the essential factors, gives us a clear picture of energy consumption.( Sasnauskaite, V et .al 2007).

Before the building's construction, which is the primary goal of energy modeling, it allows us to change any parameters and note its reflection on other electrical loads. Building electrical appliances and consuming multiple devices (lighting, electrical

appliances, air conditioning, pumps, Water heating devices, etc.) And many programs provide this technology, of the most famous of them Autodesk Revit, eQuest, Design Builder, I.E.S….etc

2. Use the passive design principle And that by indirectly benefiting from natural lighting the path of the sun during the year to reduce energy consumption from electric lighting in addition to relying on natural ventilation from knowing the wind speed and direction around the building during the year, which allows us to direct the building in the optimal approach for natural ventilation instead of the use of air-conditioning, heating, and electrical energy consumption. There are engineering programs that provide the simulation of natural lighting Wind Analysis ( Al-Homoud, M.S.2005).
3. Usage of fluid dynamics technology (C.F.D.Computer Fluid Dynamic) technologies; To distribute the air inside the room.

Finding the ideal distribution for air-conditioning or heating vents reduces electrical energy consumption from air-conditioning, heating, and cooling equipment because it works at its maximum efficiency (El Razaz, Z,2010).

4. Use of high-efficiency lamps such as L.E.D: Lamps and fluorescent lights with reasonable efficiency (specially designed) reduce electrical energy consumption.

Using remote sensors for people(Occupancy Sensor) You can set the light in the halls, stairs and rooms if there is anyone besides using natural lighting sensors. (Daylight Sensor) Monitor the electric lighting optical level to be changed to its lighting by natural light (Carlisle, N. et al.2012);

5. Significantly decreases operating costs, such as those with a high-performance factor. Careful attention to the choice of windows, soundproofing of walls and ceilings will minimize the noise factor. Performers typically evaluate a program's coefficient of performance (C.O.P.) by assigning ratings of effect (ROE) to any project elements to measure overall job progress. To stop bad air penetration and the outside, the air within the space should be kept constant. For walls and floors, paint them in bright shades, minimize sunlight absorption, insulate the air-conditioning system plumbing, and put it in places where there is plenty of sunlight. It is equipped with an air conditioner and is an A/C with

an A/C drive. With variable refrigerant technology Depending on the appropriate engine rpm, variable frequency drives greatly impact reducing the average electric use of the AC motors.

6. The use of powerful power-consuming electrical devices, which are equipped with Energy Star stickers, symbolizes their reduction in electrical power consumption over other devices (Peter O. Akadiri et al., 2012).
7. Using renewable energy, such as wind power, solar energy, or geothermal energy, to meet energy needs Significantly reduce these buildings' carbon footprint.
8. Use of load management and control devices (Energy Monitoring and Building Management System (B.M.S.) To avoid energy waste and control consumption. Intelligent monitoring technology (local or central) could apply, making it easy to Control the devices automatically or manually in the control room and knowing the energy consumption to adjust our energy consumption Only as needed (Peter O. Akadiri et al., 2012).
9. Finally, use environmentally friendly coolers (Eco-Friendly Refrigerant). For air-conditioners to increase these devices' efficiency, The most crucial thing is to reduce global warming and the hole in the ozone layer. The indirect energy would be all the energy used during the process.

Both resources utilized during the development of that must be included and used in doing the processes. In the mechanism mentioned above, the embodied energy of cities used. Other than the transit of products of the production, building, and transport. Thus, the utility life of a building can differ—the product comprises various operations of energy from the outset. The life cycle for this phase, as is seen in Figure 2.6.2.

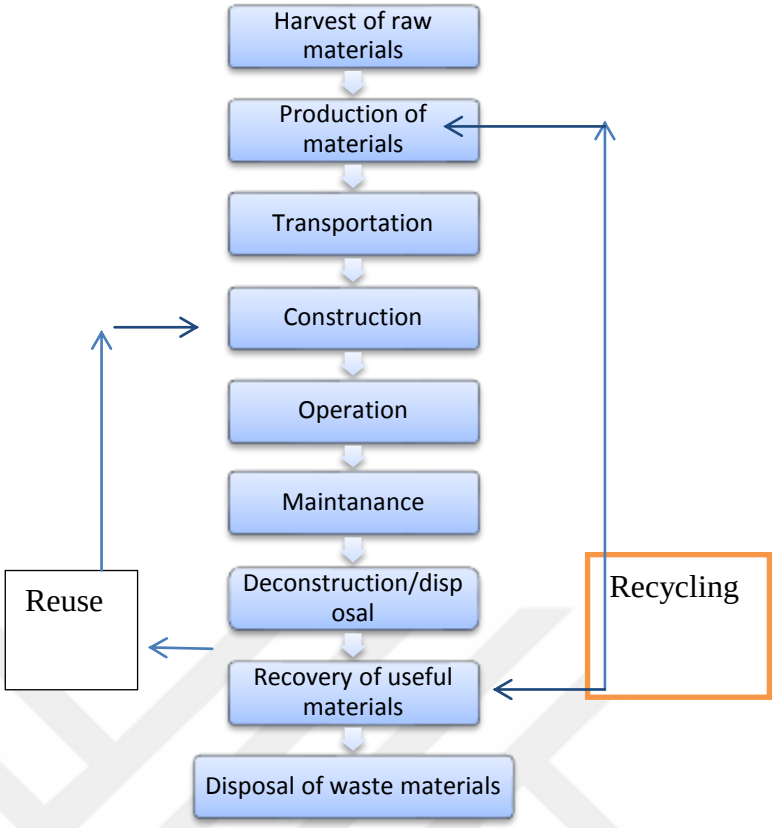


**Figure 2.4:** Stages of Strength Input Throughout the Lifestyles of A Construction

### 2.8.3 Materials conservation

The abstraction and ingesting of usual assets as structure materials or as new resources for the manufacture of structural materials and the manufacture of materials themselves in carrying out building work have a straight impact on natural biological variety due to the destruction of regions and environments due to input activities (Spence, R.1995). Carefully, vast amounts of mineral assets are expend within the surrounding areas. Therefore, the greatest of these non-renewable mineral assets is necessary to limit the use of non-renewable materials (Abeysundara, 2009). The initiative and coordination stages must take into consideration. The choice of resources is very vital and mainly depends on the ecological effects of the materials. In the structure and dismantling stages, numerous strategies can reduce material use's impact on natural resources. This segment talks about the design to help considerably attain overall material efficiency (Figure 2.7.2 above). Innovative manufacturing is one of the waste producers and is the first to generate waste, which may cause many ecological, public, and financial problems. The prevention and deduction of construction waste for housing can produce vast amounts of resources. A growing body of scientific work has primarily made using resources that have been tested so

that development designers have a critical advantage in manufacturing to produce—reducing and reducing waste. Waste should be considered part of the mission sustainability plan in planning technology by using the software program for the three principles of waste design: minimizing and recovering waste generated reuse and recycling (Coventry, S. et al., 2001).

A. Decreasing and improving internal waste: According to ESin and Cosgun, (TulayEsin, NilayCosgun 2007), the only degree to reduce the ecological impact of building debris is to use its technologies in the first place and decrease it as possible. It will reduce the need for reuse and recycling as a result of providing financial benefits. The analysis proved that waste treatment decreases the quantity of waste and greenhouse gas emissions (GHG) and decreases raw resources (Pimenteira., 2005). Besides, the emphasis placed on recovering useful energy and materials from waste as one of all basic environmental practices of the highest order to achieve financial savings in energy to alleviate urgent electricity conditions (Marchettini, N. 2007).

B. Recycling: of goods reduces ecological impacts, especially the use of assets and the introduction of waste. The meaning of substitutes presented in the literature reviews (which include recycling and reuse) re-enters the manufacturing chain's production materials and components. The recycling of structure materials is an option To discount structure and demolition waste (CWD) during the restoration and demolition of homes, using the disassembly construction performance method, which allows the recovery of building elements as additives bricks. Windows are tiles in any other case than conventional demolitions, where components are converted back into raw materials for processing (Da Rocha., 2009).

C. Storing and discarding off building waste: In circumstances where production cannot be avoided and restored and want to store correctly and keep it under control (Esin, T. 2007). Non-Harmless construction remains, and building particles are classified as unique waste suppressed in municipal solid waste landfills or landfills that best receive structure remains. All over the creation, options for ideal waste types in landfills are entirely based on a site-specific hazard assessment. Licenses have managed to manage amounts and patterns of waste to be ordinary. In the case of dangerous waste, the excessive loading fee for waste or additives is determined. Engineers want to consider plans for storing rubbish and disposing of it at the project's planning level.

2. Select long-term substances. (Mora, 2007) defined durability as a trademark that tells how fabric retains its unique necessities over time. Building sustainability improved by growing the stability of its resources (Malholtra V.M., 2002). Material that takes up a prolonged amount of time may be necessary to handle because of the limitations of the time allotted to communicate with the environment.

3. Identify local natural materials: natural materials usually decrease in electricity and embodied toxicity than synthetic materials (Godfaurd, J. 2005). It requires much less treatment and less harmful to the environment. There are many renewables like wood. When the herbal materials are combined into structure products, the products become more sustainable. The use of locally obtained construction fabric can help reduce ecological burdens and shorten delivery spaces for this reason. Air pollutants from the use of vehicles decrease. Often, local resources are ideal for climatic conditions and this, in turn, supports the economy. For example, the use of ornamental marble and quarry in the middle of the road around the creation is not a sustainable option. When it has mechanical strength and toughness, steel is a justified use, usually industrial in a place far from the construction site, generally not homemade.

4. In the attempt to protect the climate, emission-reduction techniques are applied throughout the manufacturing and building construction phases. Items that enhance the quality of life appear to be built for the environment. Unusable-assimilated products (Kibert, C.J.2008). It originates from the climate, water, as well as land. In fact, the paper does not care about the effect of emissions because the fine print is tough to understand. Soil pollutants have an effect on the market. Over the years, it was common for wastewater and low-level pollution to flow into the waterways without being handled. One of the primary causes of photochemical smogàsis is car exhaust fumes and train activities. Carbon monoxide, nitrogen oxides, and ozone are emitted due to vehicle exhaust, but the auto exhaust is a primary component of automobile emissions. Often, transporting raw resources and products leads to both pollution and resource depletion. An eco-friendly architect will name environmentally sensitive vendors and encourage customers to consider environmentally friendly construction strategies.

5. Select non-toxic or less toxic substances. Non-toxic or minus poisonous substances are much less dangerous for production labourers and structure residents. Many substances negatively affect interior air and reveal disease, fitness, and general health.

Many construction materials contain unstable biological mixes in addition to adhesives, paints, sealants, detergents, and various regular goods. They produce hazardous vapours for the best little time through, and after setting up, others can add to exceptional problems in the air during the life of the building (Kim, J.; Rigdon., 2008). Using construction resources with low or no toxic, fitness harms can be dodged, and air filters will become less required.

### 2.8.4 Water conservation

For the rapid improvements of the international economy, resource reduction, especially water capital, is turning into an ecological problem, at its most extreme, all over the world. The United Nations report (WWDR) indicates that the water we use has become scarce and is essential for a freshwater crisis (UNESCO.Spain, 2003). The results that the environmental sector can achieve do not appear in a place more than the construction industry (McCormack, M.S.et al.2007). Construction production and operations depend seriously on water from nature. Using water in cities causes a significant decrease in water level in the heart and affects agriculture. Water used in buildings is a significant problem in water consumption at the state level, yet, this is not the humblest form of water used up at some point in the construction of natural life. Water also consumed extracting, producing, industrial, and shipping materials and goods to the website via McCormack, and others are known as embodied waters (ILHA et al. 2010). It concluded that water protection techniques and policies are frequently the most unobserved factors of the entire building planning strategy. However, the various water-making plans that we use in construction are increasing, shifting to a high priority, partly due to the increased credit of availability Water found by implementing water-saving advantages. Well-known literary reviews show several techniques (Sev, A. 2009) that can reduce the amount of water ingested during the lifestyle building cycle. These strategies include

1- Using water-saving plumbing fixtures, including water that goes with the flow of massive and urinal wastes, including tools such as water-free urinals, low slip, sensor basins, tropical water showers, dishwashers, and water-saving washers to reduce wastewater ( McCormack, M.S et al. 2007).

2- Designing double plumbing for reuse of water for washing the toilet or a leaden water system that recuperates rainwater or non-potable water for irrigation. Gray water

is formed through actions that include hand wash and does not want to deal with intensively as wastewater. It is recycled in construction to irrigate ornamental plants or clean baths ( McCormack, M.S et al. 2007).

3- All rainfall, the use of rain, and the storing of greywater for irrigation, significantly decrease water consumption. You can also use water for family packages, including water consumption. Persons in numerous sectors usually rely on rainwater collected to deliver water ( McCormack, M.S et al. 2007).

4- Recycling structures to distribute central hot water, which preserves the water that users usually waste, where the hot water flow is waiting from the tap.

5- Low design to summon the landscape to use the original plants in the surrounding environment also reduces the site's water consumption. They consider these natural materials adapted to the neighbouring rainwater ranges and thus eliminate additional watering (Mendler, S.F.2000). Water performance also is enhanced by using subversive drip irrigation systems, decreasing water loss due to evaporation from floors throughout the period to or after rain.

6- Reducing pressure, given that the low price is related to stress, most of the water goes with the flow from formulations that work at difficult and fast numbers, and it may decrease if the water stress abridges. For example, reducing compression from 100 kilograms per square inch to 50 pounds per square inch in the outlet can reduce water drift by about a third (Brown, C.1984).

### 2.8.5 Land conservation

1- Choosing the building's location in a populated area where most human needs centers are located. Sites Such as education, hospitalization, medicine, food, sports, comfort, and security ensure a comfortable life for the person while reducing transportation and focusing on bicycles And healthy walking.

2-Choosing the building site to make maximum use of the surrounding environment to serve the environmental aspirations in terms of rationalization and reduction of consumption energy in summer and winter by using it directly or indirectly from the surrounding environment as a path to the sun, shade, and direction Air during the year and benefit from it through natural lighting and relying on natural ventilation instead of mechanical ventilation and devices cooling and heating.

3- Reuse abandoned buildings and sites to protect the land and reduce the impact of new urban expansion on the environment.

4- Developing the site by increasing the green area around the building, green roofs, and growing public spaces Green.

5- Not to construct a building over the natural and archaeological reserves to protect and preserve the surrounding environment's heritage and civilization.

6- Encourage the usage of public transit centers: subway, rail, bikes, and include that they are within walking distance of most of the nearby buildings and easily accessible by buses. Encourage the usage of environmentally sustainable automobiles by giving everybody a parking space.

7- An effort to reduce light emission at night The illumination was targeted at the earth and not at the atmosphere, avoiding the disruption of people who work there and animals who are harmed by light pollution.

8- Heat island method that decreasing heat islands are a byproduct of urbanization In addition to using the rooftops and pavement landscaping, we are using combustible planters. It lets water penetrate and remains in the earth to reflect sunshine, too.

9- Developing a tradition of empowering people to take a carpooling nature while leaving or on their way to work. Reducing the number of cars on the highways often can minimize traffic pollution and car emissions.

### 2.8.6 Cost efficiency

Building clients require a performance guarantee and long-term financial fees for their buildings. The supply chain of building challenges for architecture, vendors, distributors, design, and construction teams also raises consumer pressure to minimize social costs and consider the sum that construction would incur over its life cycle and how efficiency manages to satisfy residents' requirements. Buildings constitute large and long-term financing in cash pictures and other sources (Oberg, M. 2005). Thus improvements in building cost-effectiveness are a common hobby for the proprietor, operator, and humanity. The idea of sustainability implemented in building construction aims to enhance maximum performance and reduce cash prices. Design options require a preference for construction structures, building materials, and building installations that can be followed frequently with the help of investment

errors through inadequate financial management options (Giudice, F.2005). A natural life-cycle costing is an economical way to save on a good. The software is to build along with building activities with the chosen environmental concerns in mind. The life cycle cost (LCC) would lead to more cost-effective building programs. These life-cycle costings (LCC) are taken into account at the start of any building project. The original expenditure, cost of repair, and cost of recovery, as shown in Figure 2.5 below.

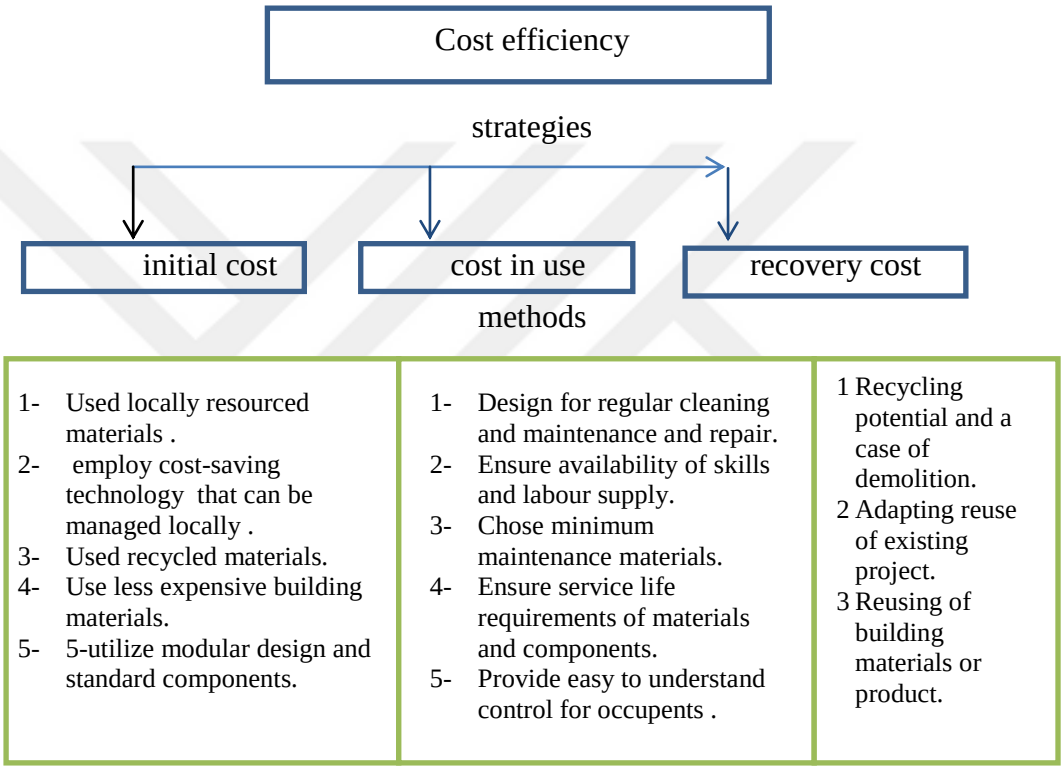


**Figure 2.5:** Strategies and Methods To Achieve Cost Efficiency

### 2.8.6.1 Initial cost

They are known as the purchase price or improvement value; the preliminary fee concealments the total amount of the building development or reconstruction (Emmitt, S.2008). The cost of the purchase price of the land/building, the fees for professional specialists, the price of materials covering the integrated structure, and the fees for assembling it. When planning to purchase a significant asset (Emmitt and Yeomans 2008), companies were spending a lot of time assessing the initial cost. For many customers, this is their first anxiety. A price reduction may be potential by choosing fewer luxurious construction resources and decreasing the quantity of time vital to collect them, but this adopts that these fees can be analyzed and known. Other

approaches related to the deduction of initial fees in construction consist of the following:

1. designers should optimize the use of resources at the regional level to obtain the materials. In most cases, locally manufactured goods are less expensive than their imported counterparts since transportation rates are not large and do not import duties. (Woodward, D.G et al., 1998).

2. The use of value-saving building strategies that consist of building blocks to build the footing as an alternative to reinforced concrete avoids many Excessive expenses. This approach is the most straightforward appropriate for low-rise one-story structures. For progressive over-push constructions, a cautious structural design with the best foundation planning can ensure less canvas dug (San-Jose, J.T.L, et al., 2010).

3. Using standardized structures and typical elements to recognize ways to limit project costs' initial costs. The framework and design of these components were matched to the best architecture. For instance, an office size and structure are relatively simple and can be adjusted as necessary, and do not necessitate constant reconfiguration. It must also allow for technical advancements (Kohn, E.; Katz., 2002).

4- Use standard components that are easy to obtain, as this is appropriate to reduce fees and store alternative custom additions. Project mechanisms that cannot quickly restore or be replaced the need to be long enough to minimize expensive replacement or costly adjustments.

5- Use recycled and reclaimed materials. Reuse of recycled materials such as building materials, demolition, and drilling, reuse on-site and loading materials recovered, and recycled materials at the first costly textile site can significantly reduce the task's overall value. For example, it could provide recycled content, including recycled asphalt or a cement substitute for intangible goods (Innes, S., 2004).

#### 2.8.6.2 Cost in use

The cost used is known as the operating cost through determinations made in the degree of precaution and subsequent choices made at some stage of the design stages (Emmitt, S.2008). It also includes frequently planned modifications and checks to

keep the structure to provide convenience, equipment, and component sources For repairs (Arpke, A.2006).

Moreover, the building's decoration and fabric (i.E., roof, outside walls), services (i.E., heating, and ventilation), additionally passed off at this level. At present, building information modelling has made tremendous and significant progress in this field, where it is possible to see the three-dimensional model and also know the estimated cost and the time required to implement it. For many years the operational cost has been given shallow attention in the planning stage. However, this has altered with the usage of lifestyle cost methods that help focus on the connection between design choices and charges. More extended service-related materials paid more than you would not expect to stay very long to reduce both protection and operating fees may also lead to an initial cost increase (Emmitt, S.2008). However, in the long run, for example, 15 years, construction may cost a little money, but operating costs are prohibitive. The cost reduction in building use can not be reaped by thinking of the following (Emmitt, S.; Yeomans 208)

1- Take adequate measures to design the main building elements to provide a dedicated and generous space for regular cleaning, maintenance, and repair of vital or significant components of the air conditioning system and ensure that access points are easily diagnosed and located.

2- Ensuring that the required skills are in the area of supply of available labour. Lack of productive hard work with capacity building and facilities maintenance can increase maintenance fees. When local talent is a building stone, preparation will have to be done to take advantage of these talents. Harnessing talents in the project can identify brick slots that need pre-cast concrete to harness the skills.

3- Choosing the minimum amount of preserving materials wherever possible, as identifying construction resources that need little renewal (such as reprocessing, waterproofing, etc.) case in point, maintaining the advantages of protection from wood-based plastic (WPC) on wood to preserve On the increase in alternative applications to wood (Markarian, J.2005).

4- Adopting the appropriate system throughout the planning stage to protect the materials from the destructive factors that include the sun, changes in temperature,

rain, and winds, and isolating the important structures sections from the damage that may occur in addition to the harms of floods, storms, and earthquakes.

5- While fully meeting the building's operative requirements, a recognizable and user-friendly handling structure will be given to passengers and building operators to ensure environmentally friendly technology's robust operation. Complicated software is not used if simple programs will perform this job.

#### 2.8.6.3 Recovery cost

Third fees are not sometimes considered, namely the cost of demolishing and recovering materials (Emmitt, S.; et al., .2008). The fact that building prices are related to the era and building's time is linked to initial cost. Again, this may be a simple challenge for the new buyer looking for short-term gains with the least possible expenses. However, if we want to take environmental problems seriously, the following methods are implemented to reduce or eliminate import duties (Paul O. Olomolaiye et al. 2008).

1-The ability to recycle and the simplicity of demolition reviewed through design levels, and fees in the design budget complement the construction's sustainability. Waste approaches new sources for new construction. In extreme cases, making goods by recycling waste from demolition creates fewer air pollutants, pollution, and water-made products. Besides, providing valuable materials for this reason defending the environment and natural resources always benefits operation and recycling costs.

2- Adaptive reuse dramatically reduces waste and conserves energy to manufacture other materials, including building materials. A lot of the job will perform using content to end up going to waste if existing resources are not used well. This approach may preserve cultural heritage by keeping and maintaining a historical building in use.

3- Use building materials or their components to minimize waste production if there is no need to rebuild fully. Determining the period in which the building is designed somewhere to last for a long time is of the utmost importance as, over time, the other factors may change in this place that will be Its creation at some point. If the resale cost is likely to be enhanced by matching new uses, a suitable design can significantly reduce costs. Adapting to new services and therefore increasing the building price is a critical strategy for sustainable building growth.

## 2.9 Design According to Human Convenience

The primary function of the sustainable structure is to offer healthy and warm situations for practicing humanoid actions. The facility must provide accommodations for the activities that have been built and provide a flat interplanetary and sizes suitable for rooms, water, sunny, and services for work, incarnate, education, treatment, etc. moreover, the structure needs to be comfortable inside. It is healthy, and the weather is suitable for people who use it. These necessities must be available in the construction, provided the building itself does not affect the environment, and it must, for example, be structurally stable and safe from fire. Sustainable development requires that the structure does not intend to threaten the atmosphere or there is no benefit in its construction; for example, to promote human adaptation, There should be calculations on one of the following two methods fig2.7.

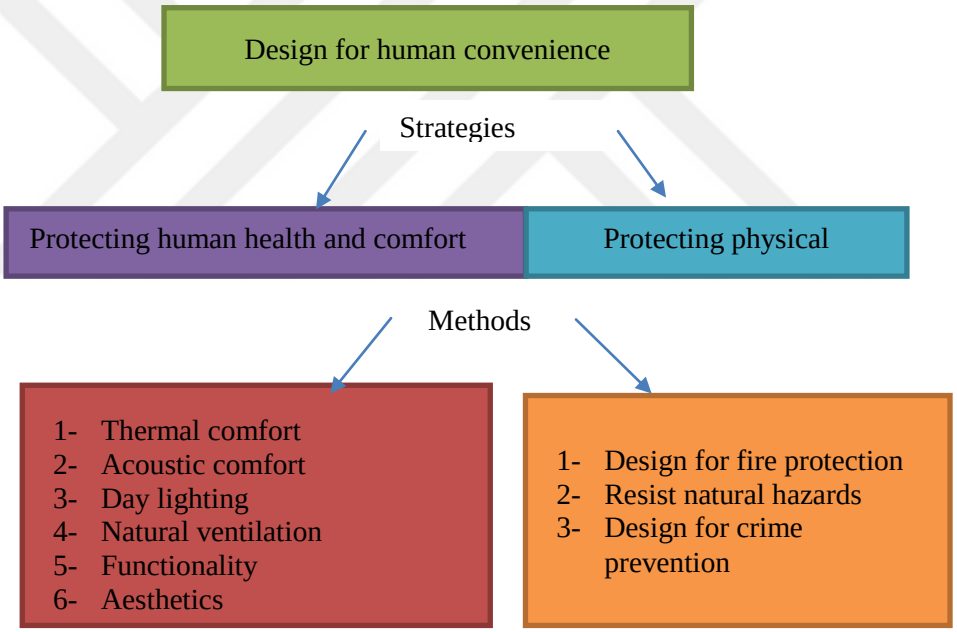


**Figure 2.6:** Design For Human Convenience

### 2.9.1 Protecting health and comfort

In a modern society where individuals spend more than 90% of their time indoors and more than 70% of their time vacationing at home (Sev, A. 2009), Luxury is an essential element in knowing what resident costs., One of the primary functions of architecture provides places comforting people inside their families that the idea of physical rest is enormous to the concept of "building Sustainable".

In terms of building performance (masked indoor air for residents, thermal insulation, first-rate lighting fixtures, and sound quality inside), a sustainable industry must balance human desires with the ability to withstand grassy and cultural environments. The healthy building is free from lead and asbestos and can enhance fitness and comfort for residents at some stage through its entire cycle, support social desires, and enhance productivity. Useful construction realizes that human health and well-being are necessary; many designers were preoccupied with deception and making attractive and modern shapes ignoring the high-quality environment and social satisfaction in the surrounding areas and others. Conferring to Sev (Sev, A.2009)], The invention may also include energy and perform well; however, if it positively affects building occupants and improves productivity, it is not a sustainable product. Literary reviews have identified (but are not limited to) a need to improve coexistence between the environment, homes, and residents.

1. Thermal insulation is a must and is essential to increase a resident's comfort and improve his health inside the home. Maintaining the residents of buildings or other facilities' thermal comfort must be one of every building designer's strong desires. Environmental parameters representing the thermal environment are temperature (air, radiation, and surface), humidity, air velocity, secret parameters, clothing, and the degree of individual activity in the home.

2. In several workplaces, there is little question about sound conditions in the design phases. The correct choice of windows and soundproofing for your home walls is critical for mitigating exterior noise. Some sound protection fabrics, coupled with acoustic ceiling tiles, have the following advantages (Oral, G.K.2004). Penetrable faces cannot alter the rooms' internal sound levels and eliminate light, tampering, or insulation. The desalinization tower device was built as an acoustic division, and the procurement of suitable structures, channels, pipes, and electrical structures was adequately designed. It could be necessary to escape some sustainability issues by careful auditory preparation.

3. The design includes daylight homes to maximize light and gives many benefits that artificial lighting does not provide. Daylight is suitable for public health. Therefore, maximizing daylight in housing is a critical concern—adequate amounts of sunlight are given throughout the day and acceptable for over flare or contrast to be noticeable.

Direct (extreme reduction) can cause discomfort, especially with excessively reflective surfaces.

4. Through natural ventilation, air quality can be preserved without utilizing the resources and requiring a mechanical operation. Air quality in the workplace influences explicitly and impacts peoples' wellbeing. The flow of fresh air significantly increased in recent construction designs.

Home treatments and adequate space ventilation will remove home odours. Effective airflow architecture will minimize costs related to automatic and electrical devices' use and service, growing consumer performance. The required environments for ventilation are temperature and the orientation of operable windows. Application examples include the transverse ventilation to take advantage of wind inlets for airflow and the usage of water vaporization structures in humid, waterless ecosystems to prevent utilizing groundwater. In sustainable building design, the opportunity to sweep a window, interact with nature, and appreciate solar energy is vital in building growth (Edwards, B.2006).

5. The building's functions must be intended to allow the tasks for which the building is designed and operates. The building's ability to accommodate future features should be studied initially in the context of expansion and minimizing additional use of materials and waste disposal costs. Refurbished building elements are uniquely important even when not necessary in the long run.

6. Building beautifully, creatively, and creatively, the fundamentals considered to contribute to personal luxury inside the work and the resident environment. This psychological consolation component may wish to suggest an eye-catching structure, visual interest, work on the walls, or natural factors. Besides fountains, plants, or fish ponds, it may be challenging to measure splendour's impact, emphasizing aesthetic requirements as a sustainable building.

### 2.9.2 Protecting physical resources

The protection of material assets is one of the most excellent significant concepts of sustainable strategy and structure. Therefore, attention necessity is given to the design to include flexibility in facing natural and human-made disasters that include fire accidents, earthquakes, floods, and criminal and terrorist attacks. It planned to mitigate

this risk to determine how to reduce the elimination of the harm of existence, possessions damage, and ways to obtain these obligations.

#### 2.9.2.1 Plan for fire protection

The most important aspect of building safety involves systems that allow the designer to investigate all the building components as a package of integrated protection tools for the building's heater, given that the houses become very complicated. The architects are now thinking about the building's cover more than before. It is essential to remember during the design of fire protection. This system must be updated and updated from time to time. One of the vital conditions is that the fire protection centers allow an impartial and pleasant stove reaction to being performed by the building residents. The attention to firefighting measures and fire safety is critical to the stability of Building security or structure. Negative protection from fires does not more effectively preserve the strength of the building's shape at some fire stage. It also provides balance and separates the building into areas with applicable risks (fire chambers). These are designs to maintain safe road fractures and facilitate thermal insulation and reduce fire and warmth, And smoke, allowing residents to escape and firefighters to do their work safely. Safety is provided with materials from the constructed buildings or introduced to restore or stabilize the fire safety (Bagchi, A.; Kodur., 2008).

#### 2.9.2.2 Resist natural hazards

Hazard resistance techniques should be a prerequisite for designing the building consistently with avoiding or reducing such disasters. Ecological attentions are now essential portions of submitting forms for the construction of any building. For example, flood extenuation strategies include lifting structures over floods in flood-prone zones, manufacturing homes waterproof, and integrating barriers and floodwalls into site design to keep water away from the building. Adding retrofitting strategies such as the iron cement peel, strengthening the vertical corners included in the tiles, and inserting connecting beams, including a pillar for building bricks and mud wall dwellings, may lead to a long move in defending against natural hazards (Marzbali, M. H et al., 2011).

#### 2.9.2.3 Crime prevention

Architectural design has emerged globally as one of the best promising and practical strategies to reduce crime opportunities. The basic principle of crime prevention is planning to build and choose the appropriate and effective design for a safe environment, reducing anxiety from crime and its occurrence and improving the life rate. A practical, safe construction strategy includes executing countermeasures to Stop, discover, and delay humanoid perpetrators. Crime prevention strategies emphasize the following planning approaches: Obtaining normal acceptance of manipulation, monitoring regional behaviour (Marzbali, M.H., 2011). Manipulation is used to access doors, fences, shrubs, external gates and depresses entrée to a place by all users except for the default users. Monitoring is carried out by insertion windows in locations that allow the planned operators to appear or the buzzards while ensuring that infiltrators are found. The monitoring improved by providing lighting and landscape that allows viewing without obstacles. Finally, the area is defined and distinguished by distinctive signs through sidewalks, landscapes, balconies, and other elements that set the boundaries between public and personal spaces. These technologies work together to create a surrounding environment in which people feel safe to use, live, travel, or visit (Marzbali, M. H., 2011).

### 2.10 Sustainability Measurement Tools

People became more environmentally conscious in the 1970s due to the oil shortage. It started to appear to architects that, as well as engineers that houses built of glass and steel had heating and cooling systems that were extremely costly and in contrast to the scale of the boxes they were enclosed.

#### 2.10.1 BREEAM standard

This standard establishes an evaluation strategy for existing buildings based on British building research objectives. This strategy defined in several fundamental principles: (BREEAM) setting an environmental assessment method Demolish and rebuild only when it is not practical or economical to reuse, adapt, or extend Current structure:

- Effective management of cost in both projects can improve the environment and our long as you minimize transportation needs when demolishing, renovating, and constructing.
- Processes to reduce noise, dust, vibration, pollution, and waste;
- Consider what the web has to do, more than what you ought to do. Gathering knowledge, we have learned that architects can better comprehend the influence on the atmosphere of a building's architecture. We have researched background and geography, predominant wind and weather conditions, and solar orientation, and the different functions to learn about building environmental effects by a system. This amenity is augmented by the availability of public transit and by the architectural design of the nearby buildings;
- An architect will redesign a building to minimize the cost of ownership while also preserving the landscape and design viability. There is an abundance of new technology to be found that can be straightforwardly integrated with electricity and energy, and water.
- Whenever possible, use construction techniques that are indigenous to the area, learn from local traditions in design and materials;
- Customer and owner/designer; tension between the people who reside in the building and the functionality, making it comfortable, adaptable, and inclusive.
- Based on quality and suitability to last. Much depends on the length of the figure,
- The finishes and assembly method works on the materials used.
- Avoid using materials from sources that are not renewable, cannot be reused, or recycle, especially into structures that are short in life;

### 2.10.2 LEED standard

This last standard developed by USGBC (American Green Building Council) For distinguished projects in (LEED) and its implementation began in 2000 AD. Furthermore, now, a certificate is awarded Green sustainable architecture applications in the USA. Aiming to produce a greener built environment and buildings with better economic performance, (LEED) standards These standards that architects, engineers, developers, and investors provided with consist of a list A simple criterion used to

judge the building's compliance with green controls, according to these Criteria Points awarded to the building in various aspects


**Figure 2.7:** Points According to LEED

**Source:** (USGBC)

- The energy efficiency of the building given within (17 points),
- Water use efficiency awarded within (10 points),
- While the points of quality and safety of the internal environment in the building reach the limits of (10 points),

Additional points gained when adding specific features to the building, such as renewable energy generators or Carbon dioxide (gas monitoring systems).

(LEED) After assessing the points for each side by the apprehensive board, total points that reflect the rating calculated, And its classification for the intended building

- A building that scores a score of (39 points) gets a (Gold) rating, and this rating means: That the structure reduces the impacts on the environment by (50%) at least compared to a similar traditional building,
- As for the building that scores a total of (52 points), it is classified as (Platinum), and this rating is It means that the building achieves a reduction in environmental impacts by (71%) at least compared to a similar traditional structure.

- Evaluating buildings in this way can reveal to us the number of inefficient, traditional buildings. Thus, we learn the reasons for this in the methods used in their design (Inefficient Buildings), constructed and operated (Philip Bernstein, 2015)

Philip Bernstein says: On the problem of inefficiency buildings: an architect and professor at Yale University say, "... it is not just energy use, but material use, water waste, and inefficient strategies that We follow it to select subsystems for our buildings It is scary. "

Architect Bernstein attributed the buildings' inefficiency to what he called (rupture or fragmentation) in construction work. He sees architects, engineers, developers, and building contractors all adopt decisions that only serve their interests. Thus there is a huge deficit and a total lack of quality and efficiency in the building in general, some estimates: The construction industries in the world consume about (10%) of the entire raw materials. This consumption is estimated at 3 billion tons annually. In the United States of America (Raw Materials), Buildings alone consume (20%) of all kinds' total energy consumption (Philip Bernstein, 2015).


**Figure 2.8:** Rating System Categorized in LEED

**Source:** (USGBC)

### 2.11 Using BIM for Sustainable Layout

Digital building models in most current applications are not able to analyze simulations and evaluate building performance. Therefore they cannot provide us with sufficient information to design sustainable buildings as traditional models and

drawings. Building performance is assessed based on the standard process of representation and illustration using a CAD system, which requires a lot of intervention and humanity explanation (Autodesk, 2005).

Building information modelling provides the building as an integrated database of coordinated information needed to achieve many sustainable design features or obtain a LEED certificate. For example, tables of building elements can be obtained directly from the model to determine the percentages of reused materials, recycled or preserved. It is also possible to study and track sustainable design options from the model through visual visualization and simulation capabilities and techniques. The drawings must be valid and conform to these standards: To obtain a building sustainability assessment certificate. They are using BIM; these drawings are produced with high efficiency as part of the model with similar properties to the building systems. All the elements in the model have a parametric relationship to each other (Autodesk, 2005).

# 3. BUILDING INFORMATION MODELING FOR SUSTAINABLE DESIGN

## 3.1 Introduction

What is BIM? Building Information modelling is an innovative method for constructing layout, creation, and control presented by Autodesk in 2002. It is considered via the constant and immediate availability of undertaking design possibility, plan, and cost facts. It is high- excellent, steady, and reliable. While various technologies are used to support BIM, Revit Architecture is purpose-constructed for BIM. It grants its highest advantages because it is miles based on parametric construction modelling technology, which uses a relational database collectively with a behavioral model to seize and present building records dynamically. Just as a spreadsheet is a device for considering numbers, software built on parametric construction modelling is a tool for evaluating buildings. Just as a trade made everywhere in a spreadsheet predicted to replace anywhere except the user's intervention, a transaction made anywhere in a parametric construction modeller is immediately reflected everywhere.

Building houses, buildings, and other facilities such as roads and bridges are some of the oldest works in history. In the past, the contractor was the architect and structural engineer; instead, it noted that this general idea had been around for thousands of years; the contractor meets in one person. It is represented by the monumental edifices and miracles of the ancient world (such as the pyramids, for example). The science of building has evolved with time, of course, both in the materials used or mechanisms and methods of construction, design, and implementation. Since the computer appeared to us in the middle of the last century, its applications began. Building science serves in all its aspects. Two-dimensional engineering drawing software came, Then it evolved into a three-dimensional drawing, which was a big-quality move. Before using the computer, the designer needed to repaint the entire board when there was a need to amend or Significantly, quickly, and at a lower cost. Correcting a mistake, which increases production time and value, and the advent of computers, became easy to do. Through the CAD system, it is a short form (Computer-Aided

Design). Computer programs have evolved from an architectural and structural design Mechanic and electrician to calculate quantities and costs, plan and calculate schedule, in addition to management and professional communication to become the science of project management. However, the compatibility problem between all these disciplines appeared in Essential Computer and the Web part One project and enough production to satisfy its owner. Here came building information modelling technology (BIM), (E, Krygiel & B. Nies. 2010).

Furthermore, that included A set of techniques and methods of work to produce a model of origin. All physical and engineering information is represented for each element it contains Origin.

BIM It represents the facility's physical and functional properties in the form of a computer-generated simulation model that is the source of information shared during that facility's life cycle and forms a reliable basis for decision-making.

The meaning of a model here goes beyond the concept of building just a three-dimensional shape. Model intended for a building using BIM technology to simulate and characterize every process that an installation goes through when constructing it. Therefore, it includes its construction as a (3D) shape.

It has its characteristics that we can enter into; On the other hand, (4D) design included time, (5D) cost involved, (6D) for sustainability, and (7D) is project management after completion of its implementation and attention to its maintenance, Things that touched the building in the future.

If we analyze the shorten of BIM, we see it contain three words :

1-Buildings: It means all kinds of buildings, such as schools, homes, factories, houses, and towers, and this also includes roads and bridges And other various installations. This word also provides for the meaning of the word building itself, not just the free-standing structure.

2-Information: It means the availability of information and data related to the type of building and all its components. Each element has its data, which we can program to define in this program and learn through it.

3-modeling: means a visual form of the attached information and a life description of the elements' properties.

### 3.2 Project Management

To obtain high-quality services at the lowest feasible cost is known as project management. A surfeit whelming amount of fascinating methods and strategies Construction practice may typically deal with only with one aspect of construction; however, they may often be used in other construction-related areas.

To see the process of planning, development, architectural design, and construction management as parts of a single process, a team that does not have any disagreement consists of the owner, the building manager, and the contractor.

They focus on the owner's desires during the process to create an excellent product. Project management aims to strike a balance between project costs, timeline efficiency, and project ROI. Construction management is not only centered on construction but on overseeing all the processes of planning and guidance as well.

Architects and construction management develop original designs and create entire buildings. Project controls, on-creative thoughts, idea coordination, project care, and on-site management are required. Also, competition rules are followed before deciding on the building owner's manager. Contractor/When it comes to building contracts, the technological facilities seem to be a standard feature of the service provided. Fixed costs plus losses are generally accepted as a standard industry practice in these contracts (S. Keoki Sears et, al 2008)

### 3.3 Project Management in Construction Industry

It is the construction industry, which produces the most significant dollar amount of economic output. In the sum of 1.5% of GNP, spending on construction has enormous implications for the overall economic well-being of the country's future.

If the company views its customers as individuals who pay a portion of their profits in order to maximize benefit, it will act according to the principle. More than eleven percent of all US retail revenues are made up of construction. It is believed that six percent of all private-sector jobs in the United States (or 3% of total) may be attributed to building construction (S.Keoki Sears et, al 2008)

It affects nearly everyone's daily lives but is taken for granted as an essential aspect of our globalized economies. The creative industry in the US Traditionally, a time of national economic growth goes hand and hand with times of national stasis.

Most specialists tend to focus only on one aspect of a project, while the team-oriented deliver services on many different facets. Their wide influence means that they are often known as "corporate contractors". Hiring subcontractors might shape a subcontracting network. Many corporations continue to transport many millions of dollars a year on a regular basis, without spending as much as a country the gross domestic product (GDP) of any one government. There are a great number of small- to medium-sized businesses in the construction industry rather than big ones (Salah KH.Zamim, et al., 2017)

### 3.4 Use of BIM In Project Management As A Tool

The construction of PMP Project Management PM standards is similar to project capability. BIM can be defined as valuable in project management, which means it is effective and easy to implement. In the PMB model, they are all about integrating production, planning, and logistics and have the same goal: to be able to operate simultaneously. As for a project, BIM integrates both strategies and procedures. Project management treats construction materials as bit-by-bit engineering and breaks down BIM. It is highly valued for keeping costs and timetables down, as 5D. Like the design scope, time, budget, and scheduling models in other areas, PMBOK is a good way to understand project characteristics. It does not reveal all the dangers but does help build a project and acts as a safeguard against them. As visual and analysis components are used in the model, you get a clash detection tool from 3D BIM. a creative and project management initiative, BIM is primary in helping to allow working relationships to occur between both partners. This includes both engineers and designers. quantities which are utilized in (BIM) (quantity takeoffs). Mostly, resources may be seen as ways of saving money or the length of time it takes to get them. No matter how large or small the projects themselves, BIM can be seen as competitive in particular knowledge fields.( Saeed Rokooei,2015)

### 3.5 History of BIM

The concept of BIM is not fresh. It was first suggested by an American architect, Steve Engelbart, in 1963. This sentence published in 1962 (with the engineer beginning to insert a chain of specifications and data, 6 inches for slab thickness and 12 inches for the thickness of the concrete walls attached at 8 feet depth, so the ending scene seems to improve the design by the engineer by previewing and adjusting it, and by getting more actual footage from the display screen. Douglas developed the idea of combining company documents into one framework. Most medical sciences later organized with an intent Specialization in different areas, no longer most comfortable within the construction region.

Douglas studied the connection between humans and machines, which eventually turned out to make the planet a safer place (not on BIM exclusively). This student should note that the mouse used by billions today is created by a man—a vital instrument for communicating with the device and improving BIM capabilities. In the 1970s, BIM was once again resurrected by Simon, Negroponte, and McHarg. BIM was extolled in the least as much by Charles Eastman by his book and essay written in 1975. He spoke regarding (Building Description System). He recorded the (critical) findings of this inquiry and how they expected to examine three-dimensional stereopsis features. At Eastman, Charles in 1977 concentrated on the GLIDE project (Official Language for Interaction Design) when the BIM applications were beginning to arise. Building Knowledge Simulation Furthermore, Tolman from the journal (Modelling different views on buildings) (1992). The first effort was VirtualBuilding, which GRAPHISOFT undertook in 1987 using CAD technologies.

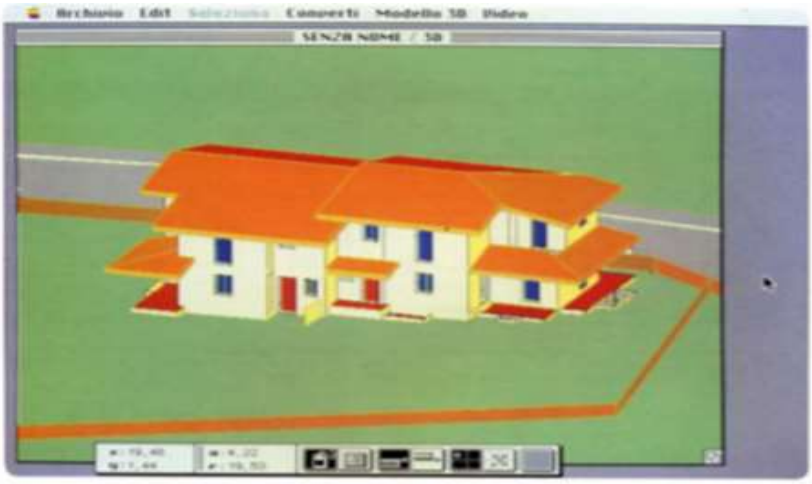

**Figure 3.5:** Picture Graphisoft of CH Radar Program In 1984 Which Named Later ArchiCAD

And then, Bentley Systems used the term (integrated project model). The Autodesk company used the word (BIM) in the Architecture AutoCAD program in 1998, and then Autodesk bought the Revit in 2002, which makes a massive transformation for building information modelling.

### 3.6 Comparison Between the BIM System and the CAD System

The CAD system is an acronym for Computer-Aided Design. This process mainly relies on assisting the processing of graphic designs. The computer distributed with drawing lines no more, and the programs that operate with this system cannot identify the elements themselves. Still, they are all lines, so we have to pull all the projections to show a specific component, and this is what the BIM system cancels because it deals with all the elements. Separately, the model is created by selecting its features and not by selecting its lines. Thus the results are staggering as all the projections obtained Sectors and even a 3D model are very easy to define just about every component and not draw it more than once in different predictions.

Building Information Modeling provides us with a complete library of three-dimensional elements of a building's physical representation. In essence, BIM is a practical method. To create the structure before actually implementing it. It is a digital simulation of the building's physical and functional properties. Moreover, building a model using different BIM technology Just about making 2D and 3D graphics (as in CAD technology), the primary dependence when building a BIM model of a building is smart elements. It varies from the blueprint thus dramatically. An illustration is a

wall in BIM structure Where the thickness of the wall, and the layers of its components, materials, the wall inventory as a whole and discount, doors and windows positions of its total area, also different details and outcome, which in the sense of setting are challenging to provide.

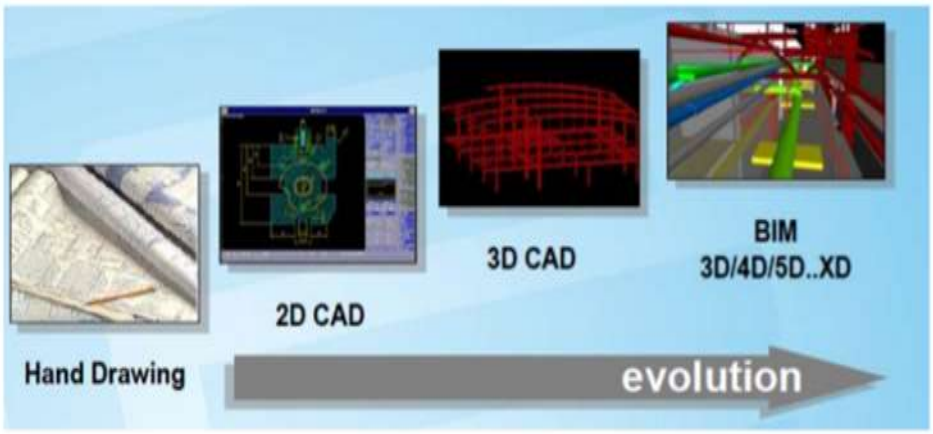


**Figure 3.6:** BIM Development

**Source:** (BIM Arabia magazine, 2017)

In terms of comparison, building a BIM project requires more time than the CAD system at the beginning of construction. As a result of defining properties, Each component will save you much time when extracting all the documents and papers needed to implement and finish the project Inverting the cad system.

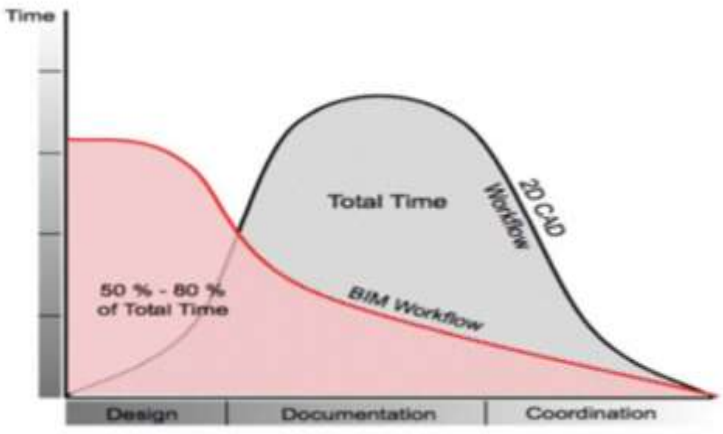


**Figure 3.6b:** A Graph Showing the Time Used in the CAD and BIM Program

**Source:** (BIM Arabia magazine, 2017)

Since everything has advantages and disadvantages, experts discovered the cad system's weaknesses, think, and create BIM. For example, it is hardly a drawback. It detects drawing errors and problems except at the time of implementation and the difficulty of resolving conflicts during execution. There is hardly any difference

between the drawing Architect's lines and drawing lines for air conditioning installations.

### 3.7 BIM Features

According to reports CMAA Owners survey 2005: CMAA Industry Report 2007, Economist Magazine 2002 ROI:

1-The embodiment of Access Information & Collaboration cooperation and design team(Architects, Structural, Surveyors, and Mechanical) and the main contractor and subcontractor and then to the owner Project, which provides information more efficiently, avoid problems and thus reduces losses, saves costs, and develops solutions. It is premature for any conflict between the departments involved in the project during design and implementation. Implementation is to avoid wasted costs due to poor planning and lack of clear vision of the project Time & Cost.

2-Allow all fields of engineering specialities (not just the architect) to have their role; for example, if we think about the sixth element of BIM, which is sustainability, and how we deal with various types of engineers in work teams.

The architect focuses his role on selecting materials, designing, dividing spaces, and directing. As for civil, the position is evident in choosing new concrete, such as green concrete and building materials. Mechanics and electricity have a role in determining Adaptive type systems HVAC with the least energy and electricity saving and renewable energy calculations. The position does not depend on the architect. Still, there is excellent cooperation between all disciplines. BIM is one of The technologies that promote collaboration in design and implementation and has played a role in promoting sustainable architecture.

3-Create an accurate, informative model for the building.

4-Ease of viewing and getting around in the navigation project before you even sign its contract, which directly impacts the customer That; when he sees only two-dimensional diagrams, he will not be able to understand it well. He will not object, but only after the building is finished. Be aware of any notes before starting. He will ask for some adjustments. Still, when he realistically sees the building and wanders around inside it, he has to see Implementation.

5-Improved final Visualization and Simulation.

6-Apply the technology of integration and coordination between the different views, sectors, and tables in the project. The one relies on automatic updating of any modification to the item.

7- Unifying and integrating all kinds of diagrams, the Design Diagram is the same as the Shop detail diagram drawing and the built-as implementation plan without the need for many adjustments for each scheme, as is the case in CAD.

8- Modification in the model and Updating are easy.

9- Improving the Bill Qf Quantity and Specification for all parts of the project, especially in the early stages.

10-Assist in the maintenance process.

11-It is considered a modern means of building with flexibility, saving money with better quality, using modern ideas such as Integrated Project Delivery (IPD) Virtual Design and Construction (VDC).

12-Provide a realistic vision for construction operations, as 92% Of clients Designs are recognized. The CAD system is not sufficient for construction operations. (Center for Integrated Facility Engineering – Stanford University). (study made on 32 projects that used BIM)

### 3.8 BIM Outputs

Along with the delivery dates at the beginning of the project, after it sets, It is necessary to agree on the project's outputs implemented by the BIM system side-by-side with the project's leading members to accommodate their participation.

The following models expected as important outputs and results from applying the BIM methodology at work (Kreider. et al., 2010):

1. Site Model
2. Massing Model
3. Architectural, Structural & MEP Models
4. Schedule & phasing program
5. Construction & Fabrication Models
6. Shop drawings

7. As-built Model
8. Data for Facility Management
9. And any other form of information in the form of stereoscopic or non-stereoscopic features.

Through these outputs, we can achieve the following:

- Environmental simulation.
- Validate the estimate of energy use requirements.
- Check that the light design is correct.
- Count the time.
- Add b Estimate the construction cost.
- Resolving conflicts between different divisions.
- Documentation with a laser scanner.
- Establish a facility management schedule.

There are studies conducted in the Center for Integrated Facility Engineering – Stanford University on 32 massive projects, and it found that (BIM Arabia Magazine, 2017):

- 40% of sudden changes can avoid during implementation
- Accuracy in cost calculations reached 97%
- Save 80% of the time needed to calculate the cost
- Save 10% of the total project cost as a result of the change in action.
- Reducing 7% of the time required to implement the project
- Reducing the amount of waste in the project by 37%

The Hill McGraw Foundation reports that 74% of BIM users are in One of my recent questionnaires. Western Europe obtained tangible positive results on its overall investment in these models against 63% of users BIM in North America (BIM Arabia magazine, 2017).

### 3.9 Roles and Responsibilities of the BIM Team

It is one of the first steps to apply BIM to a specific project or the engineering entity level, defining roles and responsibilities. That should be clarified initially and identify

the people responsible for implementing these Roles and responsibilities appropriately to reach maximum benefit and achieve the highest possible quality.

At least PEM's project team consists of:

- BIM Manager
- Coordinators.
- Modelers.

### 3.9.1 Manager BIM

The BIM manager is responsible for the Model at the Meetings, which he appreciates His needs and informs us about everything new in the stages of the building lifecycle project development as he is responsible for (Lola Karbotli, 2015):

- Set the general context for directing BIM projects at the company's level or the entire engineering establishment.
- Communicate, the company's administrative leaders are implementing BIM and the progressive manner mentioned in the strategic goals.
- Develop the necessary plans to implement BIM and follow up on implementing this plan as planned.
- Divide goals and set an appropriate timetable for implementing these goals.
- Submit reports that clarify the level of the engineering entity in applying the BIM and following the plan and the specified schedule
- Define the requirements and resources needed to apply the BIM at the level of the company or engineering establishment
- Determine the appropriate evaluation criterion that must follow to apply the BIM.
- Clarify the latest scientific updates and the practical application of BIM technology.
- Clarify the capabilities of the engineering entity and show the level of product quality that is offered to customers using BIM
- Choose Platform BIM that reflects his vision for the implementation of the work.
- There is no doubt that Facilities Management is its permanent business and direct responsibility throughout the construction phase.

- Assist the Section Procurement in producing and printing lists of materials and equipment to be purchased in a format
- Organized League.
- Procurement Requisites and Material Delivering - (Supply Chain)
- Follow up and improve the implementation schedules of the model.
- Follow up and improve the implementation schedules of the form.
- Establish specific time plans to improve the qualifications of the Modeler team through training and development and inform them of
- The latest technologies in their field.
- Quality control on the model and all Modeler & Coordinators.
- He is responsible for collecting information from all project departments (design, modelling, implementation, procurement, etc.)
- Must solve technical problems and have sufficient knowledge of various engineering disciplines (architectural, Structural, electromechanical)

### 3.9.2 Coordinators

It is concerned with coordination between the various engineering disciplines to detect conflicts in Departments and delivering each service to its designated place securely, achieving the expected result from the design (implementation of the safe plan). He is responsible for the following: (Lola Karbotli, 2015).

- Determine the objectives and uses of BIM for the project.
- Define and clarify the appropriate evaluation criteria to follow for the project
- Development of the BIM Project Execution Project.
- Ensure that the project is proceeding in the required manner and the planned efficiency.
- Quality control of the project and ensuring permanent review.
- Display the quality level reached by the project.
- Convert all instructions and information from the top management into executive orders that are easy for the team of painters or modelers. Their implementation, for example (transferring specifications and material information to Families, fulfills these specifications and is easy to handle.
- Coordinators also responsible for reporting work progress, completing the implementation timetable, and implementing work on the model implemented.

- Coordinators also the general coordinator between placing the work site inside the project on the ground, its requirements, and the progress of development stages
- The modelling process itself is responsible for converting these requirements into a visual form on the computer.
- Coordinators responsible for developing the business tools on the model and determining what programs and devices the business needs, and for developing
- Capabilities of permanent painters or modelers.
- Coordinators are responsible for the model's overall maintenance and safety and distribution of work.

Sometimes BIM Manager is appointed at the project level due to a company contracting this project using BIM. However, it was not a strategic goal for the company to implement PEM in all its projects, as it is a special requirement for the project. In this case, It has the same roles and responsibilities as Coordinator BIM.

A person is appointed at the project level to apply the BIM. Still, only the department he belongs to (Architectural, Structural, Electricity, Mechanics, Health) is called the Coordinator Model or the Manager Model. Some of its roles and responsibilities are as follows:

- It was achieving the goals that have been set at the level of its division.
- Review the project quality according to the specified criteria.
- Develop solutions to the technical problems of its division.
- Participate in Coordination and Detection Clash between departments.

### 3.9.3 Modelers

They are responsible for transforming the concept design. An idea or stage of the model for LOD (or Level Of development. Development of paper information or AutoCAD design to an executable model (Modeling.) Therefore it is required. They have to go through the standard execution settings and not violate them. They are also responsible for implementing the Model according to each speciality in a coordinated manner that is easy to print or convert to extensions (IFC, DWG, DWF, PDF, ... etc.)

### 3.10 Governments Rule For Using BIM

The application of BIM technology must support the topic and develop a specific code of appropriate standards. Governments have a significant role In making it mandatory for public sectors in Europe and America today. It has a significant impact on providing many costs and resolving the conflicts involved in building any new project.

The British government released in May 2011 a document stating Concerning state-funded projects, That starting from 2016, all the tasks funded by the government should use the BIM Technique. The form is on improving procurement for the UK publicly funded projects that account for 40% of all expenditures. Furthermore, it helps in adopting it, such as tolerance or reward for those who use the building to build, allowing more room for additional construction 30-50 %, or fee reduction. Years later, it is obligatory, with no commitment to a specific BIM program. The goal is not to apply BIM but the benefit, savings, and enhance productivity; BIM technology is just a means, not a goal in itself.

### 3.11 BIM and Sustainable Design

In current practice, many hypothetical construction costumes do not have enough records to create and evaluate performance appraisal - the building blocks for sustainable building design. As with traditional fashions and physical graphics, assessing the overall performance that mainly relies on graphs of regular CAD or Object-CAD solutions requires a fantastic deal of human intervention and interpretation, making analyzes very expensive and time-consuming. The Revit Parametric Building Viewer portrays the building as a coordinated knowledge database. In addition to graphic diagrams, several figures are required to ensure the environmental architecture is easily captured when the device is on a project. The combination of Revit Design with commercially accessible computational methods further simplifies the complex and sometimes complicated studies. Revit Architecture provides architects with exact access tools to provide instant feedback on early planning options for the design framework by linking the development model without delaying the analytical software. Revit Architecture is extraordinarily appropriate to solve the types of obstacles that environmental construction practitioners encounter every day. It will eventually generate new building functionality, such as incarnation

energy and whole lifecycle expense for measurement and optimization. Some LEED credits require sketches to help apply for credit in assignments requiring a LEED credential. These graphics will place an upper cap on the usage of standard CAD applications. As part of the building knowledge distribution, Revit Infrastructure generates these graphics more efficiently and again in the legislative reform age, which often coordinates improvements and ensures continuity.

Now nobody has to change the graphics or connections. The Revit Mathematical Building Model's LEED specifications are far less likely to be overlooked (and unintentionally violated) or disconnected from synchronization in project design than a recorded implementation in a standard CAD or CAD-based aggregate application. For several other facets of environmental planning and LEED approval, the Revit template provides a wealth of knowledge. For example, building part tables may be accessed from release instantly to reuse, recycle, or rescue products. Different concept alternatives to sustainability may be researched and controlled. Advanced visualization techniques may reassure a cynical user otherwise that an essential concept functions appropriately and looks correct.

### 3.12 Building Information Modelling/Management

"BIM" is defined as an abbreviation denoting the English words "building information modelling." Therefore, BIM is the name "building information management" it has ended widely in use at present times. There is no single great description of what BIM is "Building Information / Managing Information." It also claimed that BIM should analyze as a multi-dimensional, traditionally evolving, and complex phenomenon. BIM can have distinct meanings specific to extraordinary people. BIM can be described as a 3D model-oriented numerical representation. Statistics are stored in the project registry as an interchange aid with similar tools. BIM is unusual because it focuses on three-dimensional teamwork between developers, developers, contractors, and consultants. BIM is a predictive management scheme that extends from the project's initiation to the closure of the conveyor. BIM also creates a building structure experience, which is valuable in increasing collaboration and cooperation among the contractor, engineer, subcontractor, and stakeholders (Miettinen, R. et al., 2014).

This new device, which includes essential information to keep communication flawless and easily in control of the construction challenge, allows us to reduce our

planning and costs by providing collaboration, interoperability, and conversation. Ensures that all stakeholders accumulate the information they want in any building area by using basic tools/programs/programs designed to define the company and challenge requirements and obligations since the start of the mission. Eastman et al. mentioned that "the building model defined by its content" What are the things that describe it? "Using his skills," what kind of statistics might he need?". Rather than worrying about getting the data into a database, concern yourself about whether you have the right kind. relaxed; "What is a wall, or a wall, but made of anything like that?" How is this implemented, according to the obtained connection to other design tools? Features such as analyses, budgets, cost forecasts, and interfaces must connect to the different elements. A basic move in CAD to parametric modeling is the need for a percentage of all elements that have to be defined using parametric values. For, e.g., when a wall was relocated, the website was completely rebuilt. Any addition or subtraction to an item can often alter something else. BIM analysts use this approach to fine-tune the BIM modification ability and come up with the correct review mechanism and the most efficient sorting process. One of the most complex BIM and parametric modeling applications. (Eastman, C. M., et al. 2012). "IMACS is not just a program," His argument said that BIM encompasses not just three-dimensional models but also intelligence. It also incorporates major workflow, project management, and implementation problems. BIM promotes the idea of having ready-to-to-deliver projects, which optimizes production, competitiveness, overall success, and cost-saving through project lifecycles from the start, through combining individuals, programs, and processes, and layout and methodologies in simple ways (Azhar, S.2013).

The UK government has made it necessary to implement the BIM era for country contracts entered into through central procurement through April 4, 2016. It was designed to bring the systems of all country administrations in compliance until October 3, 2016.

According to Uysal. BIM maintains all kinds of information related to the building structure with the emergence of a computer model. Uysal makes the word "facts" more clear by claiming that it has had three common malfunctions, which are as follows (Uysal E., 2014);

1. 3D computer version (Architectural, Statical, Mechanical, and Electrical)

2. Work schedule
3. Cost records/estimation

The first of these three significant breakthroughs reflect a three-dimensional device program (3D). If they implement the time records, it will introduce a fourth dimension (4D) if you have all five-dimensional costs (5D). So within the literature, you can find meanings that include 5D BIM.

In a limited sense, BIM depends on the program's performance at the time of data and creation. On the other side, attributes that describe challenges or issues may be described as opportunities to solve or problems to be dealt with (for example, associated with changing information or verbal exchanges). One of the ways this interaction can be shown is as follows: Until evaluation of the building capacity, other statistics (such as radiation factors, radiation phase, etc.) are needed. If it is not in the BIM model, so the unstructured facts would shift as well. Input and documents describe organizational mechanisms and output, and data and processes (T. Liebich, Eastman, C. Et .al 2011,2012). It is important to retain full and exact registry mechanisms and trade correct details to ensure interoperability between premium systems. A practical and statistical approach governs the design of the technological model (the degree of detail, or complexity, required). The administrative and juridical elements identify partners' duties and liability in corporate and operational terms, as well as visual and written facts and outputs, while also defining their responsibility, respectively, while statutory and criminal definitions describe employees' responsibilities (Volk R., Stengel J., et al. 2014).

Linking emerging innovations to life cycle objectives like the booming performance, efficacy, and competitiveness of construction are key drivers of technology adoption in construction, said Al-har, Tiffins, added Smith. More important than low-cost, quick-to-to-build, and better code is better code. This ensures maximum profits by eliminating inefficiencies, increasing the profitability and efficiency of all forms of manufacturing, and by passing such benefits on to customers in the form of lower prices, the long-term value of goods and services increases. Otherwise, the whole thing has run its course (Smith, D. K. & Tardif,2009). Measuring the BIM also is a challenge because it is divorced from the organization's manufacturing processes and methods. Nevertheless, BIM has various advantages, especially because of its

improvement in competitiveness, efficacy, and overall performance. The below are some of the advantages of modern knowledge systems (Uysal E. et al., 2012);

- People working on the project ought to better communicate and cooperate with each other (interoperability),
- Reducing of time, expense, high-quality, or reduced complexity
- Project execution within the development system is better, quicker, and less stressful.
- Not just safer and greener, but quicker and more environmentally-friendly procedures
- Substantial gains in efficiency and productivity
- Accurately stated truth and longevity
- The charge involves just once-in-and-a- lifetime payments
- The more secured production contract
- More realistic visualization works produced from the BIM system with shorter time and budget.
- The 3D BIM offers greater and more precise data on CAD efficiency.
- Simultaneous superposition may be done for BIM software systems. Because of this, designers typically discuss expected/unexpected conflicts between design elements and the development website to be completed early in the process, and they discover potential problems when planning the BIM model.
- Job efficiency is increased as 3D, 4D, 5D, and others are added to the mix. Promote harmonious interactions to make a high-quality and successful judgment. Employers, contracts, sub-consultants, and contractors will begin to work with BIM in the first stages of business planning.
- Thanks to this latest BIM technology, a great deal of specific and compelling data can be collected inside the plant construction projects, including advanced visualization and interpretation. The formerly assembled materials and molecules will take their place inside the manufacturing plant at a more beneficial moment. Acting in this latest BIM method minimizes mathematical issues, eliminates alternative demands, and raises conflicts.

- More opportunity for production, better fees, lower costs, and improved efficacy could be possible using a modern BIM gadget. In some instances, the current BIM system offers monetary and performance savings.
- It quickens the layout techniques considering layout changes may make in the initial layout process without much effect on the undertaking's cost.
- It decreases the number of records exchange requests (RFI) after development begins with a proper model and enables more efficient/effective communication with other contractors/subcontractors.
- Cost estimates robotically generated from the 3D, 4D, 5D BIM models more correctly/correctly and quickly than traditional methods.
- Even after production is completed, it is used to protect and recover the building/structure using geared-up BIM models and do area occupancy assignments much more quickly than conventional methods.

In BIM, projects, architecture, and development teams can work closely together with an extraordinary number of times.

BIM helps companies, consultants, contractors, engineers, and building staff to introduce continuous project development expertise without interruptions (planning, bidding, performance, and operation). To accurately express their ideas, these concepts, therefore, creative discussions and interactions with staff must be developed prior to implementing BIM management strategies. This monitoring often encourages discovering the proper team units, key strategic efforts, deciding who can do what, and choosing a program or technology to minimize contact expenses are other functions that can be accomplished across this lifecycle (Autodesk, Inc, 2014)

Structures used in modern dams, airports, dual carriageways, and railways, in addition to new schemes such as a brand-new bridge You can think of BIM as an extension of the planning and layout stages of a project, and as being applied earlier and earlier on in the implementation process, it can save both time and money. This method, such as mission control, development, facility, and asset management, and time, is supported by the basic systems. Why is the UK government making it obligatory for all government projects starting in 2016 to apply BIM software.

BIM focuses on design, procurement, construction, design management, and coordinating, and deconstruction. Plan and transfer from design-bid-construction to IPD when working in a collaborative atmosphere. The BIM can be used to create construction control drawings and for new facilities and de-construction ones (Rice, S.et.al, 2011).

The effects of collecting, refining and shipping construction substances on the ecosystem renders their careful choosing an integral part of a sustainable design. However, explaining the ramifications for a green assignment typically poses a stumbling block for sustainable layout tasks since the content requirements are usually distinct from the layout model. They are time-consuming and error-prone. Revit Architecture combines with InterSpec's popular requirements management software solution e-SPECS®, a building report management solution, and services supplier. The creation, editing, and (most importantly) coordination of task specs can be significantly automated using e-SPECS from Revit. E-SPECS connects with the Revit statistical version via ODBC without delays, a stable and well-established way for database interoperability.

Consequently, e-SPECS For Revit automatically replaces Revit Architecture's component and fabric specifications to ensure that the undertaking's building and specs are synchronized as the design progresses. For example, while a new construction, like a sort of window or roof, incorporates the Revit edition, the e-SPECS venture specification manual is periodically refreshed to match the version's actual substances and properties. The figure below shows that: for h\those to choose an application, here come comprehensive lists of BIM providers for different categories (BIM in projets management (Faiq M.S AL-Zwainy, 2018).

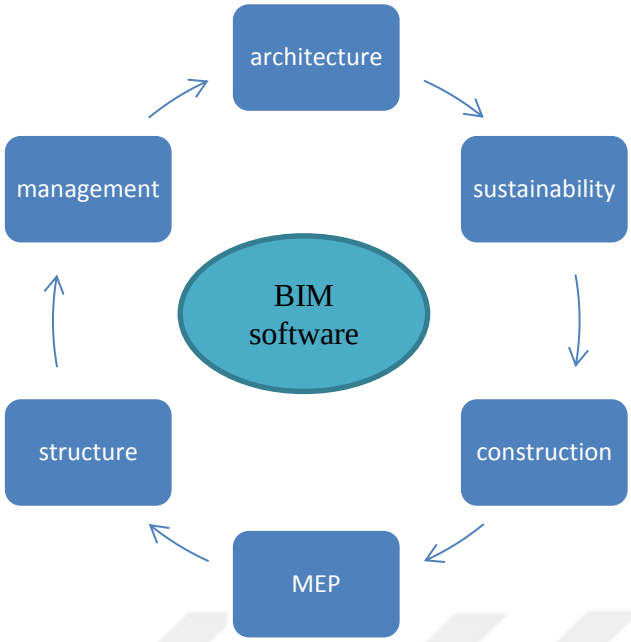


**Figure 3.1:** Categories of BIM Software Based on the Function of Engineers

**Source: (**Faiq M.S.AL-Zwainy)

### 3.13 Benefits of BIM

BIM may be thought of as two categories: primary and indirect advantages. Some of the gains would be realized sooner rather than later, but the greatest of them will be found in other ways.

There is now a reliable infrastructure in place, defined by BIM and interoperability, that allows construction stakeholders to be very critical of BIM. Through understanding how BIM delivers incentives, consider the following examples: Parameters of existence, BIM is increasing the accuracy of the design's visualization, When a change in the plan is Automatic, corrections will make, BIM will Generate accurate and constant 2D drawings, Earlier collaboration among design fields, Easy preliminary estimate, Quantity surveying, and cost estimation will make, Sustainability and energy efficiency improvement, Accurately detailed fabrication models, Clash direction, synchronizing between design and construction planning, Synchronize the purchases of materials with the construction ANDBim is the Controlling system and facility management.

### 3.14 Design Optimization

Using BIM goes beyond a one-time drawing method; it is a way to document the design. It quickly goes to a wide range of benefits resulting from the model's ability to perceive the building virtually in the form of a database during all stages of the design process. It allows us to see the database to get different pictures of the building. These Pictures can take the forms of projections, facades, tables, or sectors. Anything that is added to the building database can calculate or measure this method's effectiveness. We can envision the same project in various ways, saving time for communicating design information and has multiple uses from the documentation phase to the implementation phase to the operational degree. To be included and be able to be easily integrated within the design and implementation process (Krygiel and Nies 2008), We will present the most important of these uses and how they may affect the building in the following points:

#### 3.14.1 Document integration

All building drawings are represented within the building information model and placed within a single integrated database. This information is coordinated automatically because the model is considered a structure for the database information. After placing the drawings in the panels, the reference signals correspond to them. With the increasing complexity of the building, the number of meetings in the implementation documents' set increases. Dimensions of the building It is easy to install architectural, structural, and mechanical models and test and examine overlaps and conflicts within the building design. Several building modeling programs can perform this process and report the intersections that are inside the building (Krygiel and Nies, 2008).

#### 3.14.2 Visualization

One of the essential uses for building information modelling is the three-dimensional model. The three-dimensional structure can be viewed from all angles and imagining the building on the site before the actual construction. It is an essential tool because it helps design and visualizes the structure and spaces, but it also helps communicate design ideas to the work team, Consultants, and clients (Krygiel and Nies, 2008).

### 3.14.3 3D Simulation

The building information model allows for a three-dimensional simulation of the building with all its contents. This simulation goes beyond showing the systems used in the construction to show the effect of environmental changes on the building design and calculate the quantities and estimates of the implementation time. For example, the simulation enables us to deliver the impact of sunlight on the building at midday and clarify The importance of using sunblocks for the customer (Krygiel and Nies, 2008).

### 3.14.4 Database of building materials

The building model's digitization function, the building components with their material properties such as thickness, height, building material, and wall details applied to the building model very quickly. It can give more about the number of bricks used; for example, all of these data are modified when adding or deleting the form's walls. Due to the availability of information about the quantities of materials, it is possible to easily add a price for these materials and calculate the project's total cost. Details of the building must accurately represent a form to use in all structure studies (Krygiel and Nies, 2008).

### 3.14.5 Sustainability strategies

Building Information Modeling simulations is an incentive to use the 3D model in other applications. To speeding up studies needed to meet environmental design concepts, like electricity, natural lighting analysis, report surface, and quantities that render precise measurements (like solar energy to study orientation, flat roof of solar panels).

Natural lighting and amounts The rain that can take from the roof surface to determine the size of the tank and recycle the contents by adding the required variables to schedules and materials within the building information form; we can also calculate the quantities of recycled materials within the given materials or the entire project) and this will be detailed later.

### 3.14.6 Construction planning

The Building Information Model helps visualize all implementation phases by dividing the model into separate phases at intervals with the so-called fourth dimension technology, saving time on the job site. The outputs of building information modelling applications can also be linked directly with other programs such as Primavera and Microsoft projects. All participants in the work to follow up on the implementation work by sharing information sources through the model management environment.

### 3.14.7 Building management after the works

Once the project is completed, the Building Information Form is still a useful tool for project users to locate building fixtures and assist in administration (Azhar, S., 2011).

## 3.15 Some of the Most Important Program For Sustainable Design

### 3.15.1 Autodesk vasari

Working with information extraction and movement are two of the aspects that make one of our programs easy to use Brightness of mobility between houses. It used to show Solar Radiation And the ease of presentation, and it recommended to request it Universities.

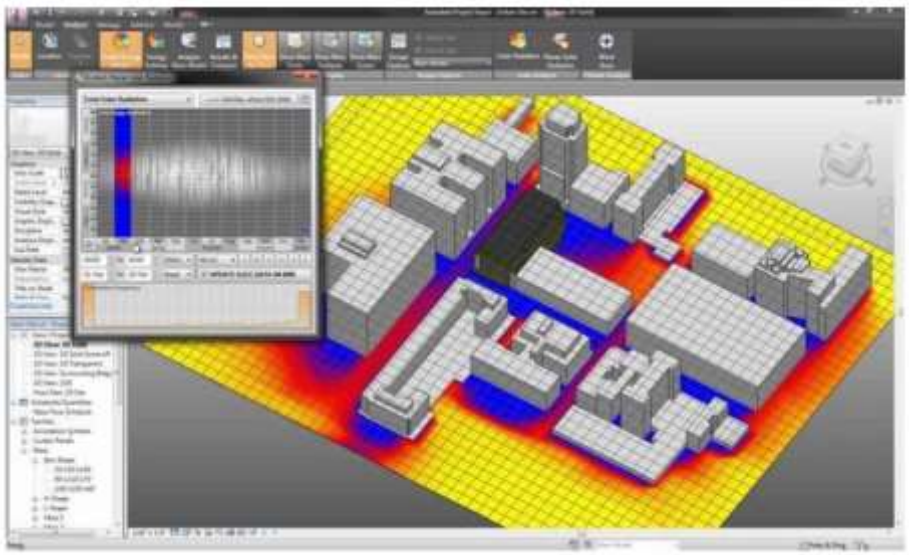

**Figure 3.2:** Autodesk Vasari program

**Source:** (Google Pictures)

### 3.15.2 Autodesk CFD

A very specialized air movement program and high precision in studying Air move it in terms of air pressure, speed, and temperature. In addition to this, it shows an analysis of the motion of fluid geometry or motion Liquids.

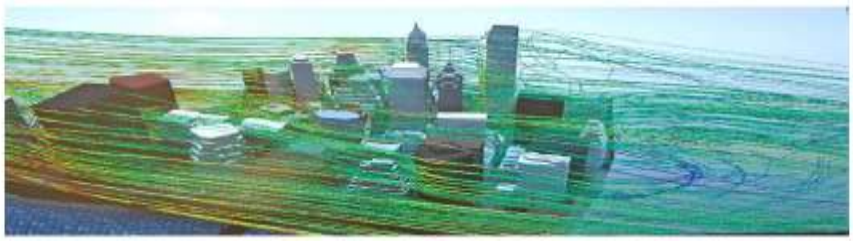

**Figure 3.3:** Autodesk CFD Program

**Source:** (Google Pictures)

### 3.15.3 Dialux

It is used by architectural engineers and Electromechanical, where his results are shown. Design and distribute lighting units in buildings And inside the inner spaces to avoid distraction and waste lighting, exploit it, and analyze the energy consumed by luminance.

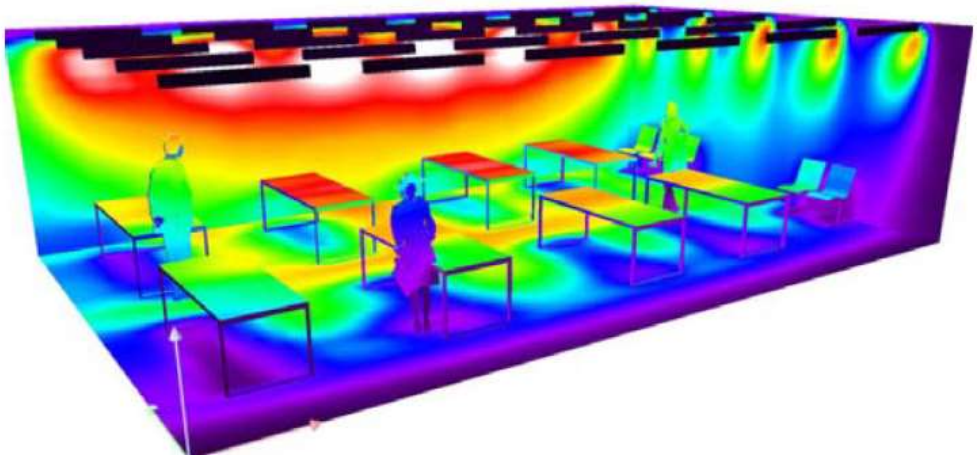

**Figure 3.4:** Dialux

**Source:** (Google Pictures)

### 3.15.4 Design builder

The building's thermal loads were studied from the aeration and the emission rate of dioxide Carbon and indoor air movement and Raw study materials found inside the building from its composition.

Furthermore, its isolation of heat and qualities of loss of electricity was done. In addition to the latest issue, the cost calculation for the loads (Energy consumption) electric And they issued a certificate of identification of the faculty building.


**Figure 3.5:** Design Builder

**Source:** (Google Pictures)

### 3.15.5 Green building studio

Given analyzes, program Autodesk Inc. The built-in electricity cost and the amount of water and heat for users. Then he gives Adding in Revit the building's interior LEED is a certificate that evaluates the building's percentage.


**Figure 3.6:** Autodesk Green Building Studio

**Source:** (Google Pictures)

### 3.15.6 Auto-desk Ecotect

Autodesk Ecotect is one of the programs that are easy to use and distinguished from the rest of the plans by showing the shadow shape throughout the year and making assumptions for Sun barker to improve the building's performance and avoid high temperature and direct lighting.

**Figure 3.7:** Auto Desk Ecotect

**Source:** (Google Pictures)

### 3.15.7 IES (Integrated environmental solutions)

It is a program produced by IESVE. It is one of the well-known programs in analyzing energy, natural lighting, the building's thermal mass, and other important matters for the establishment. It is characterized by producing a detailed report according to LEED's requirements, but it is not free and costly.

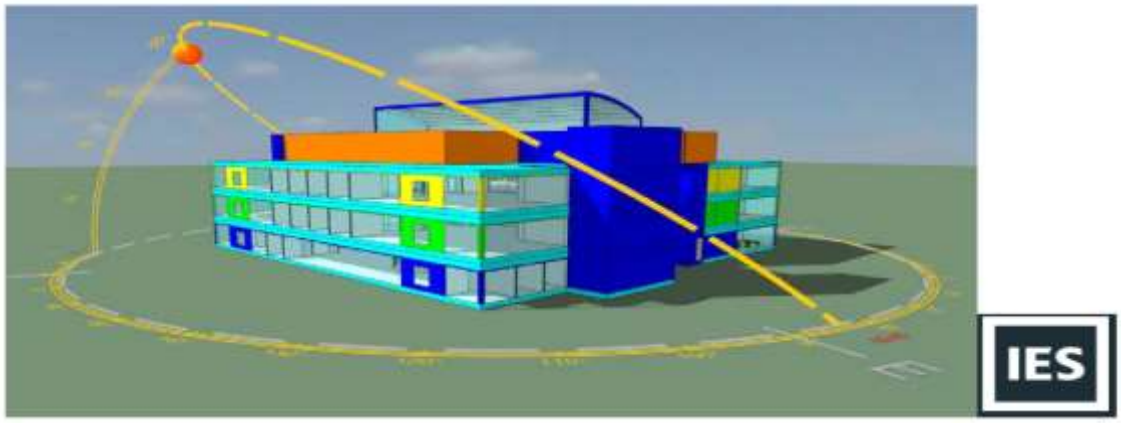


**Figure 3.8:** IES

**Source:** (Google Pictures)

### 3.15.8 Autodesk Revit

It is a program from Autodesk that analyzes the building's energy, and it will not be in a detailed manner as the rest of the programs. Still, it is considered sufficient if the project is subject to LEED evaluation as it is characterized by an analysis of natural lighting and shading.

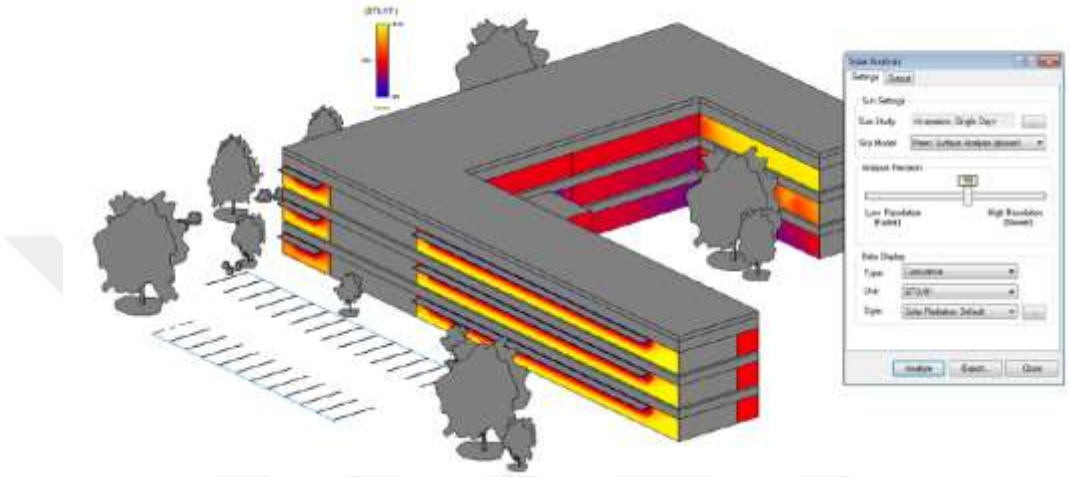

**Figure 3.9:** Autodesk Revit

**Source:** (Google Pictures)

### 3.15.9 Sefaira

It is an excellent and easy-to-use program that analyzes the energy in the building.

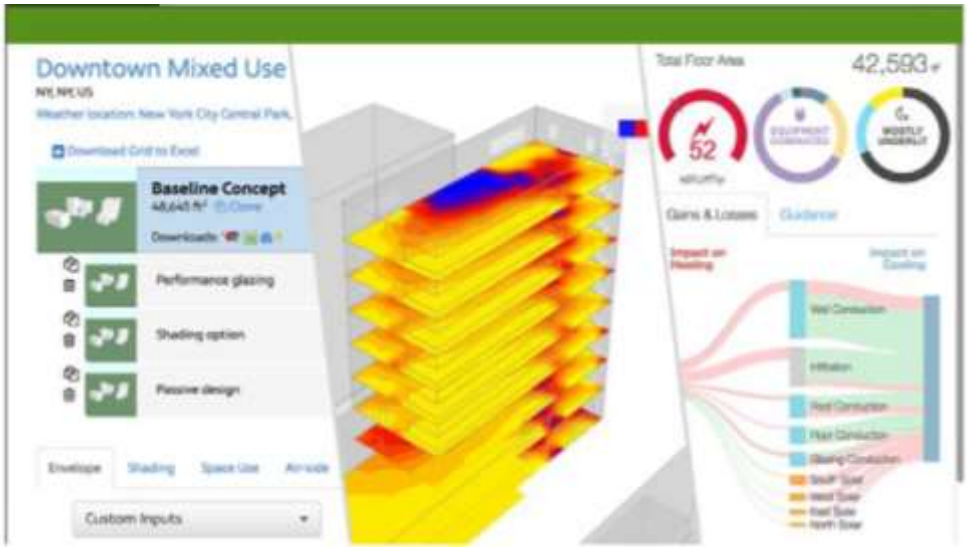


**Figure 3. 10:** Sefaira

**Source:** (Google Pictures)

### 3.15.10 Energy plus

It is an essential and well-known program in energy analysis, natural lighting, and renewable energy. Still, it does not support GRAPHIC's principle, so some companies have adopted a medium such as Sketchup.


**Figure 3.11:** Energy Plus

**Source:** (Google Pictures)

### 3.15.11-HAP

It is a program from the leading Carrier company in air conditioning and refrigeration. It is considered one of the plans well known in the area of load calculations Thermal analysis.

In addition to analyzing the building's energy, it lacks the feature of showing the structure as three-dimensional and not free and must Buy it.

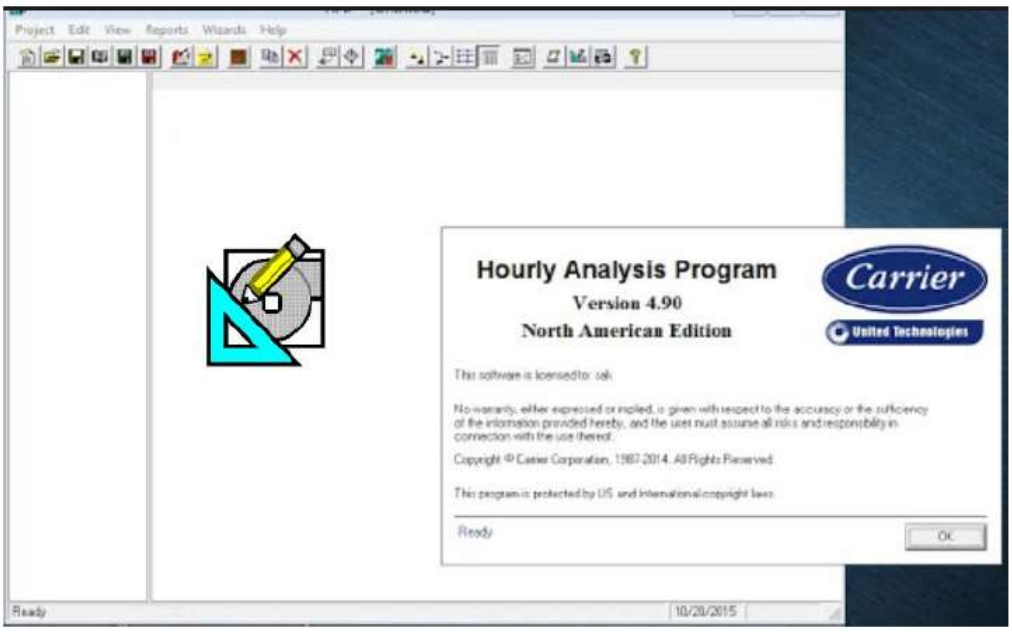


**Figure 3.12:** HAP

**Source:** (Google Pictures)

### 3.16 Types of Simulation Required For Sustainable Buildings

There are many types of programs used for sustainable or green buildings. Here we will talk about the REVIT program because it is a common effect among engineers. Still, this program so far does not do the research and calculations required for green buildings, so if we want to design a project to obtain the LED certificate, several other programs must using until this is approved. the simulations include:

Convection, whether cooling or heating, Natural lighting Industrial lighting, the sound Ventilation, The temperature inside a space, The thermal resistance of building materials, Shading range, Field of vision, Solar breaker design, Solar radiation on the building Water use (Faiq AL-zawiny, 2019).

As concern the Revit program, it Specifically helps (Faiq AL-zawiny, 2019).

- Extracting the data needed to study the site from studies of winds, temperatures, humidity, and solar radiation
- Study the thermal loads of various materials.
- Adaptive load studies, whether cooling or heating
- Make natural lighting for the building.
- Provide recommendations and proposals for the design to make the building more Light and more thermal insulation.

### 3.17 BIM Software Packages

In structural design, the engineer who does not know programs, just like a person, cannot read and write. Programs at this time represent an extensive area in the field of structural design. Every two months, three new companies aspire to a new program competing with companies and old plans. The engineer must have a minimum of knowledge of these programs and then develop himself first to keep pace with the universe's developments.

If we divide the programs in terms of use, we will divide them into three parts Drawing Programs, Structural analysis programs, Calculation programs

Although BIM is considered new, it is also a trend that penetrates the construction industry progressively fast. For those working on choosing an application, here come comprehensive lists of BIM providers for different categories:

**Table 3.1:** Programs Used In Different Engineering Fields

| NO | FILED | PROGRAM |
|---|---|---|
| 1 | Architecture Program | Autodesk Revit Architecture<br>Graphisoft ArchiCAD<br>Nemetschek Allplan Architecture<br>Gehry Technologies – Digital Project Designer<br>Nemetschek Vectorworks Architect<br>Bentley Architecture<br>4MSA IDEA Architectural Design (IntelliCAD)<br>CADSoft Envisioneer<br>Softtech Spirit<br>RhinoBIM (BETA) |
| 2 | Structure Program | Autodesk Revit Structure<br>Bentley Structural Modeler<br>Bentley RAM, STAAD and ProSteel<br>Tekla Structures<br>CypeCAD<br>Graytec Advance Design<br>StructureSoft Metal Wood Framer<br>Nemetschek Scia<br>4MSA Strad and Steel<br>Autodesk Robot Structural Analysis |
| 3 | Electromechanical programs, conditioning, and sanitary | Revit Autodesk MEP<br>Bentley Hevacomp Mechanical Designer<br>4MSA FineHVAC + FineLIFT + FineELEC + FineSANI<br>Gehry Technologies – Digital Project MEP Systems Routing<br>CADMEP (CADduct / CADmech) |
| 4 | Simulation, analysis, and conflict resolution | Autodesk Navisworks<br>Solibri Model Checker<br>Vico Office Suite<br>Vela Field BIM<br>Bentley ConstrucSim<br>Tekla BIM Sight<br>Glue (by Horizontal Systems)<br>Synchro Professional<br>Innovaya |
| 5 | Sustainability | Autodesk Ecotect Analysis<br>Autodesk Green Building Studio<br>Graphisoft EcoDesigner<br>IES Solutions Virtual Environment VE-Pro<br>Bentley Tas Simulator<br>Bentley Hevacomp<br>DesignBuilder |

**Table 3.1:** Continue

| NO | FILED | PROGRAM |
|---|---|---|
| 6 | Cost Calculation | Cost Estimate Autodesk QTO<br>Innovaya<br>Vico<br>Timberline or equal |
| 7 | Energy Analyzing | Energy Analysis Autodesk Green Building Studio<br>IES<br>Hevacomp<br>TAS<br>E Quest<br>DesignBuilder<br>Sketchup + OpenStudio Plugin |
| 8 | Facility Management | Bentley Facilities<br>FM: Systems FM: Interact<br>Vintocon ArchiFM (For ArchiCAD)<br>Onuma System<br>EcoDomus |
| 9 | Cities and urban planning | InfraWorks 36<br><br>CityEngine |
| 10 | For stations | Flow plan<br>Facilities plan |

### 3.17.1 BIM assets management

Lots of tools are required to translate 2D models to 3D formats. It is possible to rotate the whole framework such that the viewpoint of interest is available on either side or to focus on a specific feature of the architecture. BIM program is structured to detect possible mistakes or omissions inside the design components, not to determine structural integrity. To sum up, the general industry views on tech, we may claim that it follows: The same people design the Revit framework and GRAPHISOFT because they provide the same capabilities. The two sets of software analyzed various images from picturesque locations around the world to find out how different they are.

#### 3.17.1.1 BIM assets management

**REVIT packages**

All Autodesk Architecture design program is a Revit brand. He has designed his workspace to accommodate his thinking so that he can perform in an unbiased and effective manner, allowing him to produce easily and to completion.

BIM coordination also means that all improvements you bring to any project data can be made usefully in the whole project since it was designed specifically for it. Consistency and cohesiveness were preserved throughout the different stages of production, as well as prototypes and documents. If you are an architect, the following modules are compatible with Revit:

a- Revit architecture.
b- Revit MEP.
c- Revit structure.

**Bentley packages**

the BENTLEY IS MANDATHLON BASED BY MICROSOFT STATION Technology, but the expanded features have little practical uses. It is more stable than Revit, which has a higher implementation expense. The Bentley systems are in general usage among the military engineering corps.

**Archi cad by graphisoft packages**

Arctic CAD began in the decade of the 80s with the Mac. 2D and 3D archiCAD are the first computer-aided concept Smart items, such as floors, walls, roofs, and windows, can be constructed with the Graphisoft product. Photorealistic renderings (2D images) from 3D prototypes

**Other BIM software packages**

Other software that can be used in Google sketch up and 3ds max (formerly 3D studio max). This software is much less expensive, easier to learn, and can produce relatively rapidly.

**3.17.1.2 BIM analysis packages**

Analytical modeling software helps engineers to examine and evaluate the design's composition. The features of the program differ greatly. More than 80% of this software is compliant with other BIM software, so it enables the exchange of knowledge and details through the different programs.

Think about Revit as working in tandem with industry-leading architecture and code review tools. structural analysis is connected to any of the following linked applications: Autodesk Revit Link (Faiq AL-Zwainy, 2019):

1- Adapt.
2- CSC.
3- Tekla.
4- CSI(ETAB).
5- Oasys.
6- RISA.
7- Robot.
8- SOFISTIK.
9- SOFTTEK.

Apart from the research tools, extensions include additional features in the drafting world for Revit goods, including structural analysis. Extension for Revit gives users instant benefit and is straightforward to use.

**CSI ETABS packages**

CSI ERBSI's extension is an illustration of a Revit component. With the addition of CSIEBS 2008, you can have a quick and simple connection to use all Revit items together. V models prepared in the Autodesk Revit structure 2008 for study, architecture, and optimization are converted into files used in the ETABS. For import and optimization, Autodesk Revit installed the new concept details and worked with it when ETA died.

**TEKLA structure**

Tekla BIM solutions may be used to assist the planning, installation, and also after construction for management. Tekla products provide full structural analysis tools coupled with creative design capability. Tekla structures software assists in the details of product development, sourcing, as well as building the final product. When interacting with open templates, the system's greatest power is at the end of the process. More than 80 nations have used Tekla designs for their BIM-based building ventures with great results.

Tekla is able to process vast volumes of data to produce a dynamic 3D model and can be utilized in the entire design and development phase. For planning and growth, Tekla models seem to reflect the “on-site” condition. It is almost like Tekla has become part of every state-the-of-the-the-the-the-art software-driven workflow while keeping data integrity and consistency strong. The processes of interdepartmental cooperation and communication are important for competitiveness and sustainability and timely and on-time project delivery. The Tekla provides an in-betweener for structural engineers, pre-mixed concrete mixers, pre-cast detailers, and contractors.

The practice of building knowledge modeling is used in the field of planning, development, as well as to manage costs. In my opinion, one of the primary reasons BIM is used is because it has interface advantages. The architecture model aids with reliable device feedback and fewer mistakes and omissions. BIMance packages offer resources that find concept document contradictions across all layers.

Bidding also uses BIM files. The prospectives will use the BIM files to maintain continuity and accuracy. As the amounts would be consistent between vendors, the bids will be more precise and less expensive. Those managing the project constructed the designs and blueprints for the fabricator as well as the workshop and manufacturing processes.

BIM will enhance the design/construction/construction management process by providing both the owner and construction manager and contractor feedback during the project lifecycle. BIM will also communicate with contractors' estimation and timetable information directly, enhancing coordination of everyone along the building process.

#### 3.17.1.3 BIM 4D modelling assets management

A machine modeling method is known as the 4D, which incorporates a 3D model database to improve teamwork and design and schedule construction projects. Visual 4D templates greatly enhance construction records and plans by using advanced visualizations for the sequence operations. As the procedure is executed, there are less communication issues between subcontractors and the owner's staff and activities. From the blueprints, you can see the entire architecture of the house when gazing at the layout in 3D. each feature of the 3D model can be attached to any other 3D entity to construct a fourth-dimensional model

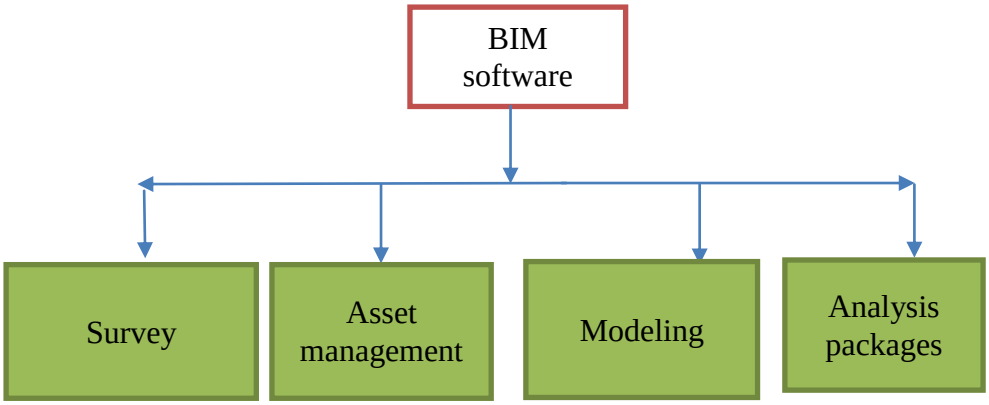


**Figure 3.13:** BIM Software Packages Based On Management

### 3.17.1.4 4D software navisworks and packages

Navis is designed to connect the PUMA (primavera) drawings with the BIM files Time has also been defined as the fourth axis of research in the model. Activities in the BIM file should be grouped together as links and assigned a schedule ID, and then elements can be seen in the order in the layout. When trying to display the replay of a rotated Navisworks 3D output, There are no plugins currently available that can simulate a four-dimensional schedule in the jetstream. Prima may use time and sequence management software to import time schedules from different sources (e.g., Microsoft Project, etc.) And link task objects.

Simulate the model's actions, and present the simulated values as well as the real values and timings. Export the images and animations utilizing these simulations. If the model or timetable is changed, the simulation will adjust itself. (Faiq AL-Zwainy. 2019)

If you want to operate a 4D time management, you would have to adopt these simple steps:

1. Lay out the model by processes/task ids and use small classes of them in the primavera software. Selecting a limited number of templates for the 4D challenge would allow it more intuitive and user-friendly.
2. Import the primavera schedule into Jetstream.
3. Time linear comes up with a set of predefined project activity types (constructed, demolished, and temporary) based on the settings. If you choose to specify your own task types, only choose those options from the configurations menu.

4. It is essential to have both the 3D operation ID and the associated 3D elements connected in the model.
5. Isolate all the operation ids that are attached to 3D objects.

Mathematically complex geometric 4D modeling was used in the concept and development processes. It provides the owner with the best means of developing a phasing series in conjunction with BIM visualization to include as much meaning during the design. It will provide both the contractor and the owner a clearer idea of the building phases' 4D modeling. BIM is a versatile architecture and construction management application, not just CAD software. A BIM is used in conjunction with the building plan results in a 3D modeling method. (Faiq AL-Zwainy. 2019)

BIM: During the design process, BIM knowledge is a valuable control mechanism for managing design conflicts. It creates the additional importance of the time and effort that was put into it (Faiq AL-Zwainy. 2019)

### 3.18 The Relation Between BIM and Sustainable Design

The challenges facing sustainable construction are that for life cycle order and sharing findings with the project's stakeholders. It is possible to use BIM to store and log projects and preserve project data on energy usage during service.The relation between BIM and sustainable construction is

- Improve and convert data on energy depletion.
- BIM can deliver an information-sharing background that produces connotation among stakeholders through the lifecycle of sustainable construction, generating an environment conducive to input-output and converting information in the BIM system.
- Energy and the environment are the essential factors in sustainable construction (Faiq AL-Zwainy, 2019).

# 4. METHODOLOGY

## 4.1 Introduction

This thesis aims to chart a path for engineers to learn about sustainability and design with information modelling technology by studying literary theories about both topics and findings. These programs serve humanity through sustainability to preserve future generations' resources.

Some literature was studied, and that literature was mentioned in the second and third semesters. The questionnaire was conducted. Students from different engineering stages and other universities and countries of the world participated, some heads of departments in the building design departments in Iraq, and some designers in Arab regions and other countries. By sending the questionnaire over the internet by email. The answers were collected, studied, analyzed, and discussed in the fifth and sixth chapters of this thesis.

## 4.2 How To Design A Questionnaire?

The questionnaire is a widely used scientific method To obtain information and data related to people's conditions, tendencies, or trends. The researcher sets of questions to derive primary data relevant to the group that is supposed to examine. (Nigel Mathers et al., 2009).

### 4.2.1 The questionnaire and its design method

Given the importance of knowing how to design a research questionnaire, we will try to present topics related to how the questionnaire gathers the necessary information to answer questions and hypotheses raised by a research problem.

#### 4.2.1.1 How to design a questionnaire

It is the cheapest to survey a mass of people through questionnaires. You can follow this data and do an analytical research study for the topic.

You can understand that collecting good data on the right questions is key to crafting well-designed questionnaires, regardless of how many or complex, they are. To make sure you have completed the whole survey process with questionnaires, begin with making sure you have identified the items you will examine and then collect the data. Each step of the phase must be specifically organized since the outcome depends on all the processes involved. Every data has to pass through a questionnaire: The price is, therefore, inexpensive, but the methodology is the most expensive (Nigel Mathers et al., 2009).

Now we will talk about two essential elements in the questionnaire design.

#### 4.2.1.2 Writing the questionnaire

Before explaining these two steps, there is a question: When can you use the questionnaire? There is no specific standard for this question, but this depends on several variables, including the type of data collected from the questionnaire and the resources available to carry out the questionnaire process. In light of this, the following points take into consideration ( Abramson JH, 1974):

A. When resources and financial support are limited:

The questionnaire may be one of the cheapest methods of collecting information in terms of administering and carrying out it. However, its preparation may be more expensive and may be equal to the cost of any other method of data collection other than the questionnaire method. (Preparing a questionnaire for a single individual may be no more than stamps, some flyers, and pictures). Time is an important consideration and is one of the essential resources in the survey process. Remember that the length and the short period when receiving results may positively or negatively affect the whole questionnaire process and draw the final results. For example, when a questionnaire is sent by e-mail to thousands of people in seconds, their answers are received within a few days; there is a difference when sent by regular mail or distributed to people handling and receiving the answers (Boynton PM et al., 2004).

B. When preserving the participants' privacy is important:

It is vital to inform the respondents in the questionnaire that their privacy and their answers are protected. No one other than the surveyors notified of whatever their answers are.

C. When it intended to conduct a documentary study of individual results:

There may be previous study results and another study intended to verify these results. Here, the questionnaire is one of the correct options for this purpose, as it is quick and inexpensive. Now we come back to the steps to be followed to design and administer the questionnaire. (Boynton PM et .al,2004)

#### 4.2.1.3 Determine the objectives of the questionnaire

Indeed, you will not get what you want from the results if there is no clear and specific goal from the questionnaire. The more the intent or purpose is unclear, the more time is a waste of the participants' time and the questionnaire's owners' resources. Let us take this example:

Suppose there is a computer program, and there is a problem with its use by several users. The purpose determined is ((identifying the points of user dissatisfaction with the program interface and how it negatively affects its performance)). You might think that is the point, but in reality, it is not.

The questionnaire designer must define what is meant by "the user's dissatisfaction." Whether it is in learning the program, in the program's strength and performance, or in the difficulty of learning the program, the user needs to understand the program quickly. It must also specify what is meant by "program performance." What is meant is that the questionnaire designer must be exact in defining the goal and not let it float or aimed at general things that may understand by several purposes and objectives and a summary of what is mentioned. If you find it challenging to write a questionnaire, remember that you did not take the time to define the questionnaire's objectives ( Fowler FJ.,1995).

#### 4.2.1.4 Writing the questionnaire

After determining the main objective of the questionnaire, it is now the turn to write it. The questionnaire design is essential as it will affect the user's response and the extent

of interaction. The questionnaire questions divided into:

- Open formula
- The closed formula

Let us take the open form, which is simply giving. There is a free exchange of opinions but no determining of the solutions. Besides, citizens have the right to choose their own answers because there is no clear identification of the participants who would answer the questionnaires. Remember that you will increase the likelihood of receiving unexpected opinions that may be strange using this method. It is a disadvantage that his questions read accurately and individually. It is challenging to do a statistical study of this type. It is clear that this type is expensive in terms of effort, time, and money, as it takes a long time to read the answers carefully, and finally, and most importantly, it will take a long time for the participant (Gillham WEC, 2000).

It mentioned that the longer the questions were, the more the participant would feel bored and bored. We have talked about the open form, and we will now talk about the closed version, which is simply questions that have several answers, and one or several options must choose by the participant.

There are no specific answers, but the answers must cover all possibilities of answering the question. It must take into account that they are not so large that they cause ambiguity. In general, the number of choices of answers ranges between five to ten possibilities. In the case of long questionnaires, it is recommended that the answers be paired so that there are not many neutral answers. The closed formula has several advantages in terms of time and cost. Specifying the solutions facilitates calculating them, extracting percentages and calculating complex statistics, and using the computer. The process is easy and fast. Whether the format we choose is open or closed, there are Considerations must be taken into account when preparing questions and their answers, as follows (Gillham WEC, 2000):

**Clarity**

In many cases, mistakes occur, and the answers are inaccurate, which results in incorrect results, and the reason for this is the lack of clarity of the question. The question must be clear and not ambiguous. When setting the question, one should think about limiting the possibility that the problem will be understood in more than one sense by more than one user. It is a significant point; This was in terms of the

question. As for answering it, it is better when setting the answers to be more accurate. There are other considerations in terms of language and expressions. We must avoid strange words that are not frequently used or unknown in a particular environment by users. Also, avoid technical terms that require a technical background or a specific technology before. Persons, The questionnaire is one of the scientific means widely used to obtain information and data related to people's conditions, tendencies, or attitudes (Oppenheim A, 2000).

The questionnaire is a set of questions that the researcher puts to derive specific information related to a particular topic or problem directed, sent, or received to the people who have chosen for the subject of study to record their answers to the questions and return them the researcher.

#### 4.2.1.5 Types of questionnaires:

1. Direct Questionnaire (Fact Questions).
2. Indirect questionnaire (extracting information from the respondents' responses).
3. Closed questionnaires.
4. Open questionnaires are not limited to the answer, i.e., the solution left open to express an opinion, such as: What are your proposals to develop the university?
5. Closed and open questionnaires: This combines the style of closed and open questions.
6. Pictorial questionnaire (highlighting a sure ambiguous thing).

### 4.3 Advantages of the Questionnaire

With minimum effort, all data can collect from scattered persons—relatively modest expenditures. The entity has more time to respond. There are more legalization criteria (measuring validity and reliability) for the questionnaire. It allows accessing knowledge that is impossible to collect using other methods. The questionnaire provides ample opportunity to address the questions more correctly and honestly (objectively) due to the respondent's lack of expertise. To follow up on the questionnaires does not require a significant number of participants. The questionnaire allows for quantitative data to be gathered and interpreted accessibly Collects the

details expected about the respondents. The questionnaire's disadvantages: The analyst loses his touch with the analysis team (postal questionnaire). For uneducated applicants, the instrument is complicated. It is hard to test the specificity of the responses. Low yield from the questionnaires (Sapsford R, 2006).

### 4.3.1 Its Features

A. Full, straightforward, and unmoderated answers are given through mail or any other means. It reappeared assuming that the respondent's reputation will be distanced from any possible liability or fault and that might arise from the results
B. Some questions are the same for all people, although some formulations can vary depending on who is giving them.
C. The questionnaire design and the unit of questions facilitate gathering information into groups, interpreting it, and reaching appropriate conclusions.
D. It is possible to respond at the time of one's choosing.
E. By dividing it into multiple-choice questions, the test permits the researcher to talk to many individuals simultaneously.
F. The survey would not cost much from its nature and knowledge collection due to transporting from one location to another, for example, travel expenses (Sapsford R, 2006).

### 4.3.2 Its Disadvantages

Preparation of questionnaires is equally essential for all study participants. Although papers can be submitted by postal mail, it is equally important to follow up on all answers if a copy gets lost in the process. Because of this or that missing response, the response is incorrect or unintentional. The individual answering the questions is the person in charge of formulating them (for example, because they are trivial). This illustrates why it is necessary to offer the questionnaires special consideration to the subject matter while planning the queries. The respondents might become frustrated and tired of the many questions on the survey (Ibrahim Rasheed, 2017).

## 4.4 Resolution Advantages

It is via this method that people obtain knowledge rapidly and conveniently. Suitable

for research that required access to confidential data besides following the hints on this webpage, you might have found that you were a little faster than most, but you will never get the answer you are looking for. Information is obtained from the recipients. It does not increase the researcher's vulnerability to the dataset's collectors' prejudice.

### 4.4.1 Disadvantages of the resolution

In planning the brochure, you must have to spend time and money. It is challenging to use whether the respondents are not first-years uneducated and can read and write. There is a small risk that some people will lose the application, there is a possibility that some people may not return it, and a chance of others not answering the questions, to put it lightly. It enables respondents to communicate their issues with other people who have similar opinions. If he does not have to call his source, he cannot mention it. Besides the goal, others might likely have answered the question. The questionnaire may be very long and tiresome to answer (Ibrahim Rasheed, 2017).

## 4.5 Questionnaire Preparation

1. Determine the type of information required:

Because the survey is about its target population, the questionnaire was built based on the study's structure. It includes the primary and subsidiary points of the research and logically arranging these points. Under each issue, the questions related to it are placed.

In general, the types of questions, according to the required information, may include real items: age - qualification - questions of opinions and trends, information questions, self-perception questions, verb metrics or specification questions, questions that define past or present behaviour, projective questions: an indirect way of asking.

2) Determine the format of the questions.
3) Determine the content, formulation, and sequence of the questions:

At this stage, the researcher determines the specific questions to be asked in terms of content and wording (is it necessary or not?) Moreover, how many items are required for each component?

In this thesis, we used the open and closed question designs because the questionnaire's questions intended to explore the connection between information

technology and sustainability. Hence, we attempted to prove that. The civil engineer could become a designer, and what techniques do they use to achieve their designs?

### 4.6 Questionnaire Design Steps

1. Determining the objectives of the questionnaire and the points that will cover.
2. Determine the fields (axes) that the questionnaire will cover.
3. Formulating questions so that they revolve around the goals.
4. Conducting a preliminary study of the questionnaire.
5. Presenting the questionnaire to the experts (arbitration)
6. Determining the validity and reliability of the questionnaire by statistical methods.

Controls that observed in writing the paragraphs in the questionnaire in general (Ibrahim Rasheed, 2017)

#### 4.6.1 Rules that should follow when formulating questions

1. The items are comfortable, do not bear more than one meaning, and can be clearly understood.
2. The questionnaire begins with easy questions, then tricky questions.
3. Each item should focus on a specific aspect.
4. Avoid increasing the number of questions.
5. Avoid problems that require honest answers.
6. Avoid complicated questions that are difficult to answer.

As for the time required to fill out the questionnaire, there is no limitation, but experts advise that it should not exceed a quarter of an hour for the questionnaire to fill out individually and half an hour for the questionnaire that filled out collectively. The number of questions varies according to the title, and experts suggest that there be (25-45) questions. The problem's length should be in the simplest possible way without prejudice to understand the respondent (Ibrahim Rasheed, 2017).

For the formulation of questions, there is a set of rules that observed:

a. The question language should be accessible and appropriate to the respondents' levels.
b. They are Formulating questions in a way that does not suggest a specific

answer.

c. That the question formula is not open to interpretation.
d. Stay away from double questions.
e. Stay away from the qualitative questions.
f. In the case of questions of the specified type, the researcher must give all possible data.
g. It ensured that the respondents have the information and thus answer the questions.
h. Putting some questions in more than one formulation to ensure the correct answers.
i. I., The questions do not require deep thinking or complex mathematical operations.
j. The type of answer required is specified.
k. Explanation of some vague terms.
l. Questions are as limited in number as possible.
m. Questions are listed from general to specific to interest individuals.
n. Split questions into coherent groups and give them subheadings.
o. To numbered sequentially. Start with easy questions.
p. Work on placing sensitive or open problems in the other.
q. Putting the issues in a logical order and light of the mutual relationship between them (Ibrahim Rasheed, 2017).

Among the conditions for a good questionnaire is that they contain the following:

1- The title, name of the researcher, and the supervising authority
2- The purpose of the study
3- natural message giving the reader to thank him for the help and assure him of confidentiality.
4- Personal information about the respondent.
5- Answer instructions.
6- Questions.

The response categories are many and determined by the type of questions. The following is a review of some of them:

- Strongly agree, agree, neutral, disagree, strongly disagree. It is called a Likert scale and is used to measure trends.

- Excellent, very good, good, poor.
- Always, usually, rarely, not at all.
- Fully satisfied, somewhat satisfied, not satisfied.

The questionnaire writing experts say (Ibrahim Rasheed et al. 2017): It is wise to exclude the category of lack of knowledge (I do not know, I do not know, I do not know, neutral). Because it is a safe and easy exit, it is challenging to choose that this point is in dispute. Experts advise staying away from the two alternatives only, such as (yes-no) Because this reduces the chance of selecting the respondent. Thus the researcher may obtain untruthful results.

Preparing the questionnaire in its final form:

In this step, the researcher coordinates and outputs the questionnaire well to interest the respondents. There are some points to be measured in the output process:

a. Writing the research title at the top of the questionnaire.
b. Arrange the questions on every page in a way that allows for an appropriate answer.
c. The questionnaire should be as short as possible.
d. Instructions for filling out the questionnaire should be clear and concise.
e. The paper should be fair and write on one side only.
f. The questions should be divided into groups and given clear headings.
g. At the end of the questionnaire, the respondent must thankes them for their cooperation.

The questionnaire often sent accompanied by a letter of introduction explaining the purpose of the study, its importance, and confidentiality of the information. It is used for scientific research purposes only (Ibrahim Rasheed, 2017).

Questionnaire testing before actual application:

It is the process of evaluating the questionnaire, which is for the researcher to select a group of experts and distribute copies of the questionnaire to them to review it, record their observations, and express their views on the questionnaire's content. Often arbitrators come from two categories:

First: Arbitrators who are experienced in research methods and preparing questionnaires.

The second: Referees who specialize in the subject area of the research in which the questionnaire is prepared.

These observations and opinions are taken into consideration and carefully discussed and studied (Willis G, 2004).

The second step is to try the questionnaire (the Pilot Survey) to test the questionnaire on individuals' simple samples. This sample is consistent in its properties with the research individuals. This experience is useful to the researcher in several ways:

- Determine the degree of respondents' responses to the questionnaire.
- Help to identify ambiguous questions.
- Support the researcher provide preliminary assignment checking.
- The questionnaire Advances our experience and appreciation of design and methodology.

#### 4.6.1.1 Questionnaire distribution

Using mail if it is to distribute in many distant regions, and in this case, it is provided with the return envelope, the address to which it will respond, and the postage stamp if possible. One of the difficulties with this method is that the questionnaires sent, not returned to the researcher. Nevertheless, suppose it is to be distributed in nearby areas or to specific institutions. In that case, it is preferable to distribute it by hand by the researcher himself or with his colleagues' help.

One of its advantages is that the percentage of responses is higher and more honest. Another way to distribute questionnaires is to publish them on newspaper and magazine pages, television, or the radio. It is happening in issues that concern the country and people. The recent trend is to distribute it through computer networks or e-mail.

#### 4.6.1.2 Receive answers

The researcher is keen to receive the most significant possible number of questionnaires. A refusal rate of 30% or 40% is acceptable. Questionnaires are scrutinized to ensure that answers are complete and valid.

### 4.7 Resolution Dimensions

Suppose the paragraphs of the questionnaire exceed ten sections. In that case, they should be placed in two or more sizes so that each dimension addresses a converging set of needs. Such as the dimension of academic requirements, after the behavioural needs, and after the administrative needs.The paragraphs of the questionnaire:

The questionnaire sections are considered the essential thing in the questionnaire because they are the expressions that represent the teacher's real needs and the purpose of identifying the extent to which the teacher owns them. There are several characteristics that the paragraphs must have to efficiently and quickly achieve the desired goal:

- To be close in length.
- To be uniform in temporal significance (in the past, present, or future)
- To be identical at the beginning (for example, it begins with the infinitive, the present tense, or the interrogative object)
- Paragraphs should be in one form in terms of positive and negative.
- To be logically sequential.
- She belongs to the dimension that she falls in.
- Include an explanation of the new terminology.

Underline the negative and exclusionary characters: such as (no, except)

The questionnaire is required to be arbitrated by specialists in terms of:

Language Integrity  Paragraph Sequence. Belonging paragraphs.

The questionnaire needs to test on a small sample similar to the target group as a form of arbitration to find out: Readability questionnaire. An estimate of the time to fill out the questionnaire. Clarity of the questionnaire instructions.

### 4.8 Analyzing the Questionnaire Results

The researcher excluded the results that the participants did not complete the questionnaire thoroughly, and then the results were collected and analyzed using the

statistical program SPSS. Each question was discussed separately first, and then the outcome of the questionnaire was discussed.

### 4.8.1 The validity and reliability of the questionnaire

It is not just a heap of unrelated questions; it is an investigation. The results of these questions must match if the test is to be valid. The design of research tools required accuracy and integrity to be developed and integrated. Researchers, therefore, must keep these points in mind. Many meanings of the word "honest" have been proposed, such as The survey was made to detect. Including that, it uses proportional weights on the questionnaire. For the most part, honesty involves the topic or expression relevant to the study's aims. The participant does not know the correct answer or may not have found the segment yet. They do not have the creativity or the ability to express themselves with insight. It could be possible that he or she has misinterpreted the instructions. If the respondent worries about telling the truth, they may choose to remain silent. There are many techniques to verify the tool's validity. The most straightforward approach is to judge the skill of the people who created the questions used in the calculation (Ibrahim Rasheed et al., 2017).

Honesty consists of telling the truth about essential things, lying about things that are not important, and withholding consent for others' lies. Treating others with kindness requires giving in to their expectations and treating those that will not give you permission with suspicion. Being cautious of anything requires protecting your reputation, as well as not lying. Both the substance and approach of the study's selected dimensions and meanings factored into the analysis: The method is useful since it tests the logical framework's validity. Attention focused on studying calculated quantities to see if each component's rhythmic output is affected (Fowler FJ.,1995).

The more accurate the test, the more thoroughly it measures something, the more valid it would be. Thus, the correlation is intended to provide accurate results and provide a reasonable future model. For this test, we must obtain the same results; they enhance the questionnaire's validity. Instead of saying “yes” or “no” in response to the question, using a four-point scale, consider going for “fantastic,” (very), “excellent,” (superior), and “good” when judging their level of comprehension instead. As far as I can see, there is so little comprehension, anywhere from five to seven. Start by using accurate and reliable questionnaires in other trials to write the questionnaire (Fowler

FJ.1995). He [or she] expands the number of quadrants in the survey. As the number of parts increases, the scale tends to become more stable. The additional sentence should not append after it is no longer similar to the inserted paragraphs' price. A paragraph scale must construct on a single unit of measurement since different measures level one from another. Increase the probabilities of the scale's reliability by choosing an appropriate scale coefficient. Resilience is most often defined as a correlation coefficient, which means that there are many approaches to measuring it. The most frequently used method is the Kernbach Alpha technique, which uses the relationship between questions to assess accuracy and credibility and depicts both questions' characteristics (Boynton PM et al., 2004).

Finally, there is an alternate picture approach for identifying stabilization controls. Verifying the questionnaire's reliability is an easy way to do this is to repeat it to get the same answers. Many other strategies are available, and each has strengths and weaknesses. Trends are impossible to escape. To ensure the stability of paragraphs or questions asked about the evidence, perform frequent reviews but understand that each issue can occur differently. After compiling an exhaustive study, the researcher could use some internal analysis, including inserting false data. This form of question or paragraph shows respondents' consideration and involvement in developing the topic or solving the problem. In a study, one type of investigation, the two separate questions are sent to two groups of respondents, which demands that the analysis be divided into two equally sized parts. In the calculation of the "averages," the actual response of the subgroup is used. An internal investigation is required and can also do at the request of management to investigate an accusation.

Furthermore, suppose questionnaire can be applied to same people to keep results' standards' integrity. Because improvements in behaviour were made over this period, we must note duration between experiment's two phases. Because of variation in terms, instructions paragraphs are difficult to reproduce. Their half-result correlation coefficient was accurate without repeating same questions, although this does not always mean that answers to questions are correct when computed second time.

### 4.9 Interview Questions

It was planned in this study that there would be articles with construction companies and designers. Unfortunately, due to the Coronavirus's circumstances and the precautions taken, no personal interviews were conducted with the specialists. Instead, the questionnaire was sent by e-mail,  the results were received, and these results are discussed in the next chapter.

## 5. FIELD STUDY AND DATA ANALYSIS

In this chapter, the results obtained through a questionnaire of some engineers in various specializations will discuss, but most of them worked as civil engineers.

As the number of participants in the questionnaire reached (101) people, and after obtaining the answers, the results analyzed using the (Spss) program, getting tables, making comparisons between the questions that relate to each other, and extracting the products for which this questionnaire designed.

In this segment, survey questions and responses gathered via e-mail or direct answers of people included and findings discovered during the study and addressed to ensure the researcher's theory that a civil engineer may be both a planner and implementer.

### 5.1 Field Study

The study field included many engineers in various specializations. The vast majority of the questionnaire participants were from Iraq and Egypt, and few were in other countries.

### 5.2 Hypothesis Testing

The questions were designed and used methods that enable the researcher to test the hypotheses and arrive at results through analysis and optimal approaches to obtain results.

### 5.3 Study Tools

The study tool employed questionnaires that used prior research samples to assemble new questions applicable to the research subject. As mentioned previously, the model studied represented engineers in all specialties and from different countries.

## 5.4 Reliability

The test's predictable outcomes are expected to lead to the same reading any time the test applied under identical conditions, and accuracy implies that when a group of people uses the test, the results can be consistent. Additionally, reliability is characterized as the quality and precision of the measurements.

- Cronbach's Alpha Formula and Pearson correlation coefficient are two common approaches to approximate the scale's reliability.
- The Spearman-Brown estimation model is used to estimate achievement scores on an exam based on an applicant's results on standardized exams in high school.
- Reapplication of the evaluation methodology.
- The stoichiometric process.

**Alpha Cronbach ($\alpha$ )** $$\alpha = \frac{n}{(n-1)}\left[1 - \frac{\sum_{i=1}^{n}\sigma_{yi}^2}{\sigma_x^2}\right] \quad \textbf{(5.1)}$$

**Person colleration formula** $$r = \frac{n(\sum xy - (\sum x)(\sum y))}{\sqrt[2]{\{n\{\sum x^2 - (\sum x)^2\}\{\sqrt[2]{n\{\sum y^2 - (\sum y)^2\}}\}}} \quad \textbf{(5.2)}$$

When it comes to authenticity, it is a measuring stick used to gauge the respondents' truthfulness. Reality is defined by the square root of the reliability coefficient (0-1). The validity, or the awareness of the instrument's truth, is a calculation of the tool's self-validity since it was made.

## 5.5 Samples Analysis

What is your gender?

**Table 5.1:** Shows The Gender of Participants

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | Male | 67 | 66.3 | 66.3 | 66.3 |
| | Female | 34 | 33.7 | 33.7 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

Table 5.1 shows that there is 66.3% of participants are male while33.7 are female.

**Table 5.2:** The Age of Participants

| | | Frequency | Per cent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 20-25 | 1 | 1.0 | 1.0 | 1.0 |
| | 25-30 | 12 | 11.9 | 11.9 | 12.9 |
| | 30-35 | 17 | 16.8 | 16.8 | 29.7 |
| | 35-40 | 53 | 52.5 | 52.5 | 82.2 |
| | 40-45 | 18 | 17.8 | 17.8 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

Table 5.2 The table shows the participants' ages in the questionnaire and the extent of the participants' age diversity. The largest share was for the age group between 35-40 years, and their percentage was 52.5% of the total people who participated in the questionnaire. This large percentage is because the researcher is of the same age group.

**Table 5.3:** Participants Specialization

| **Civil Engineer** | **51** | **50.5** | **50.5** | **50.5** |
|---|---|---|---|---|
| Electric engineer | 1 | 1.0 | 1.0 | 51.5 |
| Environmental engineer | 3 | 3.0 | 3.0 | 54.5 |
| Structural engineer | 2 | 2.0 | 2.0 | 56.4 |
| Other | 44 | 43.6 | 43.6 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

Table 5.3 The table shows the participants' specializations in the questionnaire. The largest percentage was for the civil engineering specialization, where the rate was 50.5%, and the other specializations were 49.5% in total. The reason behind this high percentage of civil engineers is that the researcher is a civil engineer

**Table 5.4:** Experience

| **How many years of experience have you had in your profession?** | | | | |
|---|---|---|---|---|
| **Valid** | **Frequency** | **%** | **Valid Percent** | **Cumulative Percent** |
| 0-5 Years | 13 | 12.9 | 12.9 | 12.9 |
| 5-10 Years | 38 | 37.6 | 37.6 | 50.5 |
| 10-15 Years | 39 | 38.6 | 38.6 | 89.1 |
| 15 - Above Years | 11 | 10.9 | 10.9 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

Table 5.4 shows years of experience for the survey participants and the largest percentage of people working between 5-15 years in engineering. This part of age is

correctly what a researcher is looking for or the purpose of this research. These people can still learn from the technology and develop construction due to their average age.

Have you ever heard about sustainability? If now sustainability is "Sustainable development is a new pattern for development. Meet the present's needs without risking future generations' ability to fulfill according to their needs."

**Table 5.5:** Sustainability

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Yes | 98 | 97.0 | 97.0 | 97.0 |
| No | 1 | 1.0 | 1.0 | 98.0 |
| Maybe | 2 | 2.0 | 2.0 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

Table 5.5 The table shows the number of people who know about sustainability or have heard of it, as the percentage of people who answered yes was 98%. This percentage indicates that the questionnaire's engineers have a clear interest in sustainability and know the subject more. There is a global desire to reduce the environmental impacts resulting from building waste.

**Table 5.6:** Sustainable Development.

**Have you ever heard about sustainable development**

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | Yes | 91 | 90.1 | 91.0 | 91.0 |
| | No | 4 | 4.0 | 4.0 | 95.0 |
| | Maybe | 5 | 5.0 | 5.0 | 100.0 |
| | Total | 100 | 99.0 | 100.0 | |
| Missing | System | 1 | 1.0 | | |
| Total | | 101 | 100.0 | | |

Table 5.6 This table shows how many people have heard of sustainable development, and the percentage of people who answered yes is 90.1%.

**Table 5.7:** Sustainability Knowledge

| Do you want to know more about sustainability? | | | | |
|---|---|---|---|---|
| **Valid** | **Frequency** | **%** | **Valid Percent** | **Cumulative Percent** |
| Yes | 99 | 98.0 | 98.0 | 98.0 |
| No | 2 | 2.0 | 2.0 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

Table 5.7 The table shows the extent to which people who participated in the questionnaire wanted to know more about sustainability, as the percentage of people who answered yes was 98%.

**Table 5. 8:**Branches of Sustainability

| What is the branch of sustainability more critical to you? | | | | | |
|---|---|---|---|---|---|
| | | **Frequency** | **Per cent** | **Valid Percent** | **Cumulative Percent** |
| Valid | Economic Sustainability | 30 | 29.7 | 29.7 | 29.7 |
| | Environmental Sustainability | 8 | 7.9 | 7.9 | 37.6 |
| | Social Sustainability | 4 | 4.0 | 4.0 | 41.6 |
| | Environmental Sustainability, Economic Sustainability | 19 | 18.8 | 18.8 | 60.4 |
| | Social Sustainability, Economic Sustainability | 20 | 19.8 | 19.8 | 80.2 |
| | Social Sustainability, Environmental Sustainability | 8 | 7.9 | 7.9 | 88.1 |
| | Economic Sustainability, Social Sustainability, Environmental Sustainability | 12 | 11.9 | 11.9 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

Table 5.8 shows which of the branches related to sustainability is the most important for the questionnaire participants, where the largest percentage of economic sustainability was 29.7%.

**Table 5.9:** Would You Like To Have More Educational Curricula Related To Sustainability And The Environment

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | Yes | 98 | 97.0 | 98.0 | 98.0 |
| | No | 1 | 1.0 | 1.0 | 99.0 |
| | Maybe | 1 | 1.0 | 1.0 | 100.0 |
| | Total | 100 | 99.0 | 100.0 | |
| Missing | System | 1 | 1.0 | | |
| Total | | 101 | 100.0 | | |

Table 5.9:In this question related to public culture on sustainability, 98% of the respondents answered yes, indicating that people want to know more about sustainability and its branches and foundations.

**Table 5.10:** Do You Find That Sustainability Is A Way To Decrease Poverty

| | | Frequency | Per cent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Yes | 96 | 95.0 | 95.0 | 95.0 |
| | No | 3 | 3.0 | 3.0 | 98.0 |
| | Maybe | 2 | 2.0 | 2.0 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

The table shows that 95% of the survey participants convinced that sustainability reduces poverty, and this, if anything, indicates that the growing awareness of sustainability increases equal opportunities in society and secures equality for all

**Table 5.11:** Do You Have New Ideas For Solving Environmental Problems?

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Yes | 60 | 59.4 | 59.4 | 59.4 |
| No | 41 | 40.6 | 40.6 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

Table 5.11:The questionnaire indicates that 59.4% of people have ideas for developing the environment. If this shows anything, it suggests an awareness of getting rid of pollution problems that threaten the world.

**Table 5.12:** Do You Have The Desire To Search On The Internet About Sustainability And Sustainable Development

| | Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | Yes | 94 | 93.1 | 94.0 | 94.0 |
| | No | 5 | 5.0 | 5.0 | 99.0 |
| | Maybe | 1 | 1.0 | 1.0 | 100.0 |
| | Total | 100 | 99.0 | 100.0 | |
| Missing | System | 1 | 1.0 | | |
| Total | | 101 | 100.0 | | |

Table 5.12: The questionnaire indicates that 93.1% of the people who participated in the questionnaire desire to search online for sustainability issues.

**Table 5.13:** Do You Watch Environmental Shows On Tv?

| | Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | Yes | 96 | 95.0 | 96.0 | 96.0 |
| | No | 4 | 4.0 | 4.0 | 100.0 |
| | Total | 100 | 99.0 | 100.0 | |
| Missing | System | 1 | 1.0 | | |
| Total | | 101 | 100.0 | | |

Table 5.13: 95% of the people who participated in the questionnaire watch TV programs related to the environment and its problems, indicating the importance of the media in combating environmental issues and developing these problems.

**Table 5.14:** Do You Any Subscription To The Journal, Magazine, Scientific Research Websites Etc., Related To Sustainability?

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Yes | 37 | 36.6 | 36.6 | 36.6 |
| No | 64 | 63.4 | 63.4 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

Table 5.14: 36.6% of the questionnaire respondents have subscriptions to magazines or websites related to sustainability. As we said earlier, this is an indication of the increased awareness of the importance of sustainability.

**Table 5.15:** Are You Ready To Isolate And Sort Your Household Waste For Recycling?

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Yes | 100 | 99.0 | 99.0 | 99.0 |
| Maybe | 1 | 1.0 | 1.0 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

Table 5.15: 99% of the people participating in the questionnaire expressed their willingness to isolate their household waste, and this is a good indicator for the implementation of sustainability in countries, which contributes to improving the environment.

**Table 5.16:** Are You Willing To Participate In Volunteer Work To Improve Your Area Environment

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Yes | 97 | 96.0 | 96.0 | 96.0 |
| No | 3 | 3.0 | 3.0 | 99.0 |
| Maybe | 1 | 1.0 | 1.0 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

Table 5.16: 96% of people expressed their willingness to volunteer to develop the environment in their areas.

**Table 5.17:** How Do You Rate Your Knowledge And Skills In Building Information Modelling (BIM)

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Very Good | 2 | 2.0 | 2.0 | 2.0 |
| Good | 31 | 30.7 | 30.7 | 32.7 |
| Little | 67 | 66.3 | 66.3 | 99.0 |
| Dont Know | 1 | 1.0 | 1.0 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

Table 5.17: This table shows that 66% of engineers have little knowledge of Building Information Modeling, which indicates that this is something new for the engineers participating in the survey.

**Table 5.18:** Have You Used BIM On Any Projects You Have Worked On?

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Yes | 50 | 49.5 | 49.5 | 49.5 |
| No | 51 | 50.5 | 50.5 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

Table 5.18: This table shows that the percentage of using building information modelling in the projects that the participants in this questionnaire work on were 49%, which indicates the lack of sufficient awareness of the importance of building information modelling in projects.

**Table 5.19:** How Long Has Your Organization Been Using BIM?

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | 0-5 Years | 77 | 76.2 | 76.2 | 76.2 |
| | 5-10 Years | 22 | 21.8 | 21.8 | 98.0 |
| | 10-15 Years | 2 | 2.0 | 2.0 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

Table 5.19: 77% of the organizations that use BIM fall into the 0-5 year category, indicating that these organizations are newly enumerated in this system.

**Table 5.20:** Do You Want To Know More About BIM

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | Yes | 100 | 99.0 | 99.0 | 99.0 |
| | No | 1 | 1.0 | 1.0 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

Table 5.20: 99% of the survey participants want to know more information about BIM technology.

**Table 5.21:** On What Percentage (%) Of Projects Have You Used BIM In The Last Year?

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | 0-25 | 71 | 70.3 | 70.3 | 70.3 |
| | 25-50 | 15 | 14.9 | 14.9 | 85.1 |
| | 50-75 | 11 | 10.9 | 10.9 | 96.0 |
| | 75-100 | 4 | 4.0 | 4.0 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

Table 5.21: The percentage of 70.3% of the respondents indicated that the rate of their use of building information modelling ranges between 0-25%. This percentage is considered low compared to the civilized world, such as European countries and the United States.

**Table 5.22:** In Your Opinion, Is BIM The Future Of Project Information

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | Yes | 97 | 96.0 | 96.0 | 96.0 |
| | No | 2 | 2.0 | 2.0 | 98.0 |
| | Maybe | 2 | 2.0 | 2.0 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

Table 5.22: 96% of the survey respondents agreed that BIM is the future of project information.

**Table 5.23:** Is The Government In Your Country Interested In Implementing BIM In Projects

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | Yes | 44 | 43.6 | 43.6 | 43.6 |
| | No | 57 | 56.4 | 56.4 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

Table 5.23: 57% of the respondents said that their governments are not interested in implementing building information modelling technology, and this is normal, given that most of the respondents in the survey are from Arab countries, especially Iraq and Egypt.

**Table 5.24:** In Your Opinion Is BIM All About Time Collaboration

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Yes | 85 | 84.2 | 84.2 | 84.2 |
| No | 14 | 13.9 | 13.9 | 98.0 |
| Maybe | 2 | 2.0 | 2.0 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

Table 5.24: 85% of the participants agreed that building information modelling is concerned with time calibration. This percentage is wrong because building information modelling saves time and effort by fully displaying the model and knowing the errors before starting the construction process, which protects the cost and time and improves the building's quality will construct.

**Table 5.25:**In Your Opinion Is BIM All About Software

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | Yes | 71 | 70.3 | 70.3 | 70.3 |
| | No | 27 | 26.7 | 26.7 | 97.0 |
| | Maybe | 3 | 3.0 | 3.0 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

Table 5.25: 70.3% of the respondents answered yes on Building Information Modeling and its relevance to the software.

**Table 5.26:** Do You Work On BIM Or CAD Standards

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | BIM | 29 | 28.7 | 28.7 | 28.7 |
| | CAD | 72 | 71.3 | 71.3 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

TABLE 5.26: 71% of the survey participants work on two-dimensional CAD programs. Since building information modelling technology is modern and new in the Arab world, this is a natural percentage due to the engineers' ignorance of this technology and the extent of its benefits in construction.

**Table 5.27:** Are BIM Added Value For The Operation And Maintenance Stage

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | Yes | 98 | 97.0 | 97.0 | 97.0 |
| | Maybe | 3 | 3.0 | 3.0 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

98% of survey respondents praised the role and effectiveness of BIM in the maintenance and operation stage.

**Table 5.28:** Is BIM Suitable As Construction Project Management

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | Strongly Agree | 51 | 50.5 | 50.5 | 50.5 |
| | Agree | 48 | 47.5 | 47.5 | 98.0 |
| | Neutral | 2 | 2.0 | 2.0 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

Table 5.28: 50.5% of the survey respondents strongly agreed that BIM is beneficial in project management.

**Table 5.29:** What Is The Highest Level You Reached In The Application Of BIM Projects?

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | 2D | 48 | 47.5 | 47.5 | 47.5 |
| | 3D | 40 | 39.6 | 39.6 | 87.1 |
| | 4D | 1 | 1.0 | 1.0 | 88.1 |
| | 5D | 10 | 9.9 | 9.9 | 98.0 |
| | 6D and more | 2 | 2.0 | 2.0 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

Table 5.29: Most of the respondents in the questionnaire work on two-dimensional and three-dimensional models. The percentage of workers in the two-dimensional system was 47.5%, and the three-dimensional system 39.6%.

**Table 5.30:** In your opinion, Is Stronger BIM Behaviour Can Improve Sustainable Design?

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | Yes | 99 | 98.0 | 98.0 | 98.0 |
| | Maybe | 2 | 2.0 | 2.0 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

Table 5.30: 98% of the survey participants answered that the stronger the BIM system, the better the results of the sustainability development

**Table 5.31:** In Sustainable Building Design, Is BIM The Best Way To Design?

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | Yes | 95 | 94.1 | 94.1 | 94.1 |
| | No | 3 | 3.0 | 3.0 | 97.0 |
| | Maybe | 3 | 3.0 | 3.0 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

Table 5.31: 87.1% of the survey participants answered that BIM is the best sustainable design method.

**Table 5.32:** What Is The Importance of Using BIM In Sustainable Design

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| All The Above | 88 | 87.1 | 87.1 | 87.1 |
| Environmental Issue | 5 | 5.0 | 5.0 | 92.1 |
| Energy | 8 | 7.9 | 7.9 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

Table 5.32: 87.1% of the respondents answered that sustainability is concerned with environmental problems and all the energy and everything contributes to reusing materials again without harming the environment.

**Table 5.33:** In Your Opinion What The Most Critical Program In Sustainable Design Is

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Autodesk Green Building Studio | 63 | 62.4 | 62.4 | 62.4 |
| Autodesk Ecotect Analysis | 10 | 9.9 | 9.9 | 72.3 |
| Bentley Hevacomp | 8 | 7.9 | 7.9 | 80.2 |
| Ies Solutions Virtual | 18 | 17.8 | 17.8 | 98.0 |
| Environmental Ve-Pro | 2 | 2.0 | 2.0 | 100.0 |
| Other | | | | |
| Total | 101 | 100.0 | 100.0 | |

Table 5.33: 62.4% of the respondents answered that it is a GREEN BUILDING STUDIO program. It is the most popular and widely used program in the design of sustainable buildings.

**Table 5.34:** What Your Perception And Understanding Of BIM And Sustainability

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| BIM Is added value for | 54 | 53.5 | 53.5 | 53.5 |
| sustainable design | 32 | 31.7 | 31.7 | 85.1 |
| BIM is a way of implementing | 15 | 14.9 | 14.9 | 100.0 |
| sustainable design | | | | |
| BIM perfectly focuses on | 101 | 100.0 | 100.0 | |
| sustainable design | | | | |
| Total | | | | |

Table 5.34: 53.5% of the survey participants answered that BIM is added value for sustainable design.

**Table 5.35:** What Is The Rule Of BIM In Designing Smart Building (Green Building)

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| All The Above | 90 | 89.1 | 89.1 | 89.1 |
| Making Simulations For Energy | 5 | 5.0 | 5.0 | 94.1 |
| And Day-Light | 3 | 3.0 | 3.0 | 97.0 |
| Reduce Pollution | 3 | 3.0 | 3.0 | 100.0 |
| Resources Conservation | | | | |
| Total | 101 | 100.0 | 100.0 | |

Table 5.35: 89.1% of survey respondents answered that BIM represents making simulations for energy and daylight. Reduce pollution resources conservation. Thus, building information modelling simulates the actual building reality, not 100%, but is closer to reality. It is possible to see the building in detail before starting the actual construction.

**Table 5.36:** IF Used BIM In The Sustainable Structure; Could It Be Enough For Structure Buildings Knowledge Area?

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Yes | 96 | 95.0 | 95.0 | 95.0 |
| No | 3 | 3.0 | 3.0 | 98.0 |
| Maybe | 2 | 2.0 | 2.0 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

Table 5.36: 95% of survey respondents indicated that BIM represents and covers a large portion of the building knowledge area.

**Table 5.37:** What Is The Added Value of BIM For Facility Management

| **Valid** | **Frequency** | **%** | **Valid Percent** | **Cumulative Percent** |
|---|---|---|---|---|
| All The Above | 92 | 91.1 | 91.1 | 91.1 |
| Human Resources | 2 | 2.0 | 2.0 | 93.1 |
| Maintenance | 7 | 6.9 | 6.9 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

Table 5.37: 91% of the survey respondents indicated that building information modelling significantly reduces human resources and maintenance work after construction and the operational phase.

**Table 5.38:** Does BIM Reduce The Cost?

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | Yes | 97 | 96.0 | 96.0 | 96.0 |
| | No | 1 | 1.0 | 1.0 | 97.0 |
| | Maybe | 3 | 3.0 | 3.0 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

Table 5.38: 95% of the survey participants agreed that building information modelling reduces the cost needed for construction. This percentage is standard because building information modelling gives detailed information about the facility to be constructed

before starting construction and facilitates the detection of errors, thus saving time and money.

**Table 5.39:** Does BIM Works With Interior Design

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Yes | 89 | 88.1 | 88.1 | 88.1 |
| No | 6 | 5.9 | 5.9 | 94.1 |
| Maybe | 6 | 5.9 | 5.9 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

Table 5.39: 88% of the participants in the questionnaire agreed that modeling children's information is appropriate for interior design work

**Table 5.40**: Does BIM Suitable For A Complicated Project Like (Airport-Dams)

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | Yes | 97 | 96.0 | 96.0 | 96.0 |
| | Maybe | 4 | 4.0 | 4.0 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

Table 5.40: 96% of the survey participants agreed that building information modeling is suitable for large projects such as dams and airports because the model will be participatory and complete by all engineering cadres, including architects, mechanical and electrical engineers, and civil engineers, and that all the details will appear in the initial model, which leads to full knowledge of the project. And the fine details in it.

**Table 5.41:** Is It Possible For A Civil Engineer To Be A Designer?

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Yes | 95 | 94.1 | 94.1 | 94.1 |
| No | 2 | 2.0 | 2.0 | 96.0 |
| Maybe | 4 | 4.0 | 4.0 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

Table 5.41: 94% of the survey participants agreed that a civil engineer could be a designer for projects.

**Table 5.42:** In Your Opinion, What Steps Should The Civil Engineer Take To Become A Designer And Executor For His Work?

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Both Options Above | 100 | 99.0 | 99.0 | 99.0 |
| Gain More Experience In The Field | 1 | 1.0 | 1.0 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

Table 5.42: 99% of the survey participants agreed that a civil engineer could be a designer of projects through learning programs and sufficient practical experience.

### 5.6 Chi-Square Analysis

1- Q18 - Is the government in your country interested in implementing BIM in projects?. The relation between this question and the (age, specialization, experience, and duration of using BIM).

**Table 5.43:** Shows The Relation Between Governments Using BIM And The (Age, Specialization, Experience, And Duration of Using BIM)

| | Cases Valid | | Missing | | Total | |
|---|---|---|---|---|---|---|
| | N | Per cent | N | Per cent | N | Per cent |
| Q18 * What Is Your Work Specialization? | 101 | 100.0% | 0 | 0.0% | 101 | 100.0% |
| Q18 * How Many Years Of Experience Have You Had In Your Profession? | 101 | 100.0% | 0 | 0.0% | 101 | 100.0% |
| Q18 * What Is The Branch Of Sustainability More Critical To You? | 101 | 100.0% | 0 | 0.0% | 101 | 100.0% |
| Q18 * Do You Watch Environmental Shows On Tv? | 100 | 99.0% | 1 | 1.0% | 101 | 100.0% |
| Q18 * How Long Has Your Organization Been Using BIM? | 101 | 100.0% | 0 | 0.0% | 101 | 100.0% |
| Q18 * How Old Are You? | 101 | 100.0% | 0 | 0.0% | 101 | 100.0% |

1-1 Specialization

**Table 5.44:** Shows The Relation Between Governments Using BIM And Specialization

| Crosstab Count | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | **What is your work specialization?** | | | | | |
| | | **Civil Engineer** | **Electrical engineer** | **Environmental engineer** | **Structural engineer** | **Other** | **Total** |
| Q18 | Yes | 24 | 0 | 3 | 1 | 16 | 44 |
| | No | 27 | 1 | 0 | 1 | 28 | 57 |
| Total | | 51 | 1 | 3 | 2 | 44 | 101 |

a-Six cells (60.0%) have an expected count of less than 5. The minimum expected count is .44.

1-2 Age

Is the government in your country interested in implementing BIM in projects * How old are you?

**Table 5.45:** Shows The Relation Between Governments Using BIM And Age

| **Chi-Square Tests** | | | |
|---|---|---|---|
| | Value | df | Asymp. Sig. (2-sided) |
| Pearson Chi-Square | 2.036[a] | 4 | .729 |
| Likelihood Ratio | 2.402 | 4 | .662 |
| Linear-by-Linear Association | .021 | 1 | .884 |
| N of Valid Cases | 101 | | |

a. Two cells (20.0%) have an expected count of less than 5. The minimum expected count is .44.

1-3 TV and medial social effect

Is the government in your country interested in implementing BIM in projects * Do you watch environmental shows on tv?

**Table 5.46:** Shows The Relation Between Governments Using BIM And Medial Social Effect

| **Chi-Square Tests** | | | | | |
|---|---|---|---|---|---|
| | Value | df | Asymp. Sig. (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
| Pearson Chi-Square | 3.143[a] | 1 | .076 | | |
| Continuity Correction[b] | 1.581 | 1 | .209 | | |
| Likelihood Ratio | 4.622 | 1 | .032 | | |
| Fisher's Exact Test | | | | .132 | .101 |
| Linear-by-Linear Association | 3.112 | 1 | .078 | | |
| N of Valid Cases | 100 | | | | |

a. Two cells (50.0%) have an expected count of less than 5. The minimum expected count is 1.72.

b. Computed only for a 2x2 table

1-4 Effect of using BIM by the organization

Is the government in your country interested in implementing BIM in projects * How long has your organization been using BIM?

| **Chi-Square Tests** | | | |
|---|---|---|---|
| | **Value** | **df** | **Asymp. Sig. (2-sided)** |
| **Pearson Chi-Square** | **4.730[a]** | **2** | **.094** |
| Likelihood Ratio | 4.716 | 2 | .095 |
| Linear-by-Linear Association | 3.774 | 1 | .052 |
| N of Valid Cases | 101 | | |

a.two cells (33.3%) have an expected count of less than 5. the minimum expected count is .87.

1- The relation between the sample opinion about BIM (Q21) with (age, specialization, experience, and duration of using BIM)

2-1 age effect (In your opinion, is BIM all about software * How old are you ?)

**Table 5.47:** Shows The Relation Between BIM and Age

**Crosstab**
**Count**

| | | How old are you? | | | | | |
|---|---|---|---|---|---|---|---|
| | | **20-25** | **25-30** | **30-35** | **35-40** | **40-45** | **Total** |
| Q21 | Yes | 1 | 6 | 9 | 41 | 14 | 71 |
| | No | 0 | 4 | 8 | 11 | 4 | 27 |
| | Maybe | 0 | 2 | 0 | 1 | 0 | 3 |
| Total | | 1 | 12 | 17 | 53 | 18 | 101 |

**Chi-Square Tests**

| | **Value** | **df** | **Asymp. Sig. (2-sided)** |
|---|---|---|---|
| Pearson Chi-Square | 14.870[a] | 8 | .062 |
| Likelihood Ratio | 11.951 | 8 | .153 |
| Linear-by-Linear Association | 5.499 | 1 | .019 |
| N of Valid Cases | 101 | | |

a. Ten cells (66.7%) have an expected count of less than 5. The minimum expected count is .03.

b. 2-2 specialization effect (In your opinion, is BIM all about software * What is your work specialization?)

**Table 5.48:** Shows The Relation Between BIM And Specialization

**Crosstab**
**Count**

| | | What is your work specialization? | | | | | |
|---|---|---|---|---|---|---|---|
| | | **Civil Engineer** | **Electrical engineer** | **Environmental engineer** | **Structural engineer** | **Other** | Total |
| Q21 | Yes | 33 | 0 | 1 | 0 | 37 | 71 |
| | No | 17 | 0 | 2 | 1 | 7 | 27 |
| | Maybe | 1 | 1 | 0 | 1 | 0 | 3 |
| Total | | 51 | 1 | 3 | 2 | 44 | 101 |

**Chi-Square Tests**

| | **Value** | **df** | **Asymp. Sig. (2-sided)** |
|---|---|---|---|
| Pearson Chi-Square | 57.491[a] | 8 | .000 |
| Likelihood Ratio | 23.290 | 8 | .003 |
| Linear-by-Linear Association | 3.268 | 1 | .071 |
| N of Valid Cases | 101 | | |

a. Eleven cells (73.3%) have an expected count of less than 5. The minimum expected count is .03.

2-3 experience effect (In your opinion, is BIM all about software * How many years of experience have you had in your profession?)

**Table 5.49:** Shows The Relation Between BIM And Experience

**Crosstab**
**Count**

| | | How many years of experience have you had in your profession? | | | | |
|---|---|---|---|---|---|---|
| | | **0-5 years** | **5-10 years** | **10-15 years** | **15 - above years** | **Total** |
| Q21 | Yes | 9 | 24 | 28 | 10 | 71 |
| | No | 3 | 12 | 11 | 1 | 27 |
| | Maybe | 1 | 2 | 0 | 0 | 3 |
| Total | | 13 | 38 | 39 | 11 | 101 |

**Chi-Square Tests**

| | **Value** | **df** | **Asymp. Sig. (2-sided)** |
|---|---|---|---|
| Pearson Chi-Square | 5.800[a] | 6 | .446 |
| Likelihood Ratio | 7.238 | 6 | .299 |
| Linear-by-Linear Association | 2.858 | 1 | .091 |
| N of Valid Cases | 101 | | |

a. Six cells (50.0%) have an expected count of less than 5. The minimum expected count is .33.

2-4 social media effect (In your opinion, is BIM all about software * Do you watch environmental shows on tv?)

**Table 5.50:** Shows The Relation Between BIM And Media

**Crosstab**
**Count**

| | | Do you watch environmental shows on tv? | | |
|---|---|---|---|---|
| | | yes | no | Total |
| Q21 | Yes | 69 | 1 | 70 |
| | No | 27 | 0 | 27 |
| | Maybe | 0 | 3 | 3 |
| Total | | 96 | 4 | 100 |

**Chi-Square Tests**

| | **Value** | **df** | **Asymp. Sig. (2-sided)** |
|---|---|---|---|
| Pearson Chi-Square | 74.330[a] | 2 | .000 |
| Likelihood Ratio | 23.106 | 2 | .000 |
| Linear-by-Linear Association | 20.088 | 1 | .000 |
| N of Valid Cases | 100 | | |

a. Four cells (66.7%) have an expected count of less than 5. The minimum expected count is .12.

2-5 BIM using duration (In your opinion, is BIM all about software * How long has your organization been using BIM?)

**Table 5.51:** Shows The Relation Between BIM Using Duration and the Organization Using BIM

**Crosstab**

Count

| | | **How long has your organization been using BIM?** | | | |
|---|---|---|---|---|---|
| | | **0-5 years** | **5-10 years** | **10-15 years** | **Total** |
| Q21 | Yes | 53 | 16 | 2 | 71 |
| | No | 21 | 6 | 0 | 27 |
| | Maybe | 3 | 0 | 0 | 3 |
| Total | | 77 | 22 | 2 | 101 |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 1.774[a] | 4 | .777 |
| Likelihood Ratio | 2.972 | 4 | .563 |
| Linear-by-Linear Association | .947 | 1 | .331 |
| N of Valid Cases | 101 | | |

a. Five cells (55.6%) have an expected count of less than 5. The minimum expected count is .06.

3-Is BIM suitable for construction project management (Q24)?

3-1 Relation between sample age and answer

**Table 5.52:** Shows the Relation Between BIM As A Management System and the Age

| | | **How old are you?** | | | | | |
|---|---|---|---|---|---|---|---|
| | | **20-25** | **25-30** | **30-35** | **35-40** | **40-45** | **Total** |
| Q24 | Strongly Agree | 1 | 6 | 8 | 30 | 6 | 51 |
| | Agree | 0 | 5 | 9 | 23 | 11 | 48 |
| | Neutral | 0 | 1 | 0 | 0 | 1 | 2 |
| Total | | 1 | 12 | 17 | 53 | 18 | 101 |

| Chi-Square Tests | | | |
|---|---|---|---|
| | Value | df | Asymp. Sig. (2-sided) |
| Pearson Chi-Square | 8.537[a] | 8 | .383 |
| Likelihood Ratio | 8.905 | 8 | .350 |
| Linear-by-Linear Association | .460 | 1 | .498 |
| N of Valid Cases | 101 | | |

a. Seven cells (46.7%) have an expected count of less than 5. The minimum expected count is .02.

3-2 specialization effect

Is BIM suitable for construction project management * What is your work specialization?

**Table 5.53:** Shows the Relation Between BIM As A Management System and Specialization

| | | What is your work specialization? | | | | | |
|---|---|---|---|---|---|---|---|
| | | Civil Engineer | Electrical Engineer | Environmental Engineer | Structural Engineer | Other | Total |
| Q23 | Strongly Agree | 38 | 0 | 2 | 1 | 10 | 51 |
| | Agree | 12 | 1 | 1 | 1 | 33 | 48 |
| | Neutral | 1 | 0 | 0 | 0 | 1 | 2 |
| Total | | 51 | 1 | 3 | 2 | 44 | 101 |

| Chi-Square Tests | | | |
|---|---|---|---|
| | Value | df | Asymp. Sig. (2-sided) |
| Pearson Chi-Square | 27.219[a] | 8 | .001 |
| Likelihood Ratio | 29.069 | 8 | .000 |
| Linear-by-Linear Association | 21.274 | 1 | .000 |
| N of Valid Cases | 101 | | |

a. Eleven cells (73.3%) have an expected count of less than 5. The minimum expected count is .02.

3-3 experience effect

Is BIM suitable for construction project management * How many years of experience have you had in your profession?

**Crosstab**
**Count**

| | | How many years of experience have you had in your profession? | | | | |
|---|---|---|---|---|---|---|
| | | 0-5 years | 5-10 years | 10-15 years | 15 - above years | Total |
| Q23 | Strongly Agree | 5 | 21 | 22 | 3 | 51 |
| | Agree | 7 | 17 | 17 | 7 | 48 |
| | Neutral | 1 | 0 | 0 | 1 | 2 |
| Total | | 13 | 38 | 39 | 11 | 101 |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 9.364[a] | 6 | .154 |
| Likelihood Ratio | 8.849 | 6 | .182 |
| Linear-by-Linear Association | .077 | 1 | .781 |
| N of Valid Cases | 101 | | |

a. Four cells (33.3%) have an expected count of less than 5. The minimum expected count is .22.

3-4 TV and social media effect

Is BIM suitable for construction project management * Do you watch environmental shows on tv?

**Crosstab**
**Count**

| | | Do you watch environmental shows on tv? | | |
|---|---|---|---|---|
| | | Yes | No | Total |
| Q23 | Strongly Agree | 49 | 1 | 50 |
| | Agree | 46 | 2 | 48 |
| | Neutral | 1 | 1 | 2 |
| Total | | 96 | 4 | 100 |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 11.545[a] | 2 | .003 |
| Likelihood Ratio | 4.385 | 2 | .112 |
| Linear-by-Linear Association | 3.282 | 1 | .070 |
| N of Valid Cases | 100 | | |

a.Four cells (66.7%) have an expected count of less than 5. The minimum expected count is .08.

# 6. CONCLUSION AND FUTURE RESEARCH

## 6.1 Conclusion

An environmentally conscious approach to architecture is referred to as sustainable design. Promoting long-term financial, civil, and environmental, and business gains Output is intricately linked to sustainable growth as you understand that it has critical social and environmental impacts on our lives. In the wake of growing environmental consciousness, construction professionals worldwide are becoming conscious of it. Building environmentally responsible practices have been urged to aid in economic growth, even though it reduces the impact on the ecosystem. Three main ideas arise that assist in success, resource productivity, cost-effectiveness, and position importance for human employees: resource savings, organizational efficiency, and project structure. As a part of this study, over 80% of contractors, project developers, employers, and engineers learned about using BIM kits to use quicker and cheaper projects.

The primary goal of a project manager is to complete the project on schedule and under budget. While mission managers are under the impression that BIM does not offer advantages in the creation task, they typically overlook the benefits of BIM in other tasks. The boss of the enterprise ought to make choices when on the job. When BIM is used, choices should be easy to test. The project manager will make better choices with data collected using standard tools because BIM lends more reliability. Building information models can allow partners to understand better the project's goals and objectives, which can assist in meeting the client's needs. BIM is one of the great benefits for loved ones with challenges; it makes dealing with difficulty even easier.

During the planning the project management process, the project manager will track how many paintings have been produced using the design background model, making it easy for the venture boss to measure success and check the project timeline and predict value. By automating the task, you increase the overall quality of the manipulation. According to the interviewed people, better building information may

result in improved management during the development stage. The benefits of BIM go well beyond the function of the project manager; they permeate into any aspect of the project. It does deliver the job smoothly is not affected explicitly by BIM.

When the enterprise is good, all owners can share the increased wealth, not just the boss. Additional concerns have been attributed to BIM like time and money-wasting conduct, legal problems with the versioning of BIM, and team damage to teamwork due to the complexity of implementation, the complexities of execution, and missing details because of lost context. Although the main focus was the representation of private thoughts and ideas, the essence of BIM was creative. People have to be convinced of the advantages of BIM if they use it. It also came to light that another initiative was BIM implementation and teaching people how to deal effectively with it. Using a design model project to spread non-company messages is key to improving and developing BIM. To bring on BIM's advantages, a set of circumstances must exist. The research study has discovered a project manager's role in BIM initiatives and is given below.

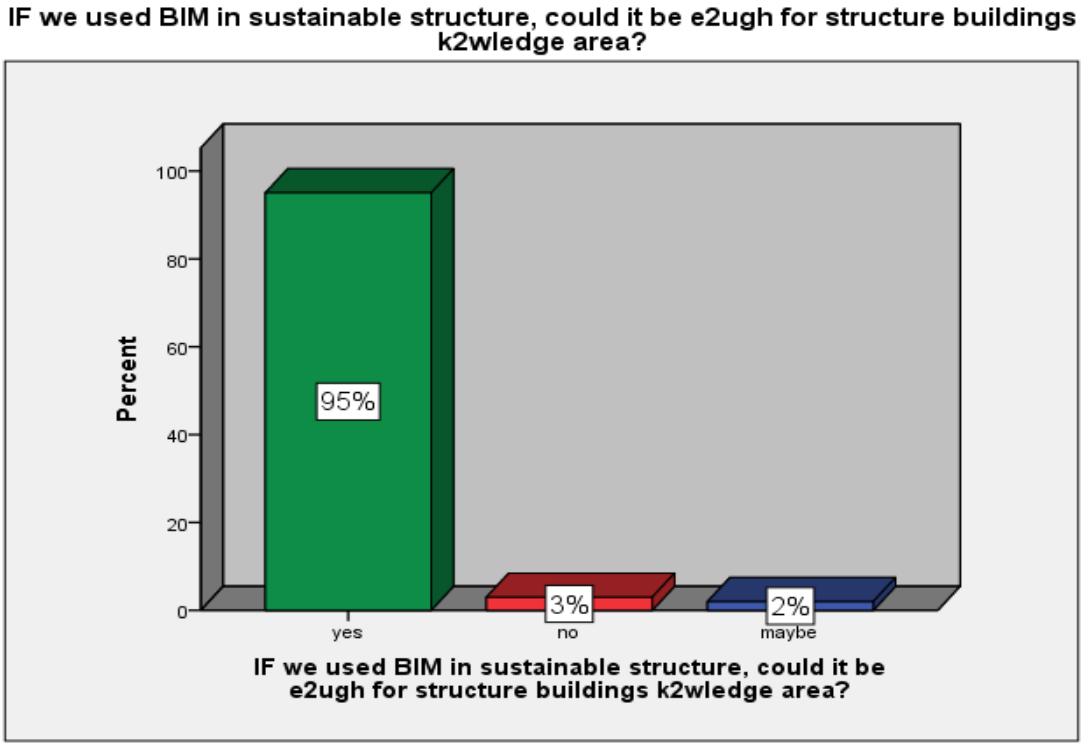


**Figure 6.1:** BIM And Structure Building Knowledge Area According To The Questionnaire

The majority of the survey respondents concluded that the use of building models enhances construction awareness. This research reveals that BIM has a broader

purpose than its architectural features. He writes that it should be the project manager's responsibility to direct BIM management in implementing complex IT systems and protocols. Because of this initiative, the benefits of BIM have finally been discovered. Assessment of Autodesk Green Building Information Modelling (GBS) showed 3D, 4D, and model-based scheduling. BIM/IT is beginning to be taken for granted in business creation. Since the need for seamless collaboration is on-the-the-the-go is-demand will eventually grow, BIM resources will ultimately be much more accessible and more functional. Generation and invention go hand in hand with the preservation of the building sector. In conclusion, BIM is increasingly in use.

As we mentioned previously, a questionnaire was conducted in this thesis to test the hypotheses that were mentioned in the first chapter, where the results obtained from the questionnaire supported the hypotheses that the researcher imposed and as shown in the table below and the graph.

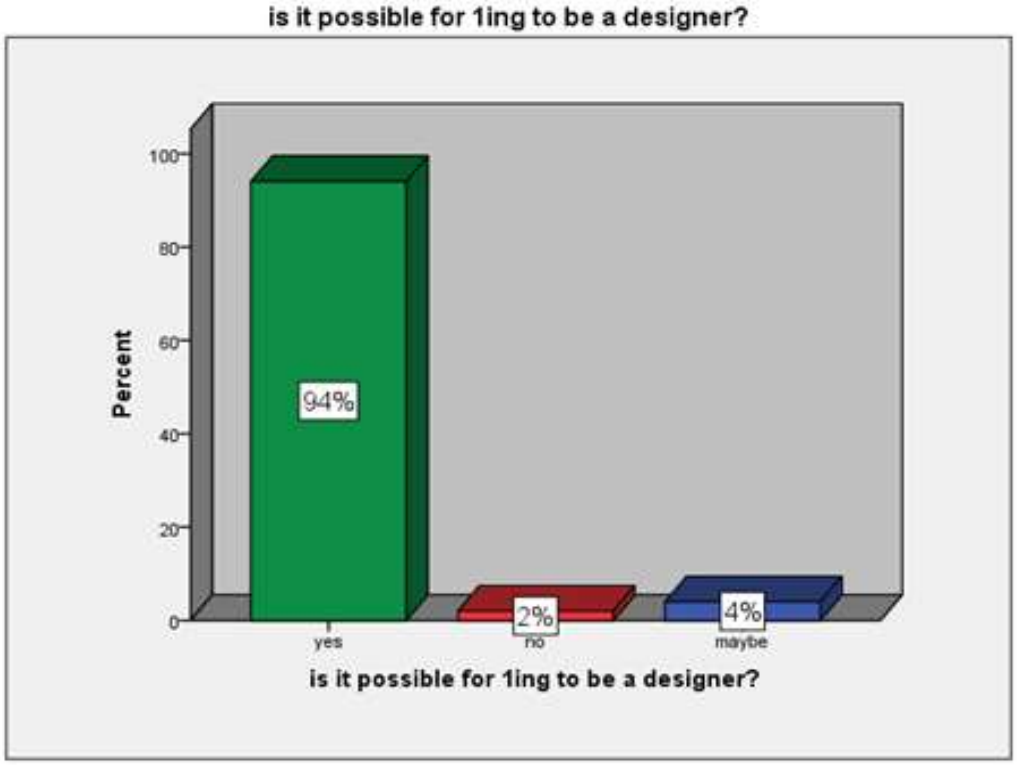


**Figure 6.2:** Is it Possible For Civil Engineers To Be Designer According To The Questionnaire.

**Table 6.1:** Is It Possible For A Civil Engineer To Be A Designer?

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Yes | 95 | 94.1 | 94.1 | 94.1 |
| No | 2 | 2.0 | 2.0 | 96.0 |
| Maybe | 4 | 4.0 | 4.0 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

Table 6.1: is it possible for civil engineers to be designer according to the questionnaire.

Regarding the second hypothesis, which concerns the relationship of building information modeling with sustainability, the results showed that 53% of the people who participated in the questionnaire believed that building information modeling represented an added value for sustainable design. In comparison, 32% believed that building information modeling is a way to implement sustainability and 15% Of people thought BIM is fully compatible with sustainable design, as shown in the figure below and the accompanying table.

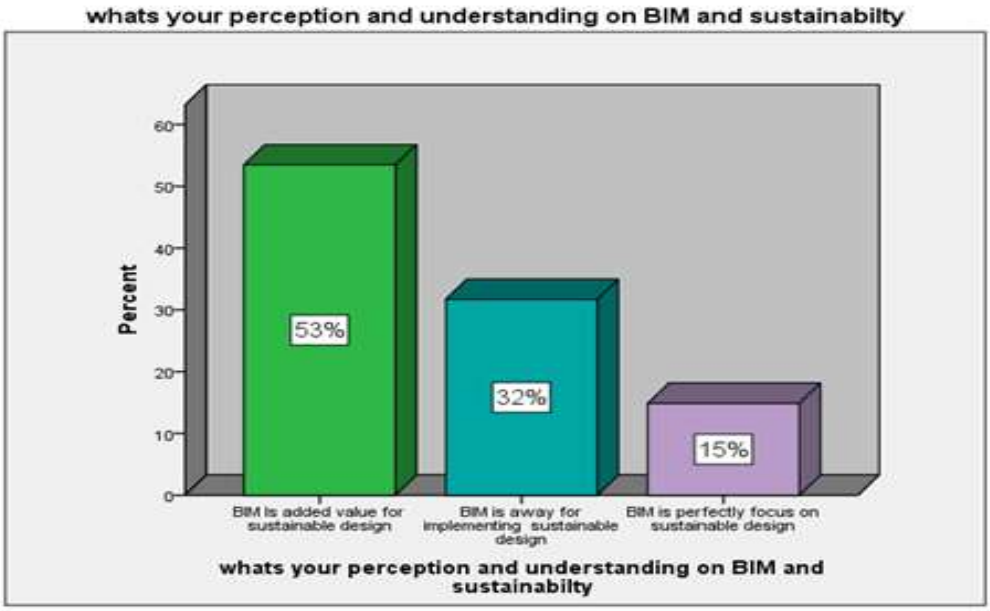


**Figure 6.3:** Relationship Between BIM And Sustainable Design According To The Questionnaire

**Table 6.2:** The Relationship Between BIM And Sustainable Design According To The Questionnaire

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| BIM Is added value for | 54 | 53.5 | 53.5 | 53.5 |
| sustainable design | 32 | 31.7 | 31.7 | 85.1 |
| BIM is a way of implementing | 15 | 14.9 | 14.9 | 100.0 |
| sustainable design | | | | |
| BIM perfectly focuses on | 101 | 100.0 | 100.0 | |
| sustainable design | | | | |
| Total | | | | |

The relationship between sustainability and building information modeling was clarified through the questionnaire, as the results showed the clear relationship between 3D design and construction by shedding light on software that is concerned with energy and material consumption. An engineer learns it during his career to be able to design a building in a sustainable manner to conserve energy, water sources, and materials used to save resources for future generations.

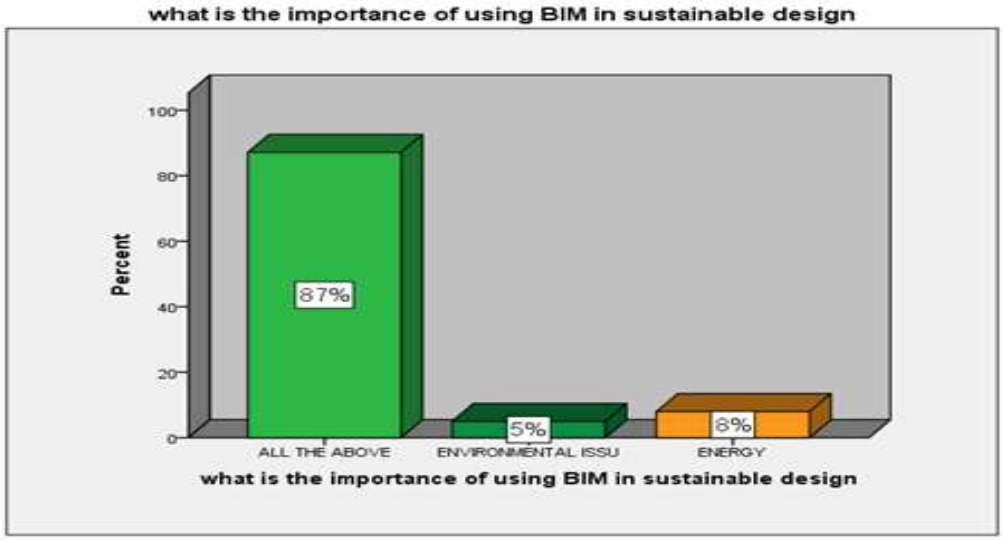


**Figure 6.4:** The Importance Of Using BIM In Sustainable Design According To The Questionnaire.

**Table 6.3:** The Importance Of Using BIM In Sustainable Design According To The Questionnaire.

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| All The Above | 88 | 87.1 | 87.1 | 87.1 |
| Environmental Issue | 5 | 5.0 | 5.0 | 92.1 |
| Energy | 8 | 7.9 | 7.9 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

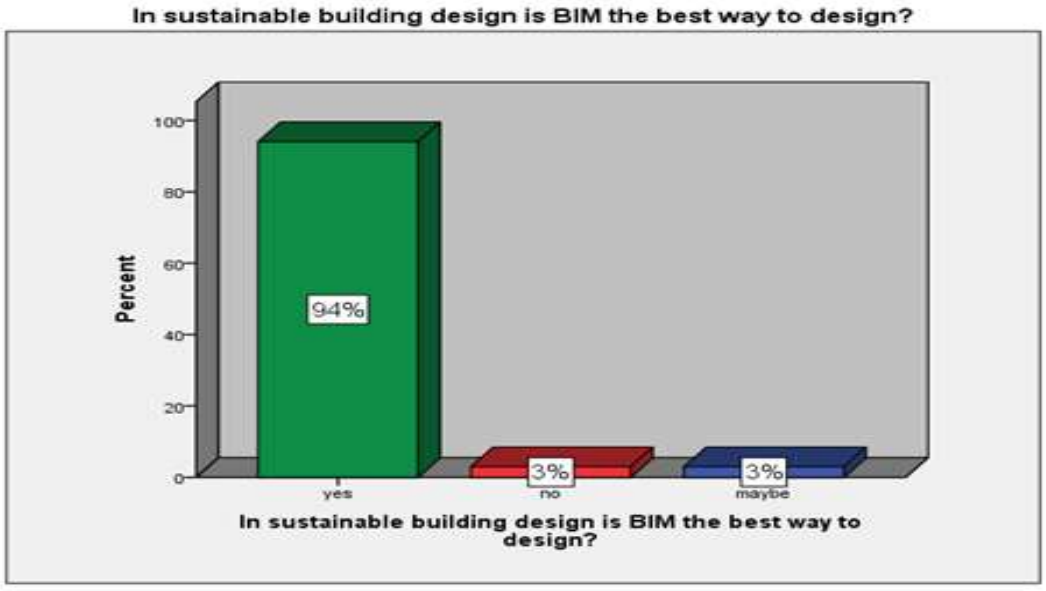


**Figure 6.5:** BIM Is The Best Way To Sustainable Design According To The Questionnaire

**Table 6.4:** BIM Is The Best Way To Sustainable Design According To The Questionnaire

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | Yes | 95 | 94.1 | 94.1 | 94.1 |
| | No | 3 | 3.0 | 3.0 | 97.0 |
| | Maybe | 3 | 3.0 | 3.0 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

Concerning engineering issues in general, the information modeling technology contributes significantly to the development of the three engineering elements (time, quality, and cost) by reducing the time before starting construction, as errors can be noticed before construction begins and necessary adjustments are made that reduce time and this, in turn, is reflected positively. For the benefit of work in general and

investors in particular, modeling of building information allows a complete view of the facility before starting work on the ground and as shown in the questionnaire results listed below.

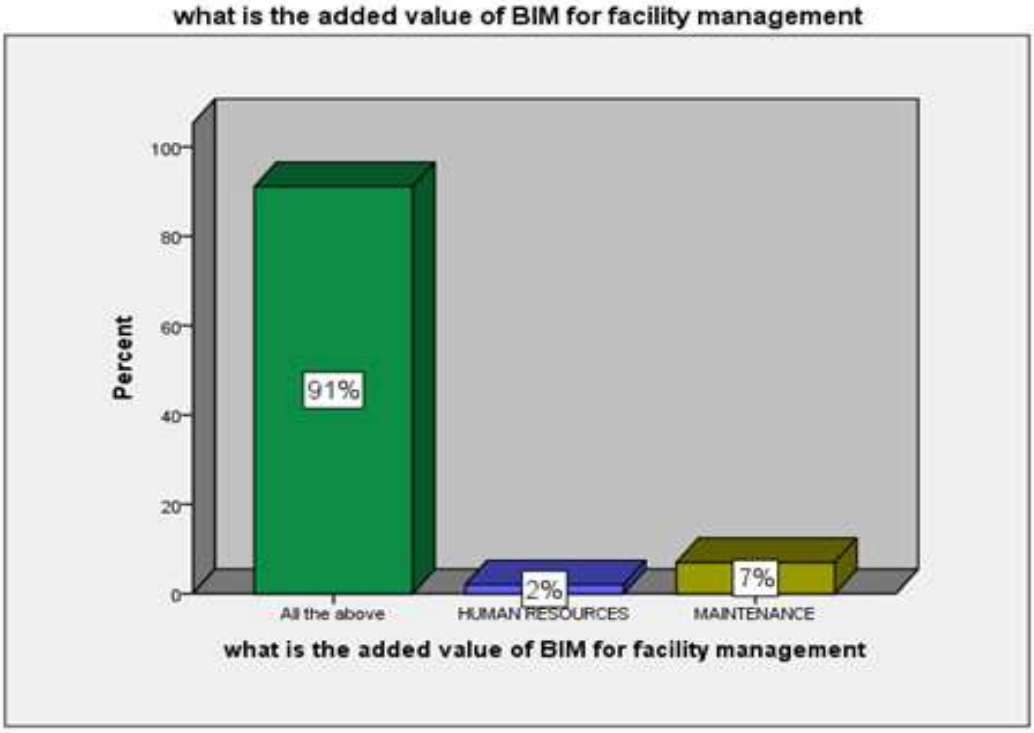


**Figure 6.6:** BIM Is Added Value According To The Questionnaire

**Table 6.5:** BIM Is Added Value According To The Questionnaire

| Valid | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| All The Above | 92 | 91.1 | 91.1 | 91.1 |
| Human Resources | 2 | 2.0 | 2.0 | 93.1 |
| Maintenance | 7 | 6.9 | 6.9 | 100.0 |
| Total | 101 | 100.0 | 100.0 | |

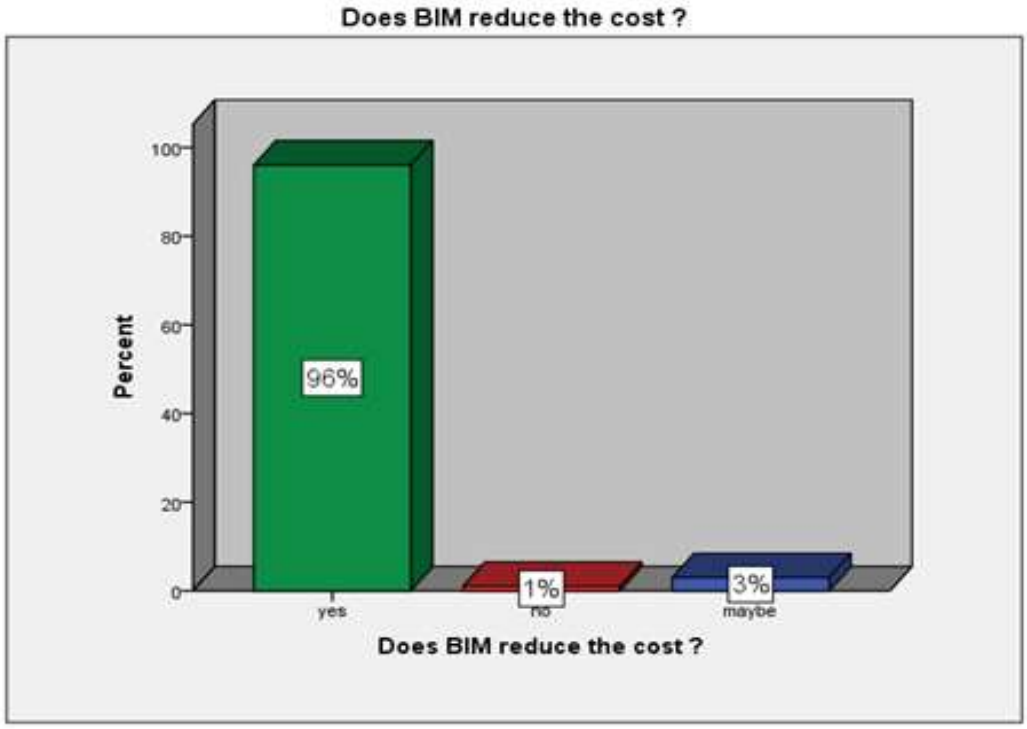


**Figure 6.7:** BIM Reduces The Cost According To The Questionnaire

**Table 6.6:** BIM Reduces The Cost According To The Questionnaire

| Valid | | Frequency | % | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| | Yes | 97 | 96.0 | 96.0 | 96.0 |
| | No | 1 | 1.0 | 1.0 | 97.0 |
| | Maybe | 3 | 3.0 | 3.0 | 100.0 |
| | Total | 101 | 100.0 | 100.0 | |

In the perspective of project management, a project manager has to apply to plan, organize, and prefabricate the details of the structure, and the construction enterprise uses parametric modeling. Preplanning and scheduling remove defects in the early phases of development. Delightful goods in managed environments with reduced costs, thus shortening construction time and increasing productivity, are part of the prefabrication. An error factor will quickly be eliminated using fast setup time and less product options and development stages in the building industry. Rising labor efficiency in the creation and production sectors is critical for narrowing the productivity gap between the two. Overcoming the business challenges using BIM is the only way to harness the synergies of Building Information Modelling. The result of this would be lower efficiency in the building industry, even in the long term. BIM is essential to the sector. The integration of BIM, like BIM preparation, building plans, and prefabrication, helps streamline the creative process. Overall, BIM promises time,

and money savings and commodity yields are positive. BIM different development hardware may be used to help develop BIM projects. An approach that is based on going from an analog-to-to-digital design to construction can be defined as BIM (Building Information Modeling.)

The models and task-based analysis may be merged with real-time databases. Often, tasks are rendered utilizing the unending flow of knowledge that passes through stakeholders, which includes different design disciplines, including engineers and ventures which have less related day-to-to-to-day activities. In day-to-to-day use, BIM is anticipated to be used by architects, builders, suppliers, and retailers. Five-and three-dimensional structures are well-organized since they facilitate all-encompassing organizing. Productions and pieces may be conceived and manufactured (Figure 6-1). Although images are easier to comprehend, there is a reduced cognitive load on the viewer when visualizing material or surface contact. Owners of appliances, plumbers, and heating, air conditioning, and fire alarm manufacturers each ought to build and engineer their systems in-house, but both of these must coordinate with each other.

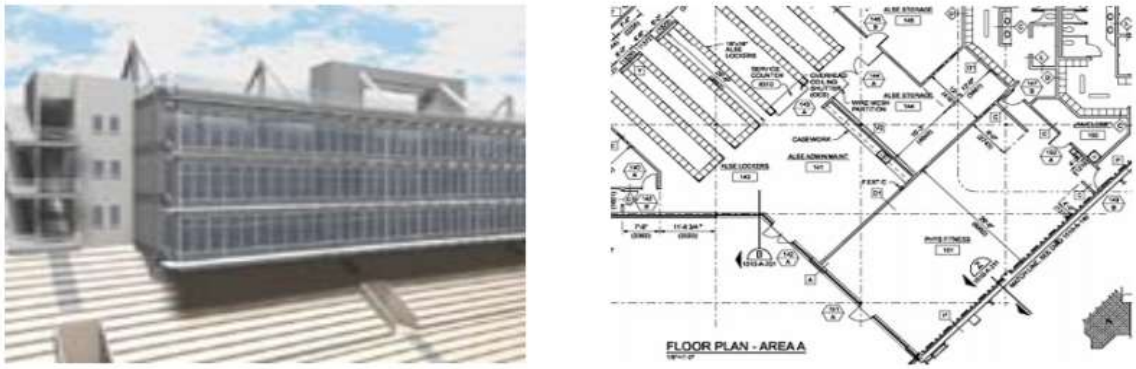


**Figure 6.8:** A 3D Polygon Model Plus A 2D-Based Collection Of Design Documents

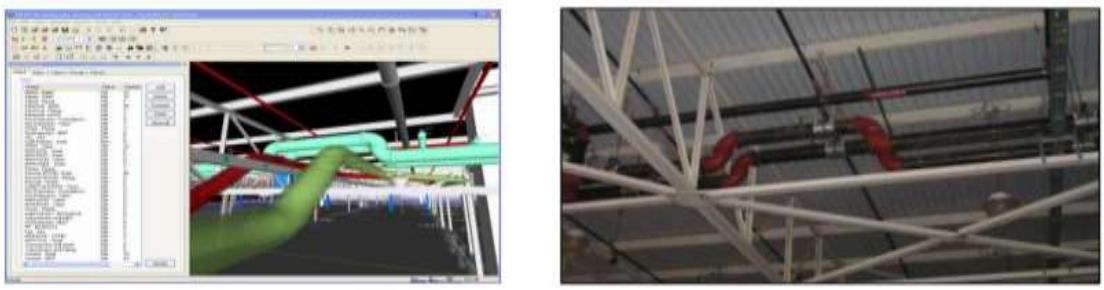

**Figure 6.9:** A Virtual Drawing And Set Of Construction/Installation Details.

In conclusion, Building Information Modeling (BIM) minimizes the possibility of clashes by enabling you to predict conflicts with design details before they occur

(Figure 6-8). We will design the models such that before production starts, then distribute the good positions for them to the hopeful models. A gauge of efficiency can provide you a precise estimate of how far you have progressed, so you can be certain that you are going in the right direction (Figure 6-9). The job estimation study shows that the construction software's standard tasks equal 50% of the time needed to complete and project but are 33% more efficient when taking into account delayed or need correction tasks and when reworks.

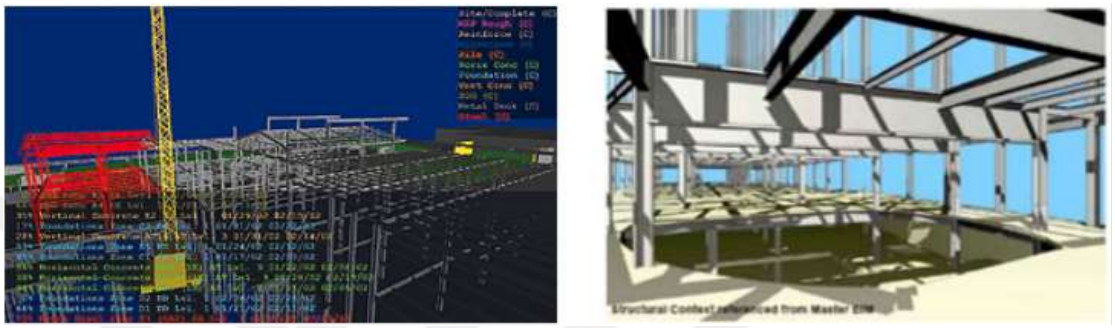

**Figure 6.10:** Compliance Installation Process and Necessary Equipment Measurement, Condition and Cost

According to the study, the Business BIM approach must be embraced in project management processes to work in the market. There are needs, such as being in accordance with the International Building Code. A BIM must classify codes in order to consider the location of areas and has to apply them to the processes of project management.

### 6.2 Future Research

With regard to future studies, there are some points that researchers in the future may study these points, including the wearhouse of sustainable materials because this topic is critical in terms of sustainable materials storage. After all, each building is unique, and the materials differ from one building to another. Surrounding us changes every day, especially the new Corona pandemic, so it is natural to think of sustainable buildings that fit these conditions and minimize the study's limitations.

- Reducing the lack of interoperability among the diverse disciplines involved constructing an undertaking using semantic interoperability and ontologies for records exchange during the building's life-cycle.

- Studies proposals may concentrate on the technical aspects of the facilities (i.e., equipment and process). Still, the overall aim is to encourage consumers to effectively engage and gather information for facility management purposes. Provide a comprehensive, correct, and easy-to-use manner for humans to view the potential profits in phrases of energy intake and environmental influences in their sustainable construction.
- The number of participants in the sample has severely limited due to this occurrence; To keep design expectations realistic, planners with differing views of the future must include them throughout the design process.

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## APPENDIX

### Appendix -A: Questionnaire

### Sustainability and BIM

Nihad Jarullah Abdullah

**Design and Construction of Sustainable Structure Buildings in Terms of Project Management.**

### SECTION 1:sustainability

Q1: What is your gender?
Q2: How old are you ?
Q3: What is your work specialization?
Q4: How many years of experience have you had in your profession?
Q5: Have you ever heard about sustainability? If now sustainability is "Sustainable development is a new pattern for development. Meet the present's needs without risking future generations' ability to fulfill according to their needs."
Q6: Have you ever heard about sustainable development?
Q7: Do you want to know more about sustainability?
Q8: What is the branch of sustainability more important to you?
Q9: Would you like to have more educational curricula related to sustainability and the environment?
Q10: Do you find that sustainability is a way to decrease poverty?
Q11: Do you have new ideas for solving environmental problems?
Q12: Do you have the desire to search on the internet about sustainability and sustainable development?
Q13: Do you watch environmental shows on tv?
Q14: Do you any subscription on the journal, magazine, or scientific research websites, etc. related to sustainability?
Q15: Are you ready to isolate and sort your household waste for recycling?
Q16: Are you willing to participate in volunteer work to improve your area environment?

**SECTION 2: BIM**

Q1:how do you rate your knowledge and skills in building information modeling (BIM)?
Q2: Have you used BIM on any projects you have worked on?
Q3: How long has your organization been using BIM?
Q4: do you want to know more about BIM?
Q5: On what percentage (%) of projects have you used BIM in the last year?
Q6: In your opinion, is BIM the future of project information?
Q7: is the government in your country interested in implementing BIM in projects?
Q8: In your opinion, is BIM all about time collaboration?
Q9: In your opinion is BIM all about software?
Q10: Do you work on CAD or BIM standards?
Q11: Are BIM added value for the operation and maintenance stage?
Q12: Is BIM suitable for construction project management?
Q13: What is the highest level you reached in the application of BIM projects?

**SECTION 3:BIM and Sustainability**

Q1: IS stronger BIM behavior can improve sustainable design?
Q2: In sustainable building design, is BIM the best way to design?
Q3: what is the importance of using BIM in sustainable design?
Q4: in your opinion, what is the most important program in sustainable design?
Q5: What is your perception and understanding on BIM and sustainability?
Q6: What is the rule of BIM in designing smart buildings (green buildings)?
Q7: IF we used BIM in sustainable structure, could it be enough for structure buildings knowledge area?
Q8: What is the added value of BIM for facility management?
Q9: Does BIM reduce the cost?
Q10: Does BIM works with interior design?
Q11: Does BIM suitable for a complicated project like( airport-dams)?
Q12: is it possible for civil engineering to be a designer?
Q13: In your opinion, what are the steps for the civil engineer that he should take in order to become a designer and executor for his work?

# Appendix- B: Questionaire Answers

**RESUME**

**Bachelor:** 2010, ALMustansiriyah University, Civil Engineering Department

**Master:** 2020 - 2021, Istanbul Gedik University Institute of Science and Art, Engineering Department, Engıneering Management Program

**PROFESSIONAL EXPERIENCE AND REWARDS**
**PUBLICATIONS/PRESENTATIONS ON THE THESIS**

- Nihad Abdullah, International Journal For Research In Business, Management And Accounting, Vol. 7 | No. 1 | Jan 2021, Building Information Modeling (BIM) as A Management system. Publication URL :https://gnpublication.org/index.php/bma/article/view1460/