# Studying the correlation between sustainability and adaptive reuse in existing buildings

## Governmental buildings adaption, Cairo, Egypt

A Thesis submitted in the Partial Fulfillment for the Requirement of the Degree of Master of Science in Integrated Urbanism and Sustainable Design

by **Yassmine Waheed Radwan**

**Supervised by**

Prof.Dr. Laila Khodeir
Professor of Project Management and Sustainable Development
Ain Shams University

Dr. Mohamed Ezz Al-Din
Assistant professor of architectural engineering
Ain Shams University

Prof. Dipl.-ing Matthew Rudolph
Professor of Building Technology and Climate Responsive Design
University of Stuttgart

**Signature**

**Examiners Committee**

Title, Name & Affiliation
Prof. (external examiner)
Professor of (...)
University of (...)

Prof. (Title/Name)
Professor of (...)
University of (...)

Prof. (Title/Name)
Professor of (...)
University of (...)

Prof. (Title/Name)
Professor of (...)
University of (...)

05/09/2022

Ain Shams University
Egypt

University of Stuttgart
Germany

# Disclaimer

This dissertation is submitted to Ain Shams University (ASU) and University of Stuttgart - Faculty of Architecture and Urban Planning (USTUTT) for the degree of Integrated Urbanism and Sustainable Design (IUSD), in accordance with IUSD-ASU regulations.

The work included in this thesis was carried out by the author during the period from March - September 2022.

The author confirms that the work submitted is her own and that appropriate credit has been given where reference has been made to the work of others. Any disputes regarding the copy right of the content is the sole responsibility of the author.

Ain Shams University holds the right to publicly distribute this thesis in the current university standard format. The author holds the right to publish the content in any other format.

15/09/2022

Yassmine Waheed Radwan

Signature



# Acknowledgment

First and foremost, I give thanks to God for the showers of blessings that enabled me to successfully complete my research work.

And then I would like to express my thanks to my patient and supportive lifetime monitor, Professor Dr. Mohamed Salheen, who has supported me throughout the whole master's study steps, as well as the life decisions that really helped me build my personality, knowledge, and career. I am extremely grateful to him.

Also, I would like to thank the following people who have helped me undertake this research: My supervisors, Professor Dr. Laila Khodeir, for her support on the topic. She has taught me the methodology to carry out the research. It was a great privilege and honor to work and study under her guidance. I am also extremely grateful to Dr. Mohamed Ezz Al-Din for what he has offered me in terms of enthusiasm for the research project, support, encouragement, and patience; and to present the research work as clearly as possible. I would also like to thank Prof. Dipl.-ing Matthew Rudolph for providing me with different international advices and experiences regarding the topic.

My heartfelt thanks to those members of my family. Ziad, my fiancée, is my all-time best friend and partner in everything. I couldn't have done it without you and your unconditional support. I consider myself fortunate to have shared every step with you, and I am looking forward to many more achievements together. My mother for her prayers and endless love. I am who I am today because of you and my father, I wish i made him proud.

A special thanks to the IUSD (Integrated Urbanism and Sustainable Design) program at Ain Shams University for giving me the opportunity to have this level of learning, academic and technical knowledge. As well as the lifetime experience i had from travelling abroad to Germany, as apart from the learning process and growing our personalities, I would particularly like to thank Engy Samir Helmy, IUSD coordinator, for her patience, support, and encouragement through this research work.

Finally, my thanks go to all the people who have supported me to complete the research work directly or indirectly.

# Abstract

Egypt witnesses a lot of interventions these days, whether it is upgrading existing cities or creating new ones. Dealing with an existing city is not that easy, especially Cairo. Different interventions we see nowadays in different aspects. After the government's planned to relocate the existing buildings functions to Egypt's New Administrative Capital, tens of governmental facilities valued at more than LE 700 billion will need a sustainable intervention. In addition to the location of those buildings are in the city center of Cairo. It's really a big challenge how we can deal with those buildings in the context of the existing city, especially they have historical and cultural values.

The aim of the research is to provide a framework that illustrates the correlational between the adaptation common sustainable aspects used and the international strategies for the adaptation of the existing buildings, and how we can deal with reusing those buildings in a sustainable way for the environment and a beneficial way for the city and the people. By applying a framework on Al-Tahrir complex building in the downtown of Cairo, to test to what extent the building is applicable to the sustainable reuse adaptation. The framework highlights most of the design elements that are consistent with the goals of sustainable adaptation design, including exterior, space, interior, and special building requirements, as well as the building performance that achieves energy efficiency.

The research is divided into three main parts. The first part illustrates the trends, methodologies, and gaps regarding the three main axis: sustainability in existing buildings; sustainable adaptive reuse; and adaptive reuse for existing buildings, following by introducing main concepts, theories, sustainable aspects, and strategies guidelines which achieve those aspects, as an introduction for the next part, which is the correlational framework. The framework illustrates the main relationships between architectural aspects and other aspects, as well as the strategies that achieve the architectural aspects, ending with an initial evaluation method as a result. To be completed for this part is the review of the international reference case for an understanding of how strategies can be applied on the ground. The third part is regarding the case study of the research, introducing building data, significance, and stakeholders. So, it shows how the old building can be used for sustainable adaptation with a proposed action plan, which can be used as a guide for future adaptation projects.

*Keywords*: Adaptive reuse of buildings; Adaptability; Sustainable adaptation; Building performance.

# Table of Contents

# List of Figures

# List of Tables

# Chapter 1: Introduction

## 1.1 Background

Regarding the adaptability of buildings, the building and construction industry faces significant obstacles from the perspective of the sustainable development. These challenges include a reduction in the cost of construction management, a decrease in the number of new constructions, the efficient use of resources, and the impact on the environment (United Nation, 2017).

As an alternative to demolition, building reuse offers reduced costs, maximum material reuse, and minimum resource usage. The extent to which sustainability can be achieved is inherently influenced by the viability of the target. And adaptive reuse, also known as the recycling of building function, became mainstream architectural parlance in the United States during the 1960s and 1970s due to a growing concern for the environment (Cantell, 2005:p.3), Especially ancient monuments, is encouraged through conservation, preservation and adaptation practices. The adaptive reuse of existing buildings is one of the most sustainable forms of sustainable architecture. Existing structures contain a large amount of embodied energy that should not be lost during demolition.

Considering this, (Lehman, 2012) suggests that there is a need for a better framework of solutions for effectively upgrading existing buildings stock, as well as a need to design new buildings with a focus on the low consumption of resources and materials, including the future reuse of building components and design for the adaptability.

## 1.2 Research contextualization

Every year, Cairo alone saw half a million new inhabitants in 2017, making it the fastest growing city in the world. Urban planning, infrastructure, and service delivery have not been able to keep up with the rapid urban growth experienced in Egypt. Among the various responses to the different challenges, Egypt is now at a stage of a development interaction to defeat the developing challenges. Strategies are held for several urban interventions carried out based on the region's characteristics and needs, which seek to generate solutions to increase productivity in cities.





We witness a lot of interventions these days, whether it is upgrading existing cities or creating new ones. Dealing with an existing city is not that easy, especially if it is a capital city like Cairo. Different interventions nowadays in different axis projects.

Among those projects is the relocating of governmental and administrative functions from the crowded capital center to the new administrative capital. There are a lot of buildings that will be relocated and have not had their original function yet. The best way to reactivate these buildings is to find a new function that fits the existing structure. In particular, they have high value because of their location or history. Adaptive reuse methods are a good answer to the demand for reactivation of these valuable buildings. It is considered as an act of finding a new use for an existing building could be a good solution to answer the question of how we can preserve our existing buildings and reuse them as an active urban space (Kenney, 1980). There is emphasis on the fact that reusing existing buildings is, in principle, a sustainable practice in itself; the number of resources needed for reuse being generally far less than those necessary for new construction (Plevoets, B., & Van Cleempoel, K., 2013). Following the transformation of cities reveals that each city can be considered as a living organism because of its ability to experience constant movement and transformation in time (Lakatos, 2015).

Working with existing buildings to repair and restore them for continued use has become increasingly important in contemporary architectural practice today. The reasons for this are multiple and include the contemporary world’s understanding of the need for sustainable development patterns; the current economic climate’s need for less costly physical architecture; All of this adds to the importance of what can be called "adaptive reuse." This term, although not fully established in the minds of people involved in the design and construction industries, is useful and is premised most obviously on changing the function of buildings as the needs of the economies and societies that originally gave them birth evolve (Brooker, G. and Stone, S., 2004).

## 1.3 Research scope

Based on the previous introduction regarding the topic and the situation in Egypt, the research tries to identify the correlation between sustainable adaption aspects and their strategies through a framework that can be applied to any case with regard to the changes according to the context. The first part of the research has a wider scope for introducing topics from the literature's point of view, identifying the trends for the world in the field and also identifying the missing gaps. Then, in the second part, which is about the sustainable aspects of adaptive reuse, the scope started to be narrowed. This was done to focus on the architectural aspect for two reasons. First, this is a research field, and second, when we talk about buildings and how they change, the architectural aspect is the most important, from which the other aspects can come in order. Based on the architectural aspects and their relationship with each other, adaptation strategies are

introduced for the building spaces and building performance. When it comes to changing function, space is the critical situation. Whether they will adapt or not, their flexibility, dimension, and even the finishing of it. So, the scope of research is related to the adaptability of spaces, whether they are exterior or interior, as they are an integrated one. In addition to the building performance, which has the second highest priority related to the adaption, how can the old building perform in a new technologically sustainable way?

### 1.3.1 Egyptian administration and the governmental building in Cairo

Relocation of building functions starts to be done after the first stage of the New Egyptian Administrative Capital has been finished in 2020. It is a new administrative capital that includes all the administration and governmental buildings for all the Egyptian official organizations. Those organizations occupy a lot of buildings in live areas in Egypt, such as the downtown of Cairo. Most of the organizations occupy important, highly valued buildings. So, after their relocation, more than 38 buildings will be empty, and the government is planning for their exploitation, investment, and reuse. So, research is needed for the future of the Egyptian building.

## 1.4 Research design

### 1.4.1 Research problem

***Problem identification***

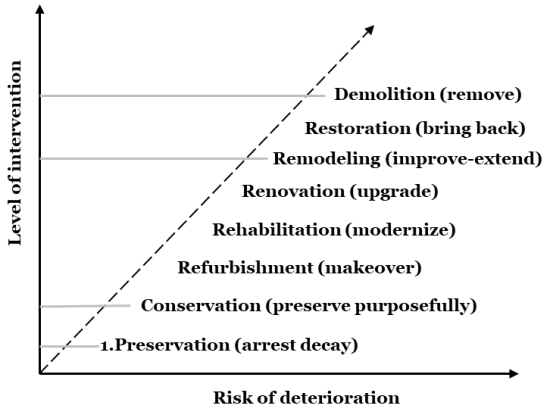
After the government finishes Egypt's New Administrative Capital, tens of governmental facilities valued at more than LE 700 billion will most likely become abandoned buildings in the following months. Most of Egypt's ministerial and government buildings are in the city centre.

The Assistant Minister of Housing added that the government buildings in the downtown area will be reused and restructured again after the ministries are transferred to the new administrative capital, as was done in the re-exploitation of the Tahrir Complex, such as hotel exploitation and some administrative and commercial offices, which worked to increase the value of the place. (Sada Al-Balad, 2022). Also, the greatest demand from investors is to invest in downtown areas after the relocating of the Ministries Square (Sada Al-Balad, 2022).

According to Kenney, adaptive reusing, defined as the act of finding a new use for an existing building, could be a good solution to answer the question of how we can preserve our existing buildings and reuse them as an active urban space (Kenney, 1980). Reusing buildings can help to create a more sustainable urban environment by reducing construction costs and time, and the less construction, the less material consumption, and the less pollution for the environment.








(Fig.1) - Range of intervention from building adaption. Source: (James Douglas, 2006)

However, according to James Douglas' range of intervention figure, the higher the level of intervention range for the building, the greater the risk of deterioration (Douglas 2006). So, in the case of remodelling, which is reuse and changing function completely, the higher the risk. According to that, dealing with the building must be done in a sustainable way, not just an economical perspective, to preserve the building as much as possible.

***Academic and technical relevance***

The research may pave the way for all types of sustainable adaption of buildings in Egypt and encourage the government to reuse and invest in abounding buildings also.

### 1.4.2 Research aim

Providing an adaption framework that considers reusing of spaces and retrofitting of service systems of relocated-function buildings through adaption strategies that achieve the sustainable aspects to avoid negative environmental impact and lead to a successful adaption process.

### 1.4.3 Research questions

***Main questions***

How adaptive buildings might accommodate sustainability and future adaptability while staying within the parameters of acceptable design standards and performance?

***Sub questions***

Q1. Which principles integrate concepts of sustainability into the adaption of existing buildings in a way that will enhance the built environment while preserving the nation’s cultural value?

Q2. Which design elements can be adapted to be consistent with the goals of sustainable design?

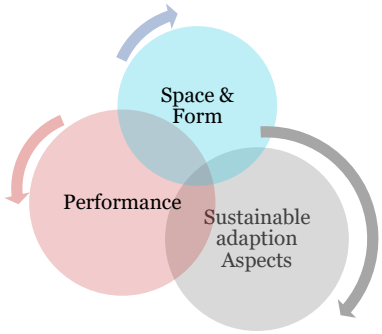
Q3. What are the appropriate strategies and tactics for sustainable adaption considering the existing building exterior and interior spaces?

Q4. How can the existing building's performance be enhanced for keeping up with the development of new technologies and Which systems has low impact on environment with high efficiency can be adapted?

Q5. In what way can new systems have implemented over the existing with low construction and cost?

### 1.4.4 Research objective

The purpose of the research is correlational for investigating the relationship between adaptive sustainable aspects and strategies regarding building spaces and performance, as well as the applicability of existing buildings to be adapted through an analytical and applied research process.



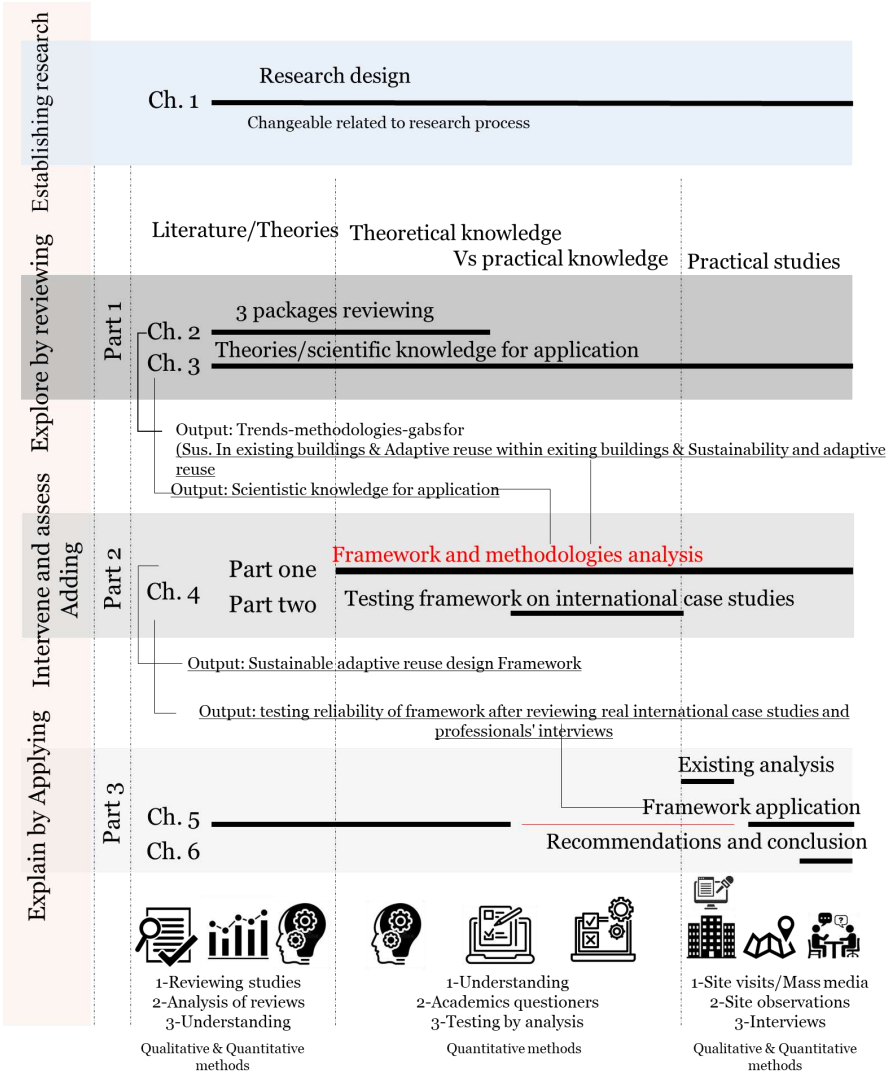

(Fig.2) - Main research scopes. Source: Author

### 1.4.5 Research structure

The research mainly consists of three main parts which are exploring by reviewing, intervening and assess adding and explain by applying. The three parts shifts between the combination of literature/ theories and practical studies. The first part includes chapter two and three. Reviewing literature to define gabs and trends is in chapter 2. Identifying theoretical concepts in chapter three. This part mainly uses analysis and understanding as a data collection methods.








(Fig.4) - Research structure. Source: Author

Chapter 2 acts mainly as a preparation step for Chapter 3, which is the framework of the thesis. Part 2 consists of one chapter which has two parts: the first part for settling the correlational between the sustainable aspects and adaption strategies with an evaluation method for testing the applicability of the building from the literature and theoretical knowledge. Then in

part two, we will review reference cases to identify how those strategies can be applied in the real world and how the adaption process can be implemented. Part 3, which is chapter 5, is testing the applicability of the building, which is the research case study to be sustainability adapted.

### 1.4.6 Research methodology

***Research instruments and data collection procedures***

The research study involved through three main stages, each of which used a mixed-mode approach (qualitative and quantitative). The first stages of the research mainly depend on the quantitative approach which the literature and the international guidelines, are analysed in an organised manner. The data are organised by topic and divided into main and sub themes. They are investigated, summarised, and a generalisation was concluded at the end. But in the other parts of the research using interviews method is the main. As the primary instrument for this study is the interview protocol guide, which contains questions identified to the research's themes and objectives. The interview method serves as a guide to direct the conversation towards the investigation of the study building data. Using three types of interviews, structured, semi structured, and open interviews. The in-depth interviews were recorded and analysed through analysing data and supported with secondary empirical material. These included site observations, archival data, and other documentation (e.g., drawings, plans, reports, press articles and websites).

***Selection of case study***

Listing all the building that the government planned to relocate its function to the new administrative capital, which are 38 building including ministries, governmental organizations, and embassies. Then mapping them to identify their location to the city and regarding to each other. Finally, The Tahrir Complex building in the downtown is selected among the 38 building more than one justification which are.

a) It will be a milestone in the country's real estate development, as it is the first project and the beginning of the road to creating a contractual and marketing framework for Egypt's heritage assets.

b) Adaption of the buildings in the downtown area will get benefit the targeted tourism and cultural activity

c) The Sovereign Fund succeeded, through the process of developing the Tahrir Complex, in attracting an investment alliance to enter the Egyptian market for the first time, which is the American alliance.

d) Tahrir comes for its historical and symbolic value to the Egyptian people, as it is the most famous government site in downtown Cairo in Tahrir Square.





e) The only building that has a clear government plan and started to work on as developing the building to be multi-use (hotel - commercial - administrative - cultural), and in harmony with the nature and development efforts undertaken by the state in the downtown area of the capital and Khedive Cairo.

***Participants and research sample***

Participants in the research are a rich source for data collection. The first one is the project's most important stakeholder, which is the owner. A structured interview is used with a few pointed questions asked for the sake of knowing the requirements and needs within the project and understanding governmental strategies towards these buildings. Second are participants involved in successfully completed Egyptian reuse projects in different typologies such as administration, hosting, residential and commercial. They are professional consultants responsible for key design decisions and have all been involved in successful adaptive reuse projects. These are experts in the field. Semi-structured interviews are used for the purpose of knowing how the adaptive reuse process goes and considerations within the Egyptian context, especially in the technical context of their past projects. The last unstructured interviews with the building director and workmen with the building work with the old method (governmental administration use) for more knowledge about building systems and data needed for the analysis as well as the opportunities and problems.

## 1.5 Unit of analysis and research variables

The unit of analysis is the central component of a study: the "what" or "whom" being analysed. Individuals, events, entities, decisions, programmes, the implementation process, or organisational change may serve as the units of analysis (Yin, 1994). The units of analysis of this research are the international standards and guidelines and the case study, which is Al-Tahrir complex features analysis. In addition to the different buildings to be studied, the different variables will be.

## 1.6 Ethical considerations

Before an interview can take place, the university must grant permission to the person's organization. Also, for the photos and site observation held through the building, as it now belongs to the government and not for public use. as well as recording the interview after his/her permission. In addition to the citations for all the sources and journal papers that are reviewed.

## 1.7 Internal validity

Using the triangulation method for the validity of data, as data collected from more than one source is likely to be accurate. For the first part of the research, after reviewing aspects and

general international strategies as theories and guidelines, they tested them on real-world cases that have been executed and ranked as successful adaptation projects. In addition to interviewing Egyptian consultants and architects to understand the local strategies and processes used.

### 1.8 External validity

The framework proposed through research is generated from reviewing international strategies and guidelines as mentioned in the literature review chapter, so it can be implemented in most cases, but each case has its own context and conditions that can be slightly changed in the framework.

### 1.9 Limitations of the research

There are limitations to the search that can be worked on as a future study. The first is the review of the literature with only one verified database journal which is Scooped indexed. The second one is regarding the case study, the difficulty in getting the new function design and the full detailed new proposal drawings for the case study, as it is an important building related to the government and data cannot be handled easily. As well as the detailed existing data and drawings for the building, because it is an old building.

# Chapter 2: Literature Review

## 2.1 Introduction

The purpose of this literature review is to investigate existing and relevant research studies for the three main fields, which are: (a) sustainability in existing buildings; (b) sustainability within adaptive reuse; and (c) adaptive reuse in existing buildings, to understand the situation for adapting sustainability in reusing existing buildings and building a framework for adaption of existing buildings. The review provides an overview of the most common trends in the three fields, different current objectives towards the topics, as well as the new and relevant methodologies used in the studies. The chapter also talks about gaps, disagreements, and debates that need to be understood and solved during the proposed study.

## 2.2 Theoretical and conceptual framework

According to Kumar (2005), it is vital to set parameters in connection to the primary themes and theories relevant to the investigation when reviewing literature. The theoretical framework starts by reviewing the most common trends related to the topic (sustainability in existing buildings) from SCOUPED indexed architectural journals, such as retrofitting, which is the domain trend among the different studies. Following by understanding how sustainability is addressed through existing buildings and which aspects are taken into consideration to build the study's proposed framework for applying sustainability in adapting existing buildings. Lastly, the literature on sustainability aspects and design futures is reviewed for adaptive reuse in existing building paradigms. The literature that was chosen to be looked at was able to cover the things that were chosen for this exploratory study.

The conceptual framework developed in this research study is based on an exploration of the relationship between sustainability and adaptive reuse in the refunction design direction. What are the principles of sustainable design and how can they be identified?

## 2.3 Sustainability within existing buildings

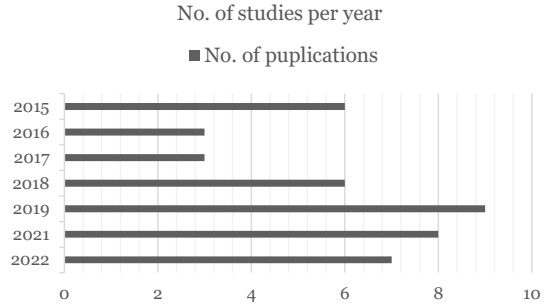
From a holistic sustainable overview, a lot of challenges face the building and the construction sector from the point of view of the adaptability concept. These challenges include





cost reduction, long-term impacts, and climate change adaptation. Existing buildings, especially those in need of facing those challenges related to sustainability, are in more urgent need of it. and how it can be updated in a sustainable way. Existing buildings, on the other hand, were not designed and built in accordance with green concepts and regulations because existing building codes did not include energy efficiency and climate change response standards (Ahmed et al., 2017).Recently, the world has become more aware that the industrial and technological revolutions are affecting the environment and human health over time, which has led to more research and studies regarding implementing more technology in healthier ways for the environment and humans also.

Part one of the review studies' primary goal is to elicit existing building transformation trends, objectives, and methodologies related to sustainable challenges. It answers the research question for the way of integrating concepts of sustainability into existing buildings in a way that will enhance the built environment while preserving its value, which is followed by studies, debates, and results. Fifty journal papers are reviewed from the Scopus database as it is reputably known for its depth and extensive exposure. The journals were reviewed from 2015 to the present because they contained data from the Paris Agreement for the Legally Binding International Treaty on Climate Change. Its goal is to limit global warming to well below 2 degrees, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. To achieve this long-term temperature goal, countries aim to reach global peaking of greenhouse gas emissions as soon as possible to achieve a climate neutral world by mid-century. To keep global warming to no more than 1.5°C, emissions need to be reduced by 45% by 2030 and reach net zero by 2050. Research of (Sustainability in existing buildings) key words was carried out to identify all related relevant publications. There are a lot of studies published in this period from 2015 to 2022 regarding the topic, but after screening the titles and abstracts, fifty-one publications meet the criteria and have been reviewed in more detail, which includes 15 research papers and 35 SCOPE-indexed journal articles.



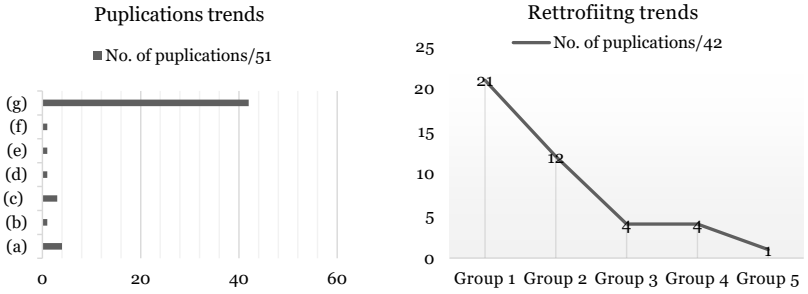

(Fig.5) - Number of package one publications per year. Source: Author

(Table 2-1) - Reviewing Scoped indexed journals. Source: Author

| | |
|---|---|
| Springer Link<br>Springer open | Research in Engineering Design - Theory, Applications, and Concurrent Engineering<br>International Journal of Environmental Science and Technology<br>Environmental Science and Pollution Research<br>The International Journal of Life Cycle Assessment<br>Int J Life Cycle Assess<br>Journal of Thermal Science<br>Environmental science Europe<br>Journal of Electrical Systems and Information Technology<br>Environment Systems and Decisions<br>Energy, sustainability and society<br>Energy efficiency<br>Clean Technologies and Environmental Policy<br>Journal of Building Pathology and Rehabilitation |
| ELSEVIER | Journal of Building Engineering<br>Design Studies<br>Frontiers of Architectural Research |
| MDPI | Buildings<br>Sustainability |
| emerald insight | Built Environment Project and Asset Management<br>Smart and Sustainable Built Environment |
| Oxford academic | International Journal of Low-Carbon Technologies |
| ASCE library | Journal of Architectural Engineering |
| Taylor, Francis online | Journal of Building Performance Simulation<br>Architectural Science Review<br>International Journal of Architectural Heritage |

### 2.3.1 Trends

Eight main world trends in sustainable existing buildings are conducted from reviewing the research papers and journal articles, which are (a) performance of existing buildings, (b) Retrofit or Rebuild, (c) Refurbishment of existing buildings, (d) Owner's perception towards greening existing buildings, (e) Adaptive reuse of heritage buildings, (f) Resilience, (g) Retrofitting of existing buildings as showed in figure 2.











(Fig.6) - Publications trends of sustainable existing buildings. Source: Author

(Fig.7) - Retrofitting of existing buildings trends. Source: Author.

Retrofitting of existing buildings which is Providing something with a component or not fitted during manufacture, it is often used in relation to the installation of new building systems related to the energy efficiency of the buildings (Brooker, G. and Stone, S., 2008) is the most issued topic related to the sustainability in existing buildings. Within retrofitting concept of existing building five groups of topic trends which are group 1 include (a) Retrofitting mechanisms application, (b) Retrofitting strategies, group 2 includes (c) Performance assessment, (d) Indicators and measure's introduction, (e) Decision making, group 3 includes (f) Life cycle optimization and circular economy, group 4 includes (g) Retrofitting barriers and risks and group 5 which includes the retrofitting computing system developments as showed in figure 3.

***Retrofitting mechanisms***

As environmental concerns have grown, sustainable development has become more sensitive to the energy crisis. As a result, retrofitting existing buildings with green building technology is intended to reduce carbon emissions and energy consumption. He et al. (2002) found that renovating existing buildings makes them more environmentally, socially, and economically sustainable than before (He et al., 2021).

Buildings can be made more energy efficient by combining building skin variables, air conditioning, lighting, and solar photovoltaic energy production on the building skin (Walter Costa et al., 2020). Most studies on architectural, systems, and materials solutions elements control energy demand in existing buildings with minimal instrumentation, achieving human comfort and energy efficiency. Facade, HVAC, and lighting are the building's biggest energy consumers (Karunaratne & de Silva, 2019). To reduce building energy demand, it's important to understand how every part and element uses energy and how every parameter is designed to invest in building energy (Tokede et al., 2018). Green energy efficiency technologies for building envelopes; renewable energy sources; HVAC equipment systems; architectural environmental control systems (Liu & Ren, 2018). According to most studies on the integration of photovoltaic technologies for electricity production instead of fossil fuel, it is a clearer system and an environmentally friendly option (Rizk Hegazy & Seddik Moustafa, 2018). Alternatively, supporting sustainable development by preserving natural and cultural resources (Galbiati et al., 2021). Few retrofitting studies. It suggests studying the green retrofitting process functionally, technically, and organizationally (Bu et al., 2015).

***Retrofitting decision making***

Although energy retrofit applications have received much attention worldwide, optimal decision-making has received the same attention to support stakeholders' mind shifts in upgrading existing buildings. It provides support for stakeholders through different measures and

indicators for how to select the most suitable and cost-effective combination of systems and strategies for a specific building. As building owners always seek to improve building sustainability and achieve green certifications and leadership in energy efficiency such as LEED within an available budget (Abdallah et al., 2020), most of the studies present optimization models for optimising LEED certification levels. In addition, to assess the effectiveness of the green remodelling (Lee et al., 2019b) and analyse the energy efficiency gained after implementing certain proposed modifications (Al-Habaibeh et al., 2022). It is a general process with different measures, including (a) building assessment; (b) recommissioning; (c) goal setting; (d) determining the level of retrofitting; and implementation help in supporting decision making. And to achieve that, energy simulation and financial/economic analysis are the most needed (Lu et al., 2021). In addition, by analysing the net environmental impacts as well as the building's cost performance (Sanchez et al., 2019) by providing a multi-criteria assessment of different retrofitting scenarios Balasbaneh and colleagues, 2022).

***Life cycle optimization and circular economy***

*"Circular Economy is a production and consumption process that requires the minimum overall natural resource extraction and environmental impact by extending the use of materials and reducing the consumption and waste of materials and energy. The useful life of materials is extended through transformation into new products, design for longevity, waste minimization, and recovery/reuse, and redefining consumption to include sharing and services provision instead of individual ownership."* (Foster G., 2020). This makes the retrofitting and reusing of existing buildings important for reducing materials consumption and energy intensity (Foster et al., 2020). The interpretation analysis in the studies is carried out for each retrofit option to determine which aspect, material, or method had the most impact on the LCA results. Furthermore, the findings demonstrated that waste material recycling benefits the environment in all areas of the LCA outcomes (Napolano et al., 2015) and (Luo & Oyedele, 2021).

***Retrofitting barriers***

Even though there are numerous governments offering improvements, retrofits only affect 0.5–1% of the building stock each year. Low financial availability, user awareness, regulatory framework ambiguity, and supply chain fragmentation are among these challenges (D'Angelo et al., 2022). According to the studies, lack of technical knowledge and expertise, lack of transparency about energy costs and usage, occupancy type of the facility, and lack of commitment and engagement are the barriers that had a significant impact on the retrofitting process (Fasna & Gunatilake, 2019 & (Galiotto et al., 2016).





***Retrofitting computing systems development***

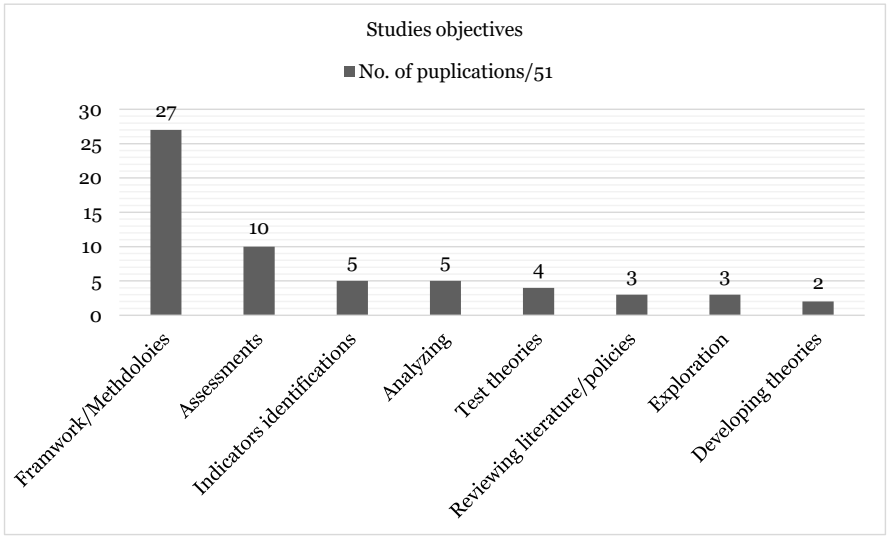
Few studies focus on developing retrofitting computing systems through simulation and analysis. It includes a well-defined application programming interface on which additional applications can be developed. It employs a common workflow to enable different types of algorithms and runs on high-performance computing systems, cloud infrastructure, and laptops to overcome (a) configurable technology stacks for performing both small-and large-scale analyses, (b) different classes of algorithms compatible with a common design workflow; and (3) analysis tools for effectively visualising large-scale simulation results (Ball et al., 2020).

### 2.3.2 Literature studies objectives

As it showed from the previous section (Retrofitting trends), application mechanisms and decision making are the most ranked among different trends, so according to this framework, guidelines and methods act as the main objective for most of the publications related to the topic under the retrofitting umbrella. And most of the frameworks are applied to different case studies as an application.

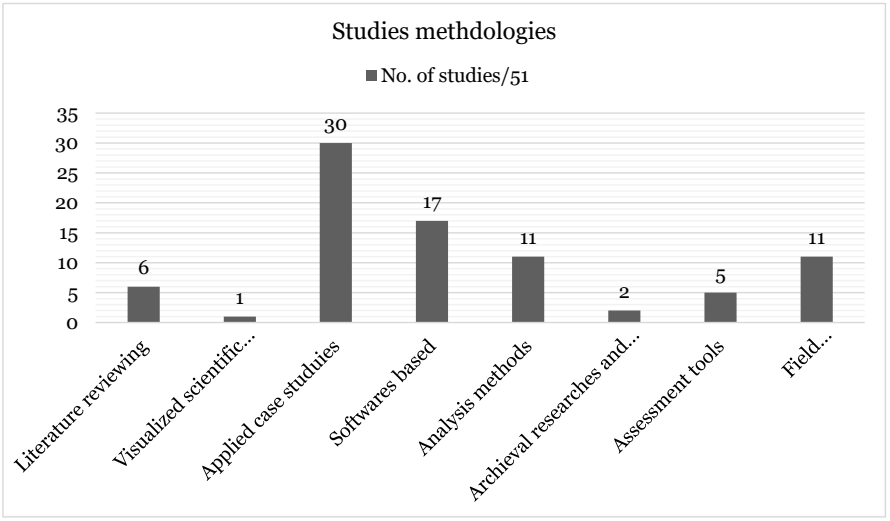
As an example, for retrofitting application and mechanisms, Walter Costa et al. (2020) propose retrofit guidelines that meet a net zero energy target and as well most of the studies and the framework introduced by Motalebi et al. (2022) for integrating mathematical optimization, 6D-Building Information Modelling (BIM), and Life Cycle Assessment to enhance existing buildings' energy efficiency through applying energy retrofit measures. And to support stakeholders' decision making (Lu et al., 2021), introduces an easy-to-follow framework for optimal decision-making of energy retrofit, as well as the multi-objective optimization framework to reach the minimum economic costs and Global Warming Potential (GWP) impact of existing buildings (Javid et al., 2019). In addition to the framework combination between application of energy efficiency guidelines and supporting decision making as the implementation of an integrated cost and environmental assessment involving alternative energy efficiency retrofit packages for a building (Tadeu et al., 2015),

The aims of 54% of the studies are framework and methodology introduction, 19% assessments and evaluations, 9.8% indicators identification, 9.8% for analyzing, 7.8% for testing theories, 5.8% for reviewing literature and policies, also 5.8% as an exploration, and 3.9% for developing theories under the topic of (Sustainability in existing buildings), as few of the studies have more than one aim. Assessing the performance of existing buildings as critical to supporting the transformation (Jiménez-Pulido et al., 2022) and the effectiveness of green remodelling and rettrofiitng of existing buildings after the transformation (Lee et al., 2019b) as the study's second-ranked main objective.




(Fig.8) – Sustainability within existing buildings studies objectives. Source: Author

### 2.3.3Methdologies




(Fig.9) - Sustainability within existing buildings studies methodologies. Source: Author

Skimming many studies on the topic (Sustainability in existing buildings), it is observed that many use the case studies as an application of a strategy or framework, proving a theory, and





as an analytical approach. The value of the case study approach is well recognised in scientific theories and physical fields such as architecture and urban planning, so most studies use it as an important method. As an example of using case studies to apply alternative energy efficiency retrofit packages to a building, a typical Coimbra building was used (located in the central area of Portugal and recently listed as a UNESCO World Heritage Site). Two other building sites were also examined (Tadeu et al., 2015). Cost-Optimal technique compares multiple retrofit scenarios, including building envelope and plant system interventions (Bellia et al., 2018). Example: A university building in South Italy's heating-dominated climate.

Building analysis software is the second most used tool for reviewing studies. This software helps architects, engineers, and building managers understand building energy use, lighting, heating and cooling, solar production, and other factors. It's a smart system that lets users generate dynamic models and visualisations based on various data sets, change them, and create numerous digital representations of existing or future facilities. Dynamic software integrates mathematical optimization and building integrated management (BIM) to analyse lifecycle costs and environmental impacts of building envelopes (Motalebi et al., 2022). BIM creates and manages information throughout a building's lifecycle. BPM optimises the retrofit workflow by providing all relevant stakeholders (D'Angelo et al., 2022). Design Builder and Energy Plus software simulate the building's energy consumption (Rached & Anber, 2022 & Balasbaneh et al., 2022).

Surveys and interviews rank highly among qualitative data approaches. Interviews are useful for studying a participant's background and obtaining in-depth information. After respondents complete questionnaires, interviews can be used to further study their responses.

So as it showed in (fig. 9), 58% of the studies use case studies, 33.3% use programme and software analysis, 21.5% use SWOT analysis, and 11.7% use literature review. It's used to show a current picture, for example. Our review relies on papers collected from peer-reviewed literature databases, highlighting recent scientific production and policy and industry trends (grey literature) (Jiménez-Pulido et al., 2022). 9.8% use different assessment methods, 3.9% use historical research and data, and 1.9% use visualised scientific literature analysis software based on the JAVA platform. He et al. It can find and show scientific fields' development trends and important changes. 93% of studies use more than two methods because each step requires a different tool. A phase 2 residential community in China's cold climate was chosen for an in-depth case study analysis. WeChat questionnaires were used to survey occupants' energy use. Six questions were asked. 200 questionnaires were distributed to case study residents, and 182 were valid. An assessment tool can be used to test a retrofitting plan based on technical specifications (Peng et al., 2021).

Although retrofitting buildings at the beginning of their life cycle increases economic, energy, and environmental effects due to increased investment cost, embodied energy, and carbon of retrofitting materials, the overall energy, carbon, and life cycle cost will be lower than non-retrofitted buildings (Luo & Oyedele, 2021). Decision-makers should consider the embodied coefficient of materials, the carbon intensity of operating energy sources, and the ratios of window surface areas to external walls (Peng et al., 2021). Studying contextual conditions, such as site constraints, topography, and solar gains, can help achieve better results. Communication, participant engagement, and other measures to improve user experience will help improve other aspects besides energy consumption and carbon footprint (Pomponi et al., 2015). In addition, preventive maintenance must be emphasised, adopted, and used to reduce life cycle costs and extend material service life (Rodrigues et al., 2018).

Some studies show that, despite being exempt from building energy rules, historic structures can make significant energy savings without compromising their historic character. Economic and environmental impacts can be reduced by choosing the best energy efficiency retrofit solutions (Tadeu et al., 2015). This reduces the building's energy demand by 55%, ensuring compliance with all regulations, avoiding derogation, and preserving its heritage value (Galbiati et al., 2021).

The studies' risk assessments show that retrofitting poses some risks. Construction cost, inflation, energy saving uncertainty, warranty risk, project completion delay, productivity and quality risks, permit requirements and approval, design changes, structure or property damage, and procurement delay influence green retrofitting (Ranawaka & Mallawaarachchi, 2018).

### 2.3.4 Retrofit/reuse vs Rebuild

#### *Concept of adapting exisitng buildings*

In most of the studies for upgrading or fully replacing existing buildings, retrofitting, and rebuilding are two different choices that have a lot of attention. However, the degrees of material efficiency in retrofitting and rebuilding schemes are vastly different, resulting in inequalities in embodied and operational energy consumption (Peng et al., 2021).

Climate change, according to the IPCC (2007), is any change in climate over time caused by natural variability or human action. Jones (2008) further said that human activities cause greenhouse gas concentrations to rise, and that buildings are responsible for many other environmental issues around the world. "An outcome of the sustainability debate, as ideas of recycling and reuse begin to filter through to all extremities of the built environment."

According to Bergman (2012), the basic 3Rs of environmentalism: reduce, reuse, and recycle, are low-cost and worthwhile solutions that are critical for long-term sustainability. Ward





(2012) also believes that the principles of reduce, reuse, recycle, conservation, and adaptive reuse are all methods of expressing the process of adapting a wasted object for a new purpose. Retrofitting as a process of adaptive reuse promotes sustainable development concepts.

Finally, Caroon (2010) emphasises that, because existing buildings exceed annual new construction by a factor of a hundred, a shift in existing building resource usage and updating is necessary and important. Both renovation and replacement consume a lot of resources. As Caroon (2010:261-262) puts it, "immediate reduction of greenhouse gas emissions is essential."

#### *Reasons for adapting exisitng buildings*

During the last half of the 20th century, adapting of exisitng buildings increasingly recogonized as it is a good solution for change rather than new buildings (Latham, 2000a). And that for a lot of reasons such as; (a) Available grants, (b) timing, (c) Deterioration, (d) Performance, (e) Change of use, (f) Legal, (g) restraints, (h) Conservation and (i) Sustainability (Douglas, 2006).

#### *Advantages for adapting exisitng buildings*

From an **economic** point of view, it is usually much cheaper to adapt a building rather than build a new one, whether it be by demolishing or developing a new site. The adaptation process is generally much faster than that of a new building. The existing infrastructure (i.e., the foundations, basic services, and superstructure) is already provided. In addition, the contract period is usually shorter and borrowing costs for adaptation are much cheaper than for new building (Douglas, 2006). The building's structure and context can be fully used, and the owner will get benefit from most of the fittings and services of the building. That leads to decreasing buying rates and installing new components from the **technical** point of view (Douglas, 2006). The allowed "plot ratio" for a proposed building may be less than that of the current structure's shell. By keeping the property, an owner will be able to optimize improvements in floor space. Large internal rooms can often be decreased by subdivision without harming the overall architectural integrity of the property as a whole (Scottish Civic Trust, 1981).

Furthermore, as an **environmental** impact, where sustainability is a significant policy criterion, a modified building should be more energy efficient than before. As we have seen in the above parts, trend adaptation is an important sustainability criterion. This is because it decreases both energy consumption and the generation of waste. It minimizes the need for using new materials resources and energy required in producing and transporting them (Douglas, 2006). Because of their unique traits, old buildings provide psychological reassurance (Scottish Civic Trust, 1981). Retaining the character of a streetscape is best achieved through adapting its buildings. However, the **social** advantages of adaptation are more obvious (Douglas, 2006).

***Economical point of view***

*Cost of Update vs Rebuild*

An office building built in 1959 is the focus of a study reviewed, it was designed for office workers of a distribution facility and used as a case study for comparing updating and rebuilding it. It was found that modest energy retrofitting for a three-story office building, built 50 years ago would cost approximately $361,400. The cost for a new building of the same size as the old was found to be approximately $950,000 to $2,200,000. Since the cost of new construction would be three to five times as much as the cost of renovation (Piva, 2019).

1-Major: 500–700/m2 2–12 approximate time in months. This will involve major changes to the services and interior fittings but without any significant structural alterations. May include addition of raised floor, improvements to core areas and entrance halls, new lighting, internal shading. Typically takes place at 25-year intervals and in conjunction with lease renewal.

2-Complete 800–1500/m2 6–18 approximate time in months. This will involve significant structural alterations, such as enlargement of the floor areas or partial demolition to create an atrium or stripping of the building back to the concrete (or steel) frame. New cladding may be fitted together with the installation of new services and full fitting out. Timing of a complete refurbishment is variable but likely to take place in conjunction with lease renewal.

3-New build 800–1500/m2 18–24 approximate time in months. Construction of a new building, excluding demolition of an existing building and loss of rent (Douglas J., 2006).

*Building owners opinion*

A study took place, it is purpose was to undertake a comprehensive inquiry of building owners' perspectives on adaptive reuse/retrofitting and solutions for enhancing the sustainability of existing structures in Western Australia. The question is, is it economically more viable to extend the life of existing buildings through adaptation or demolish and rebuild?

Philosophically, 83% of respondents said it was desirable to adapt rather than demolish, but 77% believed it would only be feasible if the costs and advantages were considered over the building's lifetime. Building Adaptation is a more long-term alternative in general, although it depends on many factors. According to 41% of respondents, it is important that decisions are made based on determining the best alternative for the most efficient use and update for the building. Updating and retrofitting were seen to be effective because 75% of the respondents that referred to economic importance, felt the costs to demolish outweighed the costs to improve the building. Provided the structure of existing buildings is still functional and in good condition. Retrofitting and adapting reuse of existing buildings appears to provide the potential to make them more visually acceptable and productive, according to owner's respondents (Pullen, 2007).





***Embodied energy of Update vs Rebuild buildings***

In addition to the cost comparison between updating existing building and rebuild it is another way of analysis and decision making. The existing structure has an embodied energy of 18,420,480 MBtu, the renovation investment is 23,189.58 MBtu, and the annual operational energy consumption is 912,600 MBtu. This means that after a year, the total embodied energy invested in this updating and retrofitting it will be 21,652,038 MBtu. The embodied energy of the new construction, on the other hand, considers the 34,819.20 MBtu of embodied energy that is already present within the existing building and in the demolition of it. For a new construction of the same size, the embodied energy investment is 18,420,480 MBtu, and the operating embodied energy is 730,080 MBtu. The total embodied energy of the new building after one year would be 22,632,480 MBtu. In one operational year the new building will have one million MBtu embodies energy more than the updated building, after forty years, a retrofitted building would have 51,105,600 MBtu's and a new building would have 57,243,438 MBtu's. A proof that is by the time the materials in the original/updated building have reached or are towards the end of their useful life the renovated structure will be more expensive than the new one. It also demonstrates that the structure still has a lot of life remaining in it, which would be wasted on a new structure (Piva, 2019).

***Influences on adaptation versus redevelopment***

However, there are some factors that influence the decision of adaption versus the redevelopment such as:

(Table 2-2) - Factors affect adaption vs redevelopment. Source: (Douglas, 2006 & Ashworth, 1997 & (Pentagon Renovation Program, 2005)

| No. | Factor | Background |
|---|---|---|
| **1** | Alternatives | Alternatives exist for decision making. |
| **2** | location of the existing building | The location of the existing building is very important for the adaption, city centres are from the most common with buildings adaption, However, accessing restrictions may prevent a building's adaptation. |
| **3** | Value of the existing site | The site might have a value exceed the value of the building itself. |
| **4** | Building condition and morphology | The is important to check the overall condition of the building and its suitability to meet the new requirements. |
| **5** | Operational factors | How the adaptation will affect the building's operation time is one of the most important factors. |

| | | |
|---|---|---|
| **6** | Occupiers' requirements | The degree of achievement of the building's additional design objectives varies among users (Ashworth, 1997). |
| **7** | Adaptation potential of building | It should provide new performance and technological efficiencies, as well as be more comfortable and convenient. |
| **8** | Constructability | The pinnacle of construction expertise and common materials (Pentagon Renovation Program, 2005). |
| **9** | Political influences | The government plan to use and develop the building property will influence the decision. |
| **10** | Cost and time considerations | If the rehabilitation costs exceed two-thirds of the redevelopment costs, this is also generally considered the more practical option. |
| **11** | Accommodation | The ability of the building's spaces and environment to accommodate client needs. |
| **12** | Design life | After adaptation, the expected useful life of the building. |
| **13** | Design process | Designers collect information on the existing asset in order to develop a design for the renovation that is comparable to it. |

As a result, retrofitting and rebuilding are two different alternatives for upgrading or totally rebuilding these old structures. However, the degrees of resources usage in retrofitting and rebuilding schemes are significantly different, resulting in inequalities in embodied and operational energy consumption (Peng et al., 2021).

### 2.3.5 Studies main Findings

Debates and conflicts found in the reviewed studies for sustainability in existing buildings revolve around three main issues which are:

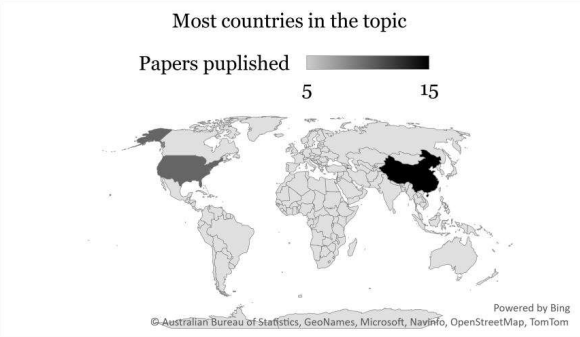
(a) Some studies show in argument that, improved sustainability certification systems for existing buildings are viewed as a critical for mainstreaming sustainable updating, that is built on the fact of most of the sustainability certification systems leading a position in terms of sustainability only. Sustainability certification systems should only provide an accurate assessment of the sustainability level achieved through the building renovation, as they do currently, but also guide and assess any interventions that are made and affect the existing building from all the sustainability aspects.

(b) Although most of the studies adopt computer software's to estimate the buildings energy performance, it is not enough to investigate the actual the actual operating performance of the building. So inaccurate building performance evaluation results from the software-based simulation is a conflict between most of the studies.





(c) The main aim of retrofitting optimization was often to reduce year-round operational energy or lower life-cycle economical costs. On the other hand, some retrofitting materials have a larger embodied energy and carbon print value, even though the yearly operational energy and life-cycle cost are very low, its life-cycle energy and carbon may be large.




(Fig.10) - The most countries published papers in the topic.
Source: Author

(d) Manuela Almeida, Marco Ferreira, and Bulatov are the writers with the most papers in this topic. China, America, and Italy are the top three most prolific countries, with China's contribution exceeding that of other nations as showed in (Fig. 10), although there are many isolated nodes in the networks of authors and countries, indicating that the cooperation in the field is still not enough.

Before 2000, research of green renovation and retrofitting are at their peak point and a very little attention is given to this field. From 2011, there is a visible increase in the number of published papers in this issue, that is a proof for the more attention for renovating old and existing building towards the environment and human beings. Building performance, model, energy efficiency, design, and simulation are hottest research issues in this field (sustainability in existing buildings).

From 2000 to 2007, researchers focused on how to obtain building information and build automatic green reconstruction models with software's and computer programs. And during 2008–2011, improving energy efficiency and energy saving have led researchers point of interest. After 2011, the multi-objective building energy optimization and computer simulation attracted a great deal of attention. Since 2013, researchers began to shift attention to the occupants, building performance and sensitivity analysis, and from 2015 attention goes towards the decarbonization and research evolve from technology-based to more management-based studies.

### 2.3.6 Gaps

Renovation building performance, modelling, and energy efficiency are among the most extensively researched topics. From reviewing various studies, it is clear that most of the analysis focuses on cost and building energy efficiency, while ignoring social, cultural, and co-benefits, which are the most important aspects for applying sustainability to existing buildings. In general, research areas must slightly shift from technology (extraction and modelling of building performance information) to managerial challenges (mainly including human experience, multi-objective optimization, and multiparticipant interests) as an important part of sustainability. It is important to combine environmental, economic, and social aspects to maximise the benefit of existing building renovations.

### 2.3.7 Concluding remarks

Indoor environmental quality, quality of life, functionality, energy efficiency, cost, climate change, employment, and human health are the main issues that need to be considered during building renovation and retrofitting, as the combination of environmental, economic, and social aspects is necessary to maximise the benefits of updating existing buildings. Our role towards the environment is not limited only to researchers and scientists. The government and other stakeholders should investigate encouraging retrofit investments in old structures. This will be an effective technique to reduce the built environment's input to global warming and climate change.

## 2.4 Adaptive reuse within existing buildings

The building and construction sector have challenging problems in terms of building flexibility and adaptability from the point of view of more sustainable development. These problems include lowering construction management costs, reducing new builds, maximizing resource efficiency as well as the socio-environmental effect (United Nations, 2017). These challenges are related to the sustainable use of buildings. Adaptive reuse provides a better alternative to demolition and new construction for a variety of existing problems and challenges in the built environment (Russell 2021). So, the need for reuse plays an increasingly important role in theoretical debates, as the current environmental challenges and developing societal and economic issues demand it (Grin 2010).

The advantages of adaptive reuse of buildings go beyond climate mitigation and resource efficiency; they also include making a positive contribution to the social and economic plan motivated by communal benefits; increasing the commercial viability of buildings; and lowering their maintenance costs (Gosling 2013). By reviewing literature, researchers have worked on adaptive reuse of buildings in many different aspects. Most of the studies proposed functional, technological, economic, social, architectural, and legal different criteria to understand the issue.





Others explored the potential of buildings to be adapted related to the sustainable challenges. Some research addressed the need for reuse within existing buildings, whether they are heritage or not, in addition to assessing and exploring adaptive reuse practices and user experiences.

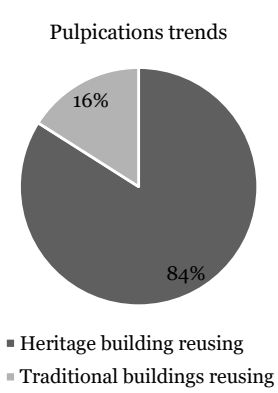
An overview will be presented in this part for two relations, which are the relation between sustainability and adaptive reuse as well as the relation between adaptive reuse and existing buildings. Because adaptive reuse is one of the strategies for incorporating sustainability into existing buildings, most of the studies for these topics are reviewed from international school-indexed journals related to the environment, architecture, and sciences. 58 studies are reviewed for the topics related to the built environment as a basis for selecting study criteria, as the built environment is a major contributor to the environmental pressures our world is facing. The reviews cover approximately 123 scoped indexed journal studies, in addition to one study with a title (Current Status and Emerging Trends in Adaptive Reuse of Buildings). In total, 181 studies have been reviewed to highlight the trends, methodologies, and gabs. The reference study reviewed 51 articles from sustainability journals; 24 from IOP Conference Series Earth and Environmental Science, 9 from IOP Conference Series Materials Science and Engineering, 8 from Wit Transactions on Ecology and The Environment, 8 from Wit Transactions on The Built Environment, 6 from buildings, 5 from the International Journal of Building Pathology and Adaptation, 4 from the International Journal of Strategic Property Management, 4 from Matec Web of Conferences, and 4 from Procedia Engineering.

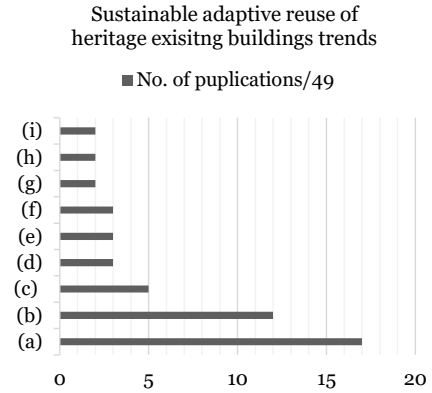
### 2.4.1 Trends

Low carbon emissions are generally regarded as one of the most important factors in achieving sustainability in the urban development and affect climate change. Adaptive reuse of buildings is a kind of sustainable urban regeneration since it extends the life of the building and avoids demolition waste, supports the reuse of embodied energy, and delivers significant social and economic benefits to society (Yung & Chan, 2012). In addition to the the European Union identifies the cultural heritage of cities as the main driver of development strategies (Della Spina, 2020). So reusing heritage buildings and exploring and potential of them within the sustainability aspects is the highest rank trend among all the issues regarding the sustainable adaptive reuse of existing buildings.

As per (fig.11), there is about nine hot topics regarding sustainable adaptive reuse of heritage buildings, (a) Reusing heritage buildings through identifying their potential by introducing different criteria and factors, (b) Decision making one of the highest ranked topics also, (c) Circular economy through adaptive reuse is an important issue related to the topic, (d) Historical buildings adaptability, (e) adaptive reuse projects as Community initiated, (f) reusing

industrial buildings especially, (g) Sustainable adaptive management, (h) the sustainable impact after adaption, and (i) the environmental performance after the adaption reuse.




(Fig.11) - Sustainable adaptive reuse of heritage buildings trends. Source: Author

(Fig.12) - Publications trends. Source: Author

And for the adaptive reuse of traditional buildings, there are common topics among the issue but the trend itself not that much recognized. Management plans, sustainable aspects, sustainable reusing of buildings, interior sustainable adaption, decision making and repurposing existing structures for medical reasons after COVID 19 are the studied topics for building adaption. For the two cases, it is important to guarantee their proper use, regular review, and sustainability (Alhojaly et al., 2022).

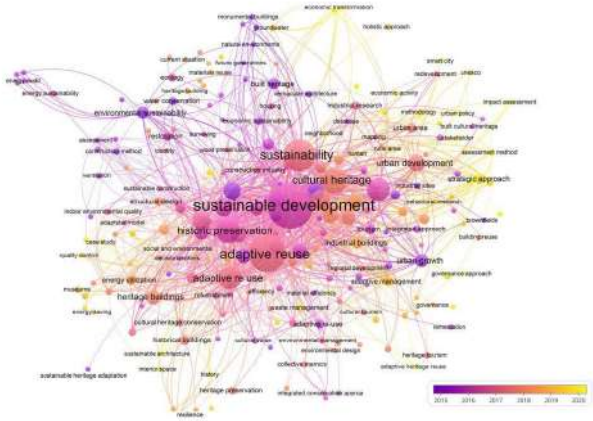
***Reusing heritage buildings***

The adaptive reuse of built heritage buildings is becoming more popular because of the growing trend toward the conservation of the world's architectural heritage; researchers have noted that this popularity can be partly attributed to the economic, cultural, and social benefits they provide to urban communities. Urban planners and developers consider adaptive reuse an effort to find a balance in the conflict between time and space (Li et al., 2021). The adaptive reuse of historic buildings has increasingly become a successful approach through which to achieve the concept of sustainable development in a rapid way (E. H. K. Yung et al., 2014). As a necessary component for identifying and distinguishing cities and regions, it promotes the well-being and health of their inhabitants, as well as employment development, environmental regeneration, and place beauty (Bosone et al., 2021). Preservation of the memory of former architectural





characteristics by repurposing them as modern functional hubs for the city is important as it provides a continuous building life cycle and eliminates building demolition. Adaptive reuse is an important architectural technique for attaining sustainability (Vizzarri et al., 2021). As a conclusion, historic and cultural buildings cannot focus on their original role in the urban complex system as the new transformations are involved in both tangible and intangible aspects, including the physical environment, economic policies, and a variety of interest groups (Wang & Liu, 2021).




(Fig.13) - Research topics concerning sustainable development within adaptive reusing from 2010 to 2020. Source: (Li et al., 2021)

***Circular economy related to the adaptive reuse of buildings***

Adaptive reuse of built environment is a driver for the circular economy, whether it is for heritage buildings or even the traditional one (Ikiz Kaya et al., 2021). The concepts of the circular economy (CE) and sustainability are embodied in the long-lasting, culturally significant, and distinctive buildings that make up Europe's urban landscapes, as it reduces the trash generated during construction and destruction, and the rate of resource extraction for new buildings (Foster & Saleh, 2021). Modern cities try to supply the cultural riches, both in the visible or physical sense and in a spiritual, political, or historical sense. Not only they are only magnets for economic growth and wealth (Gravagnuolo et al.,2021). Other studies approach the adaptive reuse of abandoned buildings and sites as one of the effective circular economy strategy, potentially contributing to climate objectives through environmental regeneration and the reduction of natural resources consumption (Bosone et al., 2021).

Recent studies (Fusco Girard & Nocca, 2019; Gravagnuolo, Angrisano, & Fusco Girard, 2019) have focused in their studies on cities that define themselves as circular cities. These towns have created special programms on a circular economy, demonstrating that the most significant

industries for creative projects are: Built environment (including re-use of historic buildings), Energy and mobility, Waste management, Water management, Industrial production, Agri-food (including industrial symbioses in agricultural lands), Citizens and communities – liaising with social businesses and sector actors that aim to raise awareness on sustainable behaviours and lifestyles (Gravagnuolo et al.,2021).

Based on reviewing different studies it is observed that that one of the most important sectors of a circular economy in cities is the built environment, which includes the reuse and re-adaptation of structures, The circular economy can be implemented in the built environment using four primary strategies: (a) Circular design of new buildings, (b) Dismantling of old buildings, (c) Refurbishment of old buildings, (d) Re-use of old buildings including adaptive re-use of cultural heritage (Gravagnuolo et al.,2021).

The strategic decisions for the development of sustainable cities are increasingly influenced by the issue of the renovation and regeneration of vacant, historical, and refunctioning building stock, paying the more particular attention to the historical heritage (Vizzarri et al., 2021). Most of the strategic developments studies adopts a four aspects framework of sustainability comprising the social, economic, environmental, and political-institutional concerns to examine the transformation process (E. H. K. Yung et al., 2014).

### 2.4.2 Objectives and Methodologies

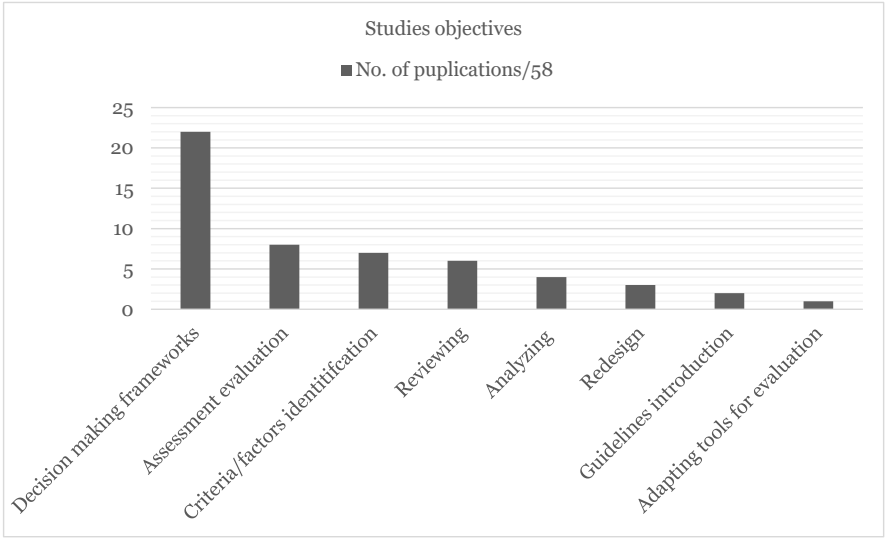
The first part of the literature review as it is showed in (fig. 9), case studies and software programs are the domain and the most popular methods, but for this part of reviewing, case studies, reviewing literature and different analysis methods not based on computer programs are the most popular among the reviewed studies and software-based analysis are the fewest. In addition to that methods are confined for this part, as they are in total 4 main common methods; (a) literature and awards reviewing, (b) non-software computer-based analysis, (c) Case studies, (d) Interviews, surveys, assessments, workshops and focus groups.

Methodologies reviewing results differ from part 1 that too extent, that is because of the difference in the objectives related to the topics. Most of the objectives revolve around evaluating proposed adaptive reuse projects and develop a reference framework for decision makers related to sustainability aspects especially the social and culture aspects as well as the environmental. Such as reversing the last decade's social changes of the local community as a step in achieving historic centre sustainability by evaluating the adaptive reuse project (El-belkasy & Wahieb, 2022). Another one in a feasible quantitative term how can adaptively reuse practices sustainability. This was attained using a set of indicators, developed combining PESTLE (the Political, Economic, Technical, Social, Legal, and Environmental aspects) (Vardopoulos et al., 2021). These objectives need another type of methods and analysis as in Vardopoulos study that

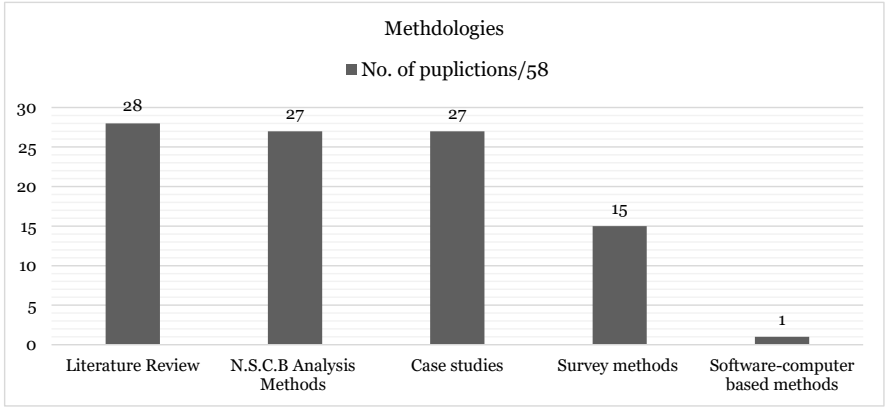




is achieved by using a hybrid analysis technique as the SWOT (the Strengths, Weaknesses, Opportunities, and Threats) approaches combines a qualitative and quantitative analysis with a decision-making mechanism to create measurable results. In addition to evaluating different scenarios in (Dell'Ovo et al., 2021) for reuse in Castello Visconteo in Cusago, located in Italy, and understanding how adaptive reuse could contribute to generating new values within a circular economy perspective with the multicriteria decision analysis (MCDA) which applied by combining economic and qualitative indicators to define the most suitable function for its adaptive reuse.




(Fig.14) - Part 2 studies objectives. Source: Author




(Fig.15) - Part 2 studies methodologies. Source: Author

Most of the reviewed studies use the hybrid analysis method as an example in (Eray et al., 2019); an extensive literature review on interface problems in construction projects is conducted. then problems that are found in the literature are compared and paired with barriers in adaptive reuse projects, and after that pairing adaptive reuse barriers and interface problems are explained on a case study. Identification and analysis of adapted objects, developing a typology of adaptive reuse strategies and survey's questionnaire research aimed at institutions located in adapted facilities are different stages and methodologies for this topic (Pieczka & Wowrzeczka, 2021).

Also, as an example of using advanced analysis methods in a study is (Wang & Liu, 2021), using literature survey, multi-agent discussion and the analystical hiraichy process to select and determine factors for the evlaution index system, the fuzzy eomperhensive evaluation methods to evalute based on factors, rules and weights, structural equation model for the adaptability mechanisims of old buildings and finally the cluster analysis for classifiying the adaptive for adaptive reuse strategies.

In (Alhojaly et al., 2022) one of the important studies that work on the aspects and try to connect it with guidelines, which develops a model for evaluating the adaptive reuse of old existing buildings to preserve their integrity and originality with a sustainable way regards its aspects. Athens Charter of 1931, the Venice Charter of 1964, the Declaration of Amsterdam of 1975, the Burra Charter of 1981, the Tlaxcala Declaration of 1982, the Appleton Charter of 1983, the Washington Charter of 1987, and the Charter for the Protection and Management of the Archaeological Heritage 1990, Principles for the Preservation of Historic Timber Structures of 1999, the Zimbabwe Charter of 2003, the New Zealand Charter for the Conservation of Places of Cultural Heritage Value of 2010, the Valletta Principles for the Safeguarding and Management of Historic Cities, Towns, and Urban Areas of 2011, and the Salalah Guidelines for the Management of Public Archaeology are taken as a reference for creating a general model that will serve as the concept of reuse both globally and locally, in addition to information was gathered through a survey of the literature and content analysis as a first level of methods, connecting to the historical Jeddah region's determinants to derive the general model's assessment model as a second level of analysis and for the third level to determine whether the suggested model is accurate and complete, it will be shown to several experts in architecture and design from the historic Jeddah region.

As a conclusion from reviewing methodologies and objectives regarding topic (Sustainable adaptive reuse within existing buildings), it is observed from the studies that a lot of them is still confined in assessing sustainable aspects which is more concentrated in the social and cultural aspect and investigate potential of building to be adapted whether it is a heritage or traditional old building. The side of generating guidelines is still missing in 99% of the studies as an objective.





As well the methodologies, case studies and different analysis methods have the highest rank among the studies.

### 2.4.3 Studies main findings

The findings showed that existing buildings can be renovated for adaptive reuse and still function well and fulfil modern indoor environmental standards, but many complex design decisions must first be made. The research also found that the use of natural light, natural ventilation, recycled materials, and water efficiency have been neglected in comparison to social and cultural focused directions among the researchers, every sustainable aspect must be taken in consideration to ensure a successful change of use. Conserving existing heritage and old buildings, while incorporating new usages with acceptable comfort, is in line with the principle of sustainability (Al-Obaidi et al., 2017). But there is no doubt that projects owners seek for the economic importance first, so within the studies political and economic aspects rank first, followed by environmental, socio-cultural, technological-technical, and legal aspect (Vardopoulos et al., 2021). All these aspects are connected directly and indirectly to the architectural aspect, such as the cultural aspect connected directly to the architectural and the cultural connected to the social. All served as a good start for decision-making and policy formulation addressing adaptive reuse practices in sustainable development strategies.

According to the studies, the sustainability of the conservation and reusing process highly depends on the local community (El-belkasy & Wahieb, 2022). In addition to the significant tendency toward the private sector participation, encouragement of proactive local actor engagement, and improved stakeholder communication, but stakeholders need to understand the correlation of adaptive reuse to the circularity framework in the limited context of the physical built environment (Ikiz Kaya et al., 2021). As well as the active collaboration among adaptive reuse stakeholders is important to reduce the risk of manipulation of an adaptive reuse decision-making process, and, for policy makers to understand better the expectations and needs of the public for optimal adaptive reuse decisions (Aigwi et al., 2020).

### 2.4.4 Gaps and debates

Unfortunately, little research has been done regarding establishing and enhancing feasible systems for the planning, assessment, and management of adaptive reuse projects, leading to disturbance in the outcome of building projects, as the buildings must achieve financial returns that cover their future maintenance and rehabilitation. According to that, stakeholders need a systematic method and framework to characterize the investment opportunity for adaptive reuse projects. In particular, different stakeholders mostly have divergent attitudes, perspectives, interests, and resources when making decisions about adaptive reuse. So, through the collaborative approach, stakeholders with various interests in adaptive reuse projects will be able

to come together and take part either directly or indirectly in any stage of the decision-making process by understanding who these stakeholders are and why and what their role regarding the process is.

By adopting green technologies and environmentally friendly materials, existing structures are typically upgraded through sustainable retrofitting. However, structural safety and checking are rarely included, which means that buildings renovated to be "more sustainable" may still be structurally unsafe and may collapse at any time. It is important that concepts of adaptive reuse expand to include all three pillars of sustainability (environmental, economic, and social aspects) and also the physical and structural aspects. Many studies proposed new frameworks to include all of these sustainability aspects in building retrofit and reuse, but these may still fall short of the goal of reducing impacts along the building life cycle and overcoming barriers to upgrading.

However, the debates over which sustainability factors are key, and how to address them all in practice, remain unresolved (Yung & Chan, 2012).

## 2.5 Overview discussion

For part one of the literature review with the topic sustainability within existing buildings, it is observed that energy efficiency, modeling, building performance, and retrofit design of existing buildings are the hottest research issues among the reviewed studies. Energy designers, architects, and other researchers concentrated on how to obtain automatic building information about the retrofit process, whether before or after implementation, as well as the reconstruction process. They are mainly focusing on how to save energy and increase the energy efficiency of existing buildings through different strategies that are reviewed in part one of the literature. Multi-objective optimization and simulation analysis have gotten a lot of attention in the field of retrofitting existing buildings, especially old ones. In light of this, other sustainable aspects such as social and economic are neglected in the highlighting of improving the environmental aspects. combination of all the sustainability aspects, including the environmental with consideration of architectural aspects also. Reviewed analysis has placed more emphasis on energy consumption and the cost, ignoring other aspects. In fact, all these aspects are necessary to reflect and minimize the building's upgrading.

Regarding the trends in the literature on knowledge creation through sustainable adaptive reuse, topics started working with an emphasis on building reuse assessment and principles of adaptive reuse only through sustainable aspects, including principles for the design of adaptable and reusable construction elements; building reuse assessment for sustainable urban reconstruction; adaptive reuse potential; supporting decision making; and evaluation of designs for reuse. According to the analysis of the literature included in this study, few publications consider the overall adaptive reuse process; instead, they tend to concentrate on particular parts





or phases of the process, such as analysis, value assessment, or design techniques, and the others mentioned above. However, no particular model or guideline has been put forth with its relation to the sustainable aspects, and this review shows that research into AR is currently patchy and mostly concentrated on various aspects of this complex process. Also, 99% of the studies explore and apply the effects of adaptive reuse, especially for the existing historic and heritage buildings, in terms of maintaining the uniqueness of cultural heritage, preserving its intangible values, and supporting, at the same time, the urban area's development dynamics. However, the need to give more attention to other existing building types is very important and is currently being studied by researchers. These types are the traditional buildings whose functions have been relocated; they have also accumulated over the years. They also have a negative impact on the environment. Additionally, deciding how to use any existing building demands a logical framework for assessing the various sustainable aspects as well as sufficient information to identify the best answer or the most exceptional negotiated solution.

## 2.6 Limitations of reviewing studies

Finally, there is no study without limitations. This study has several limitations, which are noted as follows: Firstly, studies that are selected from journals have a filter with the English language only as it is the universal language with a wide range of applications and usage, so only the English publications are reviewed. However, there is a wide variety of studies with different languages, as the Italian, German, and Chinese languages must be taken into consideration. The second one is that only Scopus indexed architectural journals were reviewed and employed in the analysis; other databases used in the academic community were not considered. However, this study provides a thorough methodology for extracting data for the chosen papers as well as the selection of a database from journals that is well trusted by experts.

## 2.7 Overview concluded remarks

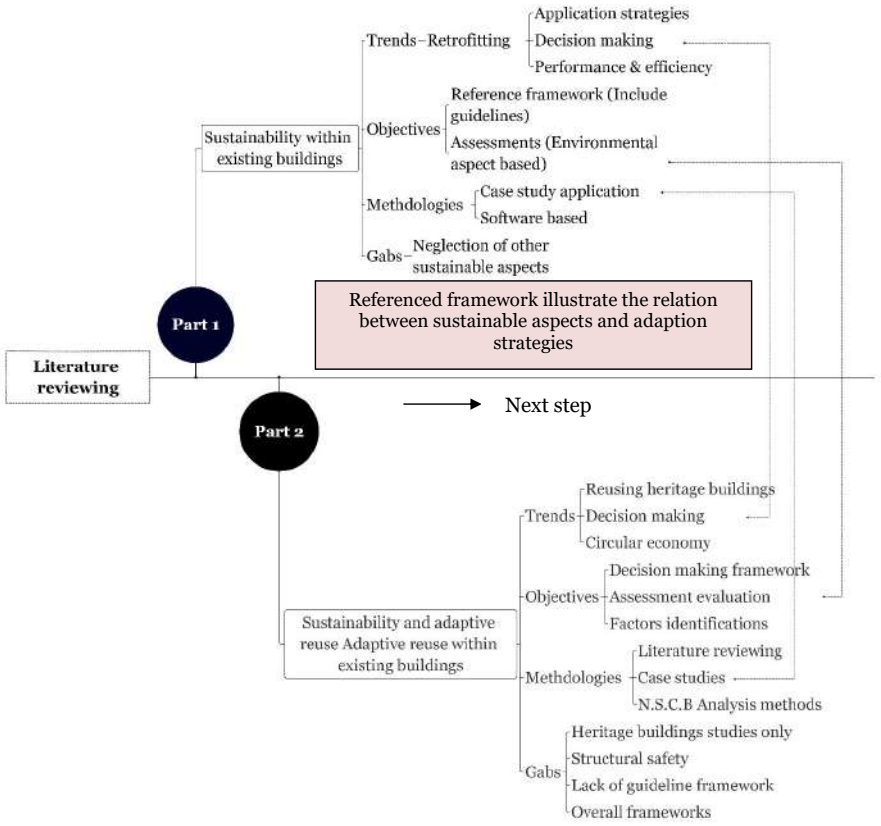
Chapter one presented the reviews of about 213 articles and papers from scoped indexed architectural and science journals. 50 articles were reviewed as a first part with the topic (Sustainability within existing buildings) from 2015 to present. It is the start of the Paris agreement for the uncarbonized, legally binding international treaty on climate change. Another 58 articles are reviewed as a second part with the topics: (a) sustainable adaptive reuse and (b) adaptive reuse in existing buildings. The second two topics are compromised together as adaptive reuse is a sustainable strategy within the existing buildings. Trends, methodologies, gabs, debates, and studies' findings are reviewed, discussed, and analyzed in a comprehensive way within the chapter as shown in (fig. 16).

Globally, the concept of retrofitting is taking much more attention than the other concepts within the upgrading of existing buildings in a sustainable way. In addition to implementing and researching sustainable aspects of heritage building redevelopment, Decision-making strategies among all the studies are the most important issue, whether it is for the government or investors. Reusing and upgrading buildings is not the desired decision for stakeholders unless it has more benefits and impacts on the environment and the economy.

Reviewing can be summarized into four main groups for each of the three topics: (a) sustainability within existing buildings, (b) sustainability and adaptive reuse, and (c) adaptive reuse of existing buildings. The first group related to flexibility in reducing the effects of construction operations on the environment; how construction activities affect the environment; and how important adaptive reuse and retrofitting are. Group two is for the multi-criteria decision tools for sustainable upgrading of existing buildings; what decision tools are applicable in what situations; and how to test the performance of the decision tools. The third group is about introducing the theoretical frameworks, assessment factors, and models. And finally, the fourth group, which indicates adaptive reuse from the standpoint of urban development and renewal (Owojori, 2021).








(Fig.16) – Concluded marks map. Source: Author

# Chapter 3: Theoretical knowledge

## 3.1 Introduction

The previous chapter (chapter 2) introduces the most important gaps through reviewing updated research articles and concept papers from international scoped indexed journals. Which are about three gaps, (a) the combination of all sustainable aspects regarding retrofitting of existing buildings, (b) what are the sustainability factors that are the main key, and how to address them all in practice, remain unresolved, (c) investigating the potential of building to be adapted for only the heritage or traditional old building, (d) The side of generating guidelines within full work frame is still missing in 99% of the studies as an objective. This chapter covers these gabs through the result end of it with a framework illustrates the correlation between sustainable aspects the social, environmental, economic, architectural, cultural, and innovative aspects with practised guidelines and methodologies. Introducing important key aspects of reusing existing buildings, illustrating the relation between architectural aspects and the other, also connecting these aspects with adaptability design guidelines. In addition to introducing and illustrating scientific concepts and theoretical knowledge related to them.

(Table 3-3) - Relevant adaptive reuse guidelines standards reviewed. Source: Author

| Relevant standards reviewed |
| --- |
| Douglas, 2006, Secretary of the Interior's Standards for Rehabilitation, High performance building Guidelines, Toward an adaptable architecture guidelines to integrate adaptability in building, Refurbishment manual, Athens Charter of 1931, the Venice Charter of 1964, the Declaration of Amsterdam of 1975, the Burra Charter of 1981, the Tlaxcala Declaration of 1982, the Appleton Charter of 1983, the Washington Charter of 1987, and the Charter for the Protection and Management of the Archaeological Heritage 1990, Principles for the Preservation of Historic Timber Structures of 1999, the Zimbabwe Charter of 2003, the New Zealand Charter for the Conservation of Places of Cultural Heritage Value of 2010. |





## 3.2 Adaptive reusing and designing for the adaptability

The question here is how can existing spaces be adapted to a new use with a view to future adaptability? It appears to be an economical way to reduce building redundancy in the developed world to adapt old structures for the same use or to convert them for new applications (Douglas 2006). Sometimes these conversion processes are uneconomical, and demolition seems unsustainable, thus making it more economical to maintain the original space with new functions. Therefore, it is important to analyse ways of utilising the existing building stock as mixed or sole use developments, because building functions have limited life, they are expensive to build, and the cost of replacement is high and clearly unnecessary when they are physically robust and adaptable (Anupa Manewa, C. P., 2013). As adaptable buildings can be defined as' the dynamic systems that carry different capacities to accommodate a set of evolving demands and requirements regarding space, function, and components', thus maximising the through life value (Adaptable Futures 2012). In addition to being sustainable, buildings should have an in-built ability to adjust to changing circumstances and technologies without waste and conflict (Kendall and Ando 2005).

## 3.3 Theoretical concepts

### 3.3.1 Reasons and affecting contexts for building adaption

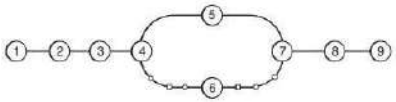
Any building after long time especially in the Egyptian context, it's use may be affected by many factors that disconnect its function whether it is technological function or a specific use. These contexts summarized in the Politics that could be represented in the main political goals, policies of general development, and partnership programs and the related stakeholders also be affect it, Urban which are the urban tissue and its physical state of buildings as well as the community needs, Economics as the funding resources, Cultural which is affected by the main cultural goal of the area, Social affected by the social class of the surrounding community or users and finally the technological evolution that is represented by the development of different sciences and fields. In aition to other factors as the management and different stakeholder's overtime (Moosa, 2018). That is are the reasons that affect disconnecting of old buildings within the surrounding and the context. Beside to another affecting contexts as the value, involved institutions and policies. These reasons and factors led to the adaption decision with an ambitious output such as formation of communities and relations through building adaption and how can be the surrounding and context integrated with the building.

### 3.3.2 Adaption classification

According to (Moosa, 2018), there are six categories for buildings adaption. Category one which is the reusing buildings Related to an Outstanding Significant Change buildings that

connected to a revolutionary event that had an impact on the context. These buildings could be repurposed in a way that preserves historical memories within the architecture, Category two is reusing buildings related to a main development strategy which supports a main development strategy to the community, Category three is reusing supporting a basic community need such as education, residency, hospitals or others as the basic needs for the communities, Category four is reusing related to economical investment, it is one of the conserving strategies, Category five absolute conserving trend that is considered the minimum use between the building and people as conservation is the main purpose and category six the exceptional incidents as the special and sudden circumstances as wars and dieses that is the same case of COVID 19, many places has converted to health care facilities.

### 3.3.3 The whole life cycle of the building




(Fig.17) - Whole building life cycle linear model. Source: (Douglas, 2006)

There are nine different stages for any building which are, (1) decision to build, (2) Design stage, (3) Construction stage, (4) Occupancy, (5) Maintenance, (6) Adaption, (7) Irreversible building obsolesces sets in, (8) Building fully obsolete, (9) Demolish (Douglas, 2006). Any building may be sustained for decades by combinations of maintenance and adaptation process. Many church buildings, for example, have lasted for hundreds of years because of the periodically maintenance for it. And for other types of buildings, however, the original use may not be sustainable for more than a few decades so in this case there is an adaption is needed. So, adaptation and maintenance are two primary aspects in any building life cycle depends on the function.

### 3.3.4 Adaption concept

Adaption include any work done to a building that goes above and beyond maintenance to change its functionality, performance, or capacity (i.e., any intervention to adjust, reuse or upgrade a building to suit new conditions or requirements) (Douglas, 2006). For building interventions that go beyond maintenance, there are a lot of words that are employed. Words like "refurbishment," "rehabilitation," "renovation," and "restoration" are sometimes used. Despite the lack of a widely accepted definition between the authors, the phrase "building adaptation" is used in this book to refer to all forms of adaptation. It is the one, in the Douglas opinion.



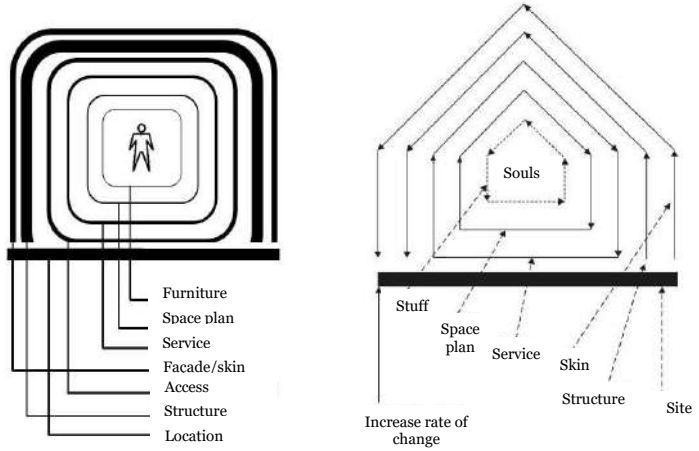


### 3.3.5 Scale of adaption and degree of change

(Table 3-4) - Scale of adaption. Source: (Douglas, 2006)

| Scale | Degree of change | Type | Example |
|---|---|---|---|
| **Small** | Limited | Improvements of surfaces<br>Upgrading of fittings | New floor coverings, re-roofing, painting/re-painting, or rendering/re-rendering external walls.<br>Replacement of doors, windows, and kitchen/toilet fitments. |
| **Medium** | Large | Upgrading of surfaces<br>Retrofitting of services<br>Enlargement of capacities<br>Structural alternations<br>Change in buildings use | Over cladding of walls and recovering of roofs with improved thermal qualities.<br>New air-conditioning system addition of lift/s and service cores.<br>Major lateral or vertical extension |
| **Large** | Extreme | Reconstruction of new building<br>Extensive structural update | Major extension to as well as internal and external modification. |

### 3.3.6 Shearing layers of change in existing buildings




(Fig.18) - Building's independent layers. Source: (Hinte and Neleen, 2003)

(Fig.19) - Shearing layers of change. Source: (Douglas, 2006)

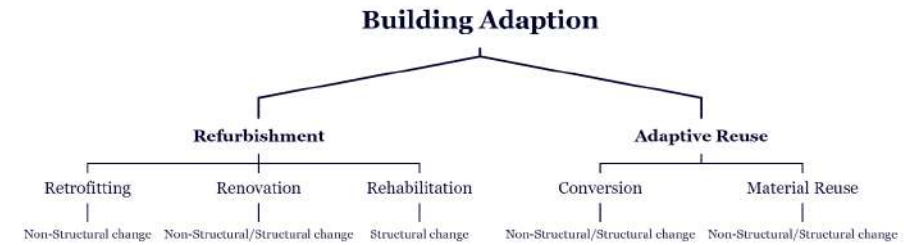
Brand (1994) provides strong evidence that buildings are not just static objects but that they are dynamic. For instance, Brand presents a model (shearing layers of change) on the way a building can be altered over time. Hence, designing or redesign a building to adapt to a potential

change of use means allowing its hierarchical layers to change; each in its own time scale. These shearing layers by arrangement are souls (people) which their typical life span is daily according to (Douglas, 2006), staff (furniture and equipment's) for less than 3 years, space plan (interior layout) for 3 years, services (life blood) for 7-10 years, the skin (envelope and façade) for +20 years, structure (Bones) for 30-300 years and site (location and context) is permeant. Those are building layers of change that must be taken into consideration in any adaption process. Affecting rate of change depends on which layer.

### 3.3.7 Adaptation criteria for old buildings

Whatever solution is made for the adaptation of an old building, it should be based upon carefully considered and selected criteria according to (Douglas, 2006) which are; (a) The Philosophical considerations, (b) Present location, (c) Relationship of building to other buildings, (d) space required by the new scheme/use, (e) Degree of protection in respect of Listed buildings, (f) The building with the context historical and architectural significance (g) The building's condition and flexibility for change, (h) Size and form of the existing building according to the new use, (i) Economics such as; current assess value, value after adaption and cost in use, (j) Functional potential of adjacent facilities and services, (k) and Legislation relating to new use.

### 3.3.8 Adaption terminologies




(Fig.20) - Building adaption terminologies, drafted by the author. Source: (Shahi et al., 2020b)

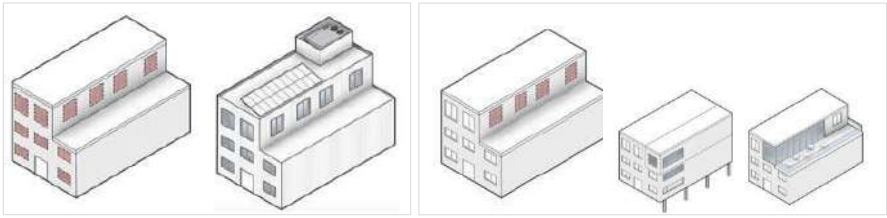
### 3.3.9 Adaption through retrofitting and conversion

Retrofitting is the addition or the upgrading of an existing building with features or capacities that it was not initially constructed with, to improve energy use and efficiency. Retrofitting focuses mainly on improvements to the envelope, systems, and the addition of renewable energy sources. Within a scope of four main elements, (a) Energy Efficiency, (b) Building Envelopes, (c) Replacing HVAC Systems, and (d) Addition of Renewables. In addition to improving energy efficiency and improving occupant comfort as main benefits through minimum non-structural improvement as; replacing windows, increasing insulation and addition of





renewable energy sources and efficient HVAC (Albatici et al., 2016 & Antoine et al., 2016 & Ma et al., 2012). An adaptive reuse is process of reusing an existing old building by changing its function and maximizing the reuse and retention of existing materials and structures. With the scope of (a) Change the function of buildings, (b) Rehabilitation, (c) Renovation, (d) Retrofitting, (e) Material reuse. In addition to preventing demolition/decreasing waste and increasing economic/social performance through converting spaces through an addition and changing use of the building and converting interior/exterior spaces (Bullen & Love, 2011 & Conejos et al., 2011 & Langston et al., 2008).



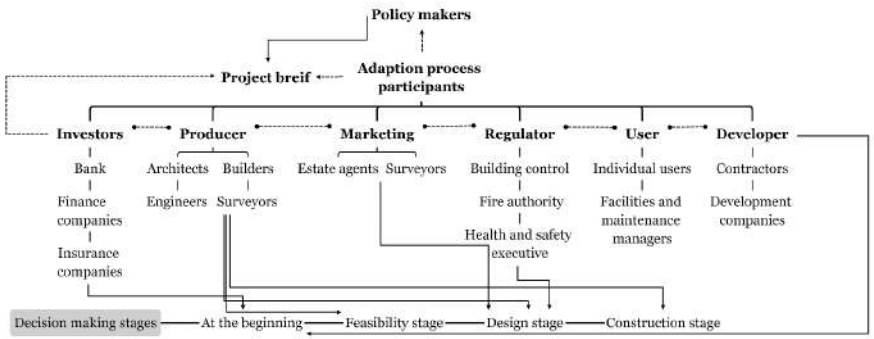
(Fig.21) - Retrofitting process illustration, Source: (Shahi et al., 2020b).
(Fig.22) - Adaptive reuse through conversion process, Source: (Shahi et al., 2020b)

### 3.3.10 Potential levels of change

There are six levels of change for the building adaption starts from the more fixable to the less one. Change of use through flexibility of the building 'as found', Change of use through flexibility with minor adaptation, change of use adaptation/refurbishment of vacant facility, change of use adaptation with selective demolition, change of use adaptation with extension of facility and change of use through demolition and redevelopment (K, 2022). The more the level of change increase the more the waste and the cost. So, decision must be held carefully for which level can be adapted.

### 3.3.11 Decision making criteria and stakeholders

Many researchers argue that the decision making to adaptive reuse of existing buildings is a complex stage (Douglas, 2006 & Wilkinson and Reed, 2009 & Alauddin, 2014). The main reason is that there are numerous types of stakeholders that involved in decision-making and that each participant has a different point of view. Investors who adaptation projects and purchase buildings, developers, producers who specify, cost, and execute adaption projects which are the architects, builders, engineers, regulators who ensure compliance with the statutory requirements, and marketers who find users for the building and vice versa are all involved in the decision-making process for adaptation. And each one has different backgrounds.




(Fig.23) - Adaption process stakeholder and stages relations. Drafted by author. Source: (Nutt, c. 1993 & Wilkinson and Reed, 2009)

### 3.3.12 Decision making criteria

There is a complexity of decision making with regards to adaptive reuse of buildings and the criteria for decision making. Most of them has been identified by thorough review of literature, they are adapted from (Wilkinson, S. J., 2011 & Bullen & Love, P, 2010,2011 a&b & Wang H. & Zeng, Z., 2010 & Yildirim. M., 2012 & Wilson, C. A., 2010). They are sub criteria under the main criteria which are the economic, environmental, social, legislative and architecture. Based on a survey done on which factors are important for the building reusing decision making on 30 members of a multi-stakeholder group of business, public sector and education professionals from the Western Australian Sustainable Industry Group (WASIG). WASIG is also a member of the Regional Network of the World Business Council for Sustainable Development. Percentage of respondents is 68% for cultural significance, 32% for life cycle assessment, 83% for heritage significance, 79% for effectiveness in meeting sustainability benchmarks, 70% for economic sustainability, 87% for environmental sustainability, 51% social sustainability, 47% value to local community, 28% orientation of building, 32% for the influence on local economy, 74% for technical ability of building to adapt and 33% for the stakeholder views (Pullen, 2007).

(Table 3-5) - Decision making sub criteria, Source: Author based on different references

| | | |
|---|---|---|
| ▪ Target market | ▪ Reduce of greenfield use | ▪ Building code |
| ▪ Source of finance | ▪ Resources consumption reduction | ▪ Heritage designated buildings |
| ▪ Financial support | ▪ Suitability of the new use with the surrounding | ▪ Development and government initiatives |





| | | |
|---|---|---|
| ▪ Investments in future maintenance | ▪ Public interest | ▪ Conditions of integrity |
| ▪ Tax exclusion | ▪ Social and cultural value | ▪ Building system and technological value |
| ▪ Building value | ▪ Location (transport & Services) | ▪ Structure condition |
| ▪ Site and building situation | ▪ Enhance role of communities | ▪ Architectural condition and space layout |
| ▪ Land use and zoning | ▪ Retaining sense of place | ▪ Site layout |
| ▪ Environmental quality of surrounding | ▪ The regional development policies | ▪ Building suitability for new uses |
| ▪ Sustainability | ▪ Official zoning regulations | ▪ Client requirements |

## 3.4 Sustainable aspects

### 3.4.1 Architectural aspects

The architectural aspects in AR projects have received little attention, but the cultural implications have gained significant attention in the literature as a sublimation aspect. Even the most extensive source for effectiveness criteria, Bosone et al. , didn't mention any statements about architectural features of AR sustainable aspects. But (Schmidt, R., 2016) considered as a main sublimation aspect. This table shows aspects and their grouping ins the criterion of:

- Group 1 (G1): Providing areas that can accommodate various spatial configurations.
- Group 2 (G2): Enhancement of visual and physical connections between interior and exterior spaces.
- Group 3 (G3): Accommodation of a variety of open rooms through spatial separation suitable for different uses and groups of users.
- Group 4 (G4): Providing spaces that can be used for multiple users.
- Group 5 (G5): Providing interventions within the AR project to be separated from the building (with the minimum of damage). And group 6 (G6): providing multiple entry-points to serve different uses or users.

The elements of the NRP and Europa Nostra awards, which are associated with the description of redesign effectiveness, have been grouped under the headings "quality of design, material, and execution" and "complementary redesigns." Which are group two and group four. They outline the attributes that were considered during the planning and execution phases as well as the qualities the intervention offers.

(Table 3-6) - Architectural aspects. Source: (Arfa et al., 2022)

| | | |
|---|---|---|
| **G1:Joinable/divisible spaces** | 1 | Bringing the building's structure to a human scale |
| | 2 | Adjustable, transparent, and delicacy in the design of the layout of the larger areas |
| **G2:Quality of design, material, and execution** | 3 | Building enhancement through the high quality of the new design and materials |
| | 4 | Excellent design execution |
| | 5 | Appropriate attention to detail in the existing building's adaption |
| | 6 | Securing the building's structural elements and installing necessary protective elements |
| | 7 | Revitalization through the assignment of expertise in craftsmanship and design |
| **G3: Physical and visual linkage** | 8 | Connection of the existing building and the new design in a new story |
| | 9 | The new additions improve the connection of the spaces. |
| | 10 | Improvement of the interaction of the existing building with the surrounding natural landscape |
| **G4:Complementary redesigns** | 11 | Highlighting the values of the existing building via the new design |
| | 12 | Appropriate balance of original and new functions |
| | 13 | Contributing to a better understanding of the existing building |
| | 14 | Interventions that are respectful of the architectural essence of the building and its surroundings |
| | 15 | Innovative design solutions to meet user needs while maintaining the architectural integrity and history of the space |
| | 16 | Effective preservation through new modern additions |
| | 17 | Complementing the original design with new multi-purpose facilities designed in a contemporary style. |
| | 18 | In the new design, a clear presentation of the building's original function. |
| | 19 | Finding an appropriate use to ensure the existing building's future |
| | 20 | The successful evocation of a dramatic meeting of the existing building's old and new parts |
| | 21 | High-quality preservation and design with no attempt to imitate what has come before |
| | 22 | New modern additions to the heritage building that are well-integrated and respectful. |
| | 23 | Using to supplement the original design innovative methods |
| **G5:Spatial quality and zones** | 24 | Creating a variety of atmospheres |
| | 25 | Creating a pleasant environment |
| | 26 | Spatial organization that is both peaceful and structured |
| | 27 | Acoustic comfort and visual peace |
| | 28 | Appealing new intervention |
| | 29 | Openness |
| | 30 | Simplicity and tranquility |
| | 31 | Clear orientation in the new design |
| **G6:Multi-functional spaces** | 32 | Bringing an abandoned building back to life through creative use of space |
| | 33 | Having multi-functional spaces for a wider range of visitors and locals to host different functions |
| | 34 | Improvements to the existing building's functionality |
| **G7:Reversibility** | 35 | The new additions are reversible and easily distinguishable from the original fabric. |
| **G8:Multiple access points** | 36 | Accessibility for visitors with disabilities |





### 3.4.2 Cultural aspects

Some of the old structures are distinctive and frequently landmarks that contribute to or enrich the identity of the surrounding area. By preserving and reusing these structures, societies can adjust to the environmental needs while preserving their cultures and histories (Leeuwarden declaration., 2018). Architectural and cultural aspects considered as a sublimation aspect, as sublimation may appear that it is only focuses on maintaining the materiality of the structures, it involves maintaining the culture and authenticity through the preservation of particular historic traits (Guidetti, E., 2021 & (Saifi, Y., 2021) & (Torrieri, F., 2019). There is a direct relationship between the cultural features and people aspects are revealed by grouping the aspects into seven categories (local community, wider community, residents, and users) (Arfa et al., 2022). And

especially many aspects are related more to the local community and preserving their cultural and histories.

Originality and integrity as a group one (G1) are aspects defined by UNESCO and ICOMOS. Cultural aspects are divided into seven main groups according to (Arfa et al., 2022) to the following:

- Group 2 (G2): the hybridization between historic and contemporary values integrated with the cultural landscape and coherent with the essential value of cultural heritage.
- Group 3 (G3): Enhancement of recognition through the educational function of the local identity through the AR project.
- Group 4 (G4): Enhancing and simulating the production of knowledge through the AR project.
- Group 5 (G5): providing training opportunities for the local community to improve the traditional skills.
- Group 6 (G6): application of an interdisciplinary approach applied to the project.
- Group 7 (G7): Increasing of cultural activities and events because of the AR project.

(Table 3-7) - Cultural aspects. Source:(Arfa et al., 2022)

| | | |
|---|---|---|
| **G1:Authenticity (originality) and Integrity** | 1 | Respect for the building's history, authenticity, and materials |
| | 2 | The old building's unity must be preserved |
| | 3 | Describing the existing building's history |
| | 4 | Preserving and restoring the original design to the greatest extent possible |
| | 5 | Preservation of the characteristics of the existing building |
| | 6 | High-quality building restoration and landscape preservation |
| | 7 | Effective protection of the cultural values of the existing building |
| **G2:Intrinsic value** | 8 | Realization of an existing building with future value |
| | 9 | Proper recognition of the existing values and restoration to the original shape |
| | 10 | An excellent recuperation (recovery) of the existing building |
| **G3:Local identity** | 11 | Presentation of the site's history for public viewing |
| | 12 | Presentation of the long-term and sustained effort to ensure building preservation |
| **G4:Cultural and knowledge capital production** | 13 | Proper narration of the building's history |
| | 14 | Effective recovering of the history of the existing building and its wider context |
| | 15 | Well-integrated into the wider context of the existing building |
| | 16 | Detailed archaeological, structural, and historical research with extensive documentation |
| | 17 | Visitors are given a clear and distinct presentation of the various stages of development. |
| | 18 | Presentation of the building's historical and contemporary functions, as well as its cultural and artistic aspects |
| | 19 | Provision of educational programmed for permanent users and others to increase their understanding of its history and key features |
| **G5:Traditional skills** | 20 | Traditional techniques and crafts are used in adaption |
| **G6:Mutual cooperation** | 21 | Exceptional use of an interdisciplinary approach to the project. |
| **G7:Cultural vibrancy** | 22 | Introducing a new cultural dimension to the area |

### 3.4.3Social aspects

Many authors have addressed the social value aspects in AR projects in the scientific literature from different perspectives. Some of them addressed the need of it to enhance this criterion using various techniques, like involving the public in the process (Balest, J. 2021). As They believe that these methods can enhance the sense of attachment of the local communities to the place. And In order to improve societal values, several researchers have offered design solutions for the (AR) projects. For instance, the authors investigated the AR process and, more specifically, the new addition to an existing building that would highlight peoples' collective memories for the building and the context (Fausto, I.C.I., 2020). Other researchers have proposed tools for assessing the impacts of AR projects in contributing to the sustainable development goals, especially social value creation (Vardopoulos, I., 2021). Social aspects according to the two awards and (Arfa et al., 2022) are illustrated as the following:

- Group 1 (G1): Improvement of beauty, harmony, and aesthetic values of the landscape, enhancement of the atmosphere of the building with the context.
- Group 2 (G2): Enhance integration between different communities and increase building opportunity to have a large participation scale.

- Group 3 (G3): Providing of many educational and learning facilities to enhance local community skills.
- Group 4 (G4): Improvement of safety and accessibility of public spaces for all.
- Group 5 (G5): Using of green and natural materials, enhancing indoor air quality, natural lighting to improve of citizens and users mental and physical health related to the AR project.

With the social aspects for sustainable adaptive reuse projects, the same attention the given to the local community also given to the wider communities, as the balance should be kept between the two groups. When the balance is broken, tourism aspects failure or isolation between target groups of the AR project may occur, both of which could lead to the failure of the project (Arfa et al., 2022).

(Table 3-8) - Social aspects. Source: (Arfa et al., 2022)

| | | |
|---|---|---|
| **G1:Landscape quality and atmosphere** | 1 | Continuation of city dynamics and transformation into a vibrant environment |
| | 2 | Development of the human-natural landscape relationship |
| | 3 | Integration of the existing structure and its natural surroundings |
| | 4 | Having a significant positive impact on the surrounding area |
| | 5 | Contribution to the neighborhood's revitalization |
| | 6 | More space and quality for social and cultural entrepreneurship |
| | 7 | Introducing new intervention |
| **G2:Wider community** | 8 | Rapid recruitment of various target groups to the building |
| | 9 | With an impressive increase in national/international users |
| | 10 | Becoming an interesting place for everyone |
| | 11 | People's access to a closed building is being improved. |
| | 12 | Becoming a new city destination for everyone |
| | 13 | Bringing together larger communities through public and private events |
| | 14 | Adding a new dimension to the area's tourism |
| | 15 | The creation of new job opportunities |
| | 16 | Focused to knowledge transfer in traditional craftsmanship and related fields for the local community, students, and researchers. |
| | 17 | Residents, entrepreneurs, and visitors are making active use of the space (living, working, meeting, and relaxing) |
| **G3:Local community** | 18 | Increasing the local community's attachment to the location (living, working, meeting, and relaxing) |
| | 19 | Preserving the historical stories and memories of the place and its people |
| | 20 | In the process, local skilled workers are employed |
| | 21 | Excellent demonstration (proof) of local support |
| | 22 | Becoming the pride of the community |
| | 23 | Improvements to residents' and citizens' quality of life |
| | 24 | Citizens are extensively involved in the process. |
| | 25 | Provision of public amenities for the benefit of the neighborhood |
| **G4:Safety** | 26 | Contribution to making a safe environment for visitors |
| **G5:Well-being and health** | 27 | Acoustic comfort and visual peace |
| | 28 | The establishment of a vibrant cultural, educational, and social center for residents and others who respond to their needs |

### 3.4.4 Economical aspects

In the scientific literature, study publications that emphasise the benefits of adaptive reuse of old existing buildings along with other additional values, such as social, environmental, and cultural values are generally mentioned as the economical values criteria. But in the regulations of the NRP award, economic value has been illustrated as an improvement in the economic structure and value development of real estate (Arfa et al., 2022). Adaptive reuse projects can create different opportunities from the economical point of view such as generation of new jobs (Bosone, M., 2021 & Regelment NRP Gulden Feniks, 2020/2021), also via place branding the provide more attractive urban areas can lead to the creation of economic values that lead to the increasement of tourists (Arfa et al., 2022), and finally and economic advantages of visiting museums, shops, and the catering industry (Persoon, T., 2019).

Economical aspects have direct relation with the social aspects from wider community point of view, such as (a) Becoming a new destination in the city for everyone, (b) Adding a new dimension to the tourism of the area. As well as the local communities also for the social aspects which the generation of new employment opportunities.

Economical aspect may secure the funding required for the project duration. The potential of AR projects to attract users and visitors from a wide range of population provides funding. Because of its attractiveness, an AR project attract thousands of users and visitors for small cities and boost the local economy. That is an important answer for the concern that asked in chapter 2, that we must assure firstly from the the financial return of the project that will cover it's reusing and maintenance as it is an old building. Economical aspects are illustrated related to the two awards and grouped related to (Arfa et al., 2022) as the following:

- Group 1 (G1): Localization of innovative entrepreneurs, cultural and creative industries, and research and development activities.
- Group 2 (G2): improving of the local economic activities.
- Group 3 (G3): Creation of long-term jobs directly and indirectly linked to the AR project.
- Group 4 (G4): having both the direct and indirect effects on the local economy (e.g., building construction, tourism, research, education, creative activities, and innovation, etc.).
- Group 5 (G5): Self-production of financial resources needed for reusing buildings and continuous maintenance independently from the public sector.

Finally, it is possible to see the similarities between social and economic aspects. Bringing in tourists from different backgrounds and creation of jobs that can improve the social values held by society. Additionally, the start-up of innovative, creative, and creative businesses draws different user groups to the repurposed structure.

(Table 3-9) - Economical aspects. Source: (Arfa et al., 2022)

| | | |
|---|---|---|
| **G1:Attractiveness for creative, cultural, and innovative enterprises** | 1 | Increasing economic value through a variety of activities |
| | 2 | Smaller businesses are housed here, as are workshop spaces for creative businesses |
| | 3 | Enhancement of a specific industry's economic value |
| **G2:Attractiveness for circular cultural tourism** | 4 | Provision of national and international branding |
| | 5 | Having financial benefits from attracting visitors to the heritage building |
| **G3:Jobs creation** | 6 | The creation of new job opportunities |
| **G4:Economic spillovers** | 7 | Contribution to the area's and the local community's economic growth |
| **G5:Financial self-sustainability** | 8 | Creating financial resources for existing conservation through various economic activities |





### 3.4.5Environmental aspects

As mentioned in chapter 2 part 1, AR of heritage and old existing buildings has a direct positive effect on environmental sustainability, as it reduces the amount of new construction materials needed and contributes to saving embodied energy. But there is always a gap between cultural heritage and climate protection either at the broader levels or providing solutions for a particular building, as it is the most challenging among adaptive reuse topics, how can an old building preserve its cultural and unique character within healthier environmental systems. For the environmental aspects that are mentioned at the criteria of the two awards and grouped by (Arfa et al., 2022), there are only two groups which are: Group 1 (G1): Reduction of energy consumption through compatible technologies and self-production of energy sources and Group 2 (G2): Contribution to reduce GHG emissions through various methods.

Which they are not covering all the building system sustainable solutions only the energy efficiency and GHG emissions, but for making the heritage building comfortable and energy efficient, it can be considered as all the building systems to be comfort. Many aspects for achieving "environmental sustainability" for example, freshwater efficiency, water quality, and biodiversity have been not mentioned, the gap between awards criteria aspects and scientific research aspects still missing.

(Table 3-10) - Environmental aspects. Source: (Arfa et al., 2022)

| | | |
|---|---|---|
| **Energy efficiency** | 1 | Making the existing building comfortable and energy efficient |
| **GHG emissions reduction** | 2 | Utilization of low-carbon, sustainable and local materials |
| | 3 | Environmentally sustainable and traditional technologies and design solutions are used |
| | 4 | Making the exisitng building a circular building |
| | 5 | Development of innovative and nature-based building technologies as a model for the long-term transformation of other historic structures |
| | 6 | Making the heritage building as environmentally friendly as possible ($CO_2$ neutral) |

### 3.4.6 Innovation aspects

The NRP award regulations define "innovation" as having creative ideas with exceptional value in areas like organisation, procedure, communication, and technology. It shows the extent to which a project has learning implications for upcoming AR assignments (Arfa et al., 2022). As well as the definition of the term “innovation” is the use of a new idea or method as mentioned in Cambridge dictionary (Cambridge Dictionary, 2011). In terms of the innovation aspects, the effective AR project should have some insightful and useful lessons for other future projects. These lessons can vary from technical installations to the methods and tools which have been used to involve people during the AR process (Arfa et al., 2022). Innovation aspects are illustrated related to the two awards and grouped related to (Arfa et al., 2022) as the following:

- Group 1 (G1): Employment of innovative new technologies during different phases of AR projects using new updated systems while preserving building identity.
- Group 2 (G2): The cooperation between different groups of stakeholders with learning effects for other projects.

Group 3 (G3): Production of useful models to be implemented by other projects (to assure the importance of learning effects of the AR projects in the criterion of innovation.

(Table 3-11) - Innovation aspects. Source: (Arfa et al., 2022)

| | | |
|---|---|---|
| **Using digital and innovative technologies** | 1 | Story preservation and narration via serious game development using AR (augmented reality) and VR (virtual reality) |
| | 2 | Having innovative examples of technology use |
| **Cooperation between different stakeholders** | 3 | Demonstrating perfect symbiosis and cooperation between client, manager, and architect, with lessons learned for future projects |
| **Replicable models in different aspects** | 4 | Becoming a model in various aspects for similar heritage buildings, demonstrating that these heritage buildings have value and contribute to the city's more sustainable development |
| | 5 | Provision of a replicable fundraising strategy designed to be repeated in similar projects |
| | 6 | Being an example of a private initiative to reuse a heritage building that can teach other similar projects |
| | 7 | Demonstrating perfect citizen involvement throughout the process, providing lessons for future projects |

## 3.5 Adaption strategies through space design adaptive reusing

### 3.5.1 Technical general adaptive reuse strategies for spaces design

Most of the aspects mentioned through previous part can be achieved through this general technical strategies adapted from (City of New York, 1999). To ensure a successful adaptation, the





user and the structure must be compatible. A mismatch indicates either the incorrect user or the incorrect building, so matching demand and supply is an important strategy for buildings adaption (Douglas, 2006). In addition to decreasing the future waste streams by design for building longevity and durability, easy removal and replacement-friendly detailing building elements will cut down on future demolition trash and maintenance cost and it is also significant to select building systems that allow for future adaptability and expansion. It is important to minimize extreme changes to the existing layout, if possible, If the building's capabilities don't fit the needs of the users. Working with the building rather than against it is always preferable because it will be less expensive and less likely to have an undesirable effect on the surroundings (Douglas, 2006). When approaching a building adaption, consider creative programming changes that avoid unnecessary reconfiguration and minimize the construction intervention.

### 3.5.2 Space design main elements vs shearing layers of change

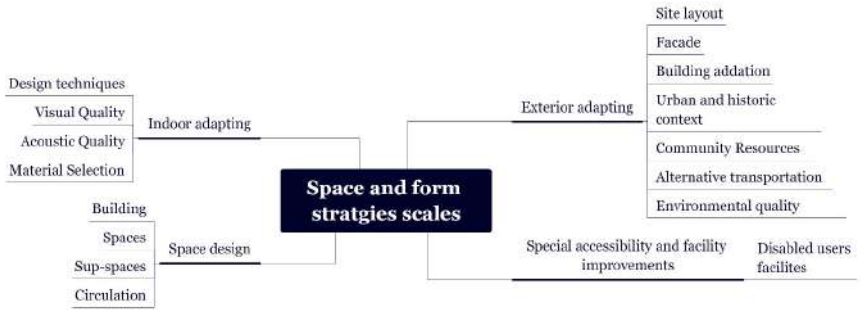
(Table 3-12) - Space design main elements vs shearing layers of change. Source: Author

| Layers of change/Design Adapting grouping | Exterior Adapting/Form | Space Design | Interior Adapting | Special Accessibility |
|---|---|---|---|---|
| Site | ● | | | |
| Structure | ● | ● | ● | |
| Access | ● | | | |
| Skin | ● | | | |
| Services | | ● | | |
| Space plan | | ● | ● | ● |
| Stuff | | ● | ● | ● |
| Souls | ● | ● | ● | ● |

As per mentioned previously by (Brand, 1994) and illustrated by the author on theoretical concepts part of the reviewing, every building has shearing layers that affect each other and must be taken into consideration within the adaption process of it. By applying this concept, it is observed that each element of space design affects different layers of change, the exterior adapting affects site, external structure, access to the building, as well as the skin and souls that use building and approach it. Layout spaces design and interior adapting mainly affect the same shearing layers of change which are the internal structure elements, buildings services, space plan, stuff, and souls. However, the special accessibility affects mainly three layers of change which are the space plan, stuff, sand souls.

### 3.5.3 Classification of space/form adaption strategies elements and sub elements

Strategies for space and form design are divided into these elements and sub elements as showed in figure 25:




(Fig.24) - Space and form strategies scales. Source: Author

### 3.5.4 Space and form adaption design strategies

***Exterior adapting strategies***

Integrating the building into the surroundings is a significant strategy as it is the approach and the first perception to people. Design the building as a series of interconnected spaces with the surrounding natural and the built environments to maximize its interaction, increase permeability, and improve accessibility (Nakib, 2010). These can be achieved through site layout, façade, building addition, urban context, community resources, environmental quality, and transportation.

*Site layout*

It is important to maximize utilizing the site's physical characteristics and microclimate that will lead cutting heating and cooling loads, resulting in a reduction in overall energy usage (City of New York, 1999). Through some strategies as (a) incorporating of outdoor recreational areas that have multiple functions in addition to visual value. For example, rooftops can be used as gardens, also the water features in the landscape can provide both cooling and recreation, (b) Using of earth forms, plantings, drainage and water detention systems, and soils to support the functions of the building and site (e.g., screening, windbreaks, etc.), (c) Use courtyard pavements that retain heat with shading that stop winter winds, and let summer breezes in, (d) Design landscaping that optimizes selection and positioning of plants for sun and shade, and finally (e) Include enough room for recycling operations and servicing, including collection, storage, and access for collection vehicles.

*Façade*

Those are four main strategies for reusing building facades that can retrofitted and adapted to present and future uses. It is important to adapt facades to the new use with minimum changes, so avoiding the excessive ornamentation while paying attention to the details (Nakib, 2010). This makes it simpler to adapt to new uses. However, it is important to redesign or add façade new





elements on the modular system that it is designed on to allow replacement, updating, integration of new technological features and suit of fashion (Salingaros, 2000). Also, the amount of changes made to the current existing modular should be maintained to a minimal. Use existing openings and keep any new ones to a minimum (Douglas, 2006). However, versatile envelop able to meet the building internal changes is significant in the adaption process. As an example, the double façade, when possible, to allow absorbing internal changes without affecting the exterior skin (Nakib, 2010).

*Building additions*

The choice of new additions location is necessary for adaptive reuse buildings. Because such an expansion has the potential to significantly alter the historic and the old appearance of the building. Based on (Secretary of the Interior's Standards for Rehabilitation & Morton et al., 1992 & Birnbaum et al. 1996 & Vonier et al., 1981) recommendation regarding building additions.

- Place the external alterations as well as the balconies and greenhouses in the back or on a side that is less visible of the main elevation structure that identify the building with the historic context considerations regarding the site.
- Place a new addition that may be necessary to increase energy efficiency on noncharacter-defining elevations or on the roof top.

Furthermore, there are two significant design characteristics according to (Douglas, 2006) which are the Harmonization, which refer to the exterior alterations that made to the current structure, like the extensions, should blend in with the context properties. For instance, the design could either complement or contrast with the one of the current existing structures whether it is historical or not, and the Dominance as any external works should form integrated addition to the original building.

*Urban and historical context*

Before the reusing process, some legislative reviews should take place in order to effectively respond to the cultural issues, such as reviewing of the land use patterns in the area, reviewing the site's cultural resources for possible reusing or incorporation. In addition to examining the architectural style(s) present in the context surround the building and analyze the cultural features and activities in the area with the identify of possible connections to the reused project. And as a servicing systems to the reused project, checking existing infrastructure and utilities is important. Analyzing transportation system and existing/potential linkages to the site (City of New York, 1999).

*Parking, Impervious Surfaces, and Heat Island Effects*

In order to minimize the effects of heat islands, the amount of impervious surface (paved) on a site or building landscape should be kept to a minimum. As reducing the number of impervious surfaces, causing a lower microclimate temperature of the site, lowering building energy consumption, and reducing the temperature stress on wildlife habitat. It can be reduced by mini-interventions can made during the adaption construction process within the building and it's context as mentioned in (Donald F. Fournier and Karen Zimnicki, 2004) such as:

- Minimize impervious surfaces by sizing parking capacity at minimum requirements or adding no new parking, the shared parking among several buildings in the same area and also providing parking for vanpools for 5 percent or more of the building occupants with the using of an open-grid pavement system with a net impervious area of less than 50 percent. Of equal importance the attention for the addition of parking's or loading docks or ramps to be function well and not affect the identity of the building context.
- Retain plant life, trees, and landscape elements, especially those that serve as windbreaks and sunshades for passive solar energy. Shade at least 30% of the site's non-roof and heat-absorbing surfaces.

*Alternative transportation*

As a sustainable strategy, the site should provide facilities to encourage the use of electric automobiles, carpooling, mass transit, bicycles, and other less-polluting modes of mobility. And ensure there are enough bicycle amenities. Include amenities like lockers, secure interior and/or external storage, and showers this is regarding to the urban projects not the buildings scale. For the building scale, building can provide bus stop seating areas covered, wind-sheltered bus stop or waiting areas within enclosed building lobby (City of New York, 1999).

*Environmental quality*

The Secretary of the Interior's Standards (Donald F. Fournier and Karen Zimnicki, 2004) advice preserving the historic link between the buildings and the landscape and not proposing a new landscape elements, including plant material, that is visually incompatible with the site, or that modifies or destroys the historic and cultural context patterns. New landscape features, such as shade trees, may be added if they are visually harmonious with the site and do not disrupt the context patterns. If new trees are to be planted on a historic site, native trees or shrubs should be used. From design point of view, coordinating landscape design with building envelope design is important. For example, use plant materials to screen parking and service areas, or orient a conference and meeting room windows toward a pleasant view. Cooling demands can be reduced within the building by using shade trees and outside structures such as louvres and pergolas (City of New York, 1999). Considering hot climate not Rainey regions reduce plant types that needs frequent irrigation and upkeep. Consider automatic sprinklers irrigation and other water-saving

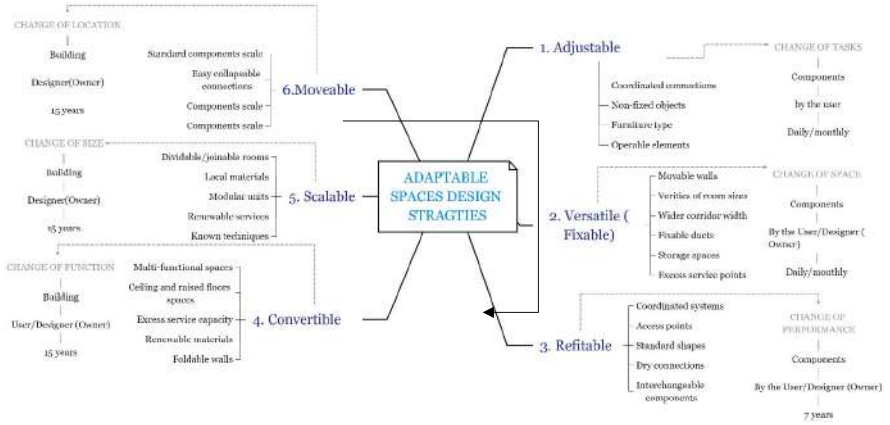




irrigation techniques if irrigation is required. Plant diversity, species native to the location and microclimate, and plants that naturally grow together and are self-sustaining should be prioritised (City of New York, 1999).

***Space design strategies***

In the reusing process, it's important to separate each building layer's components so they can be easily upgraded, added, replaced, or removed without affecting the other layers or the entire system. Creating a structure as a collection of separate, system-based layers (see table 3-12) arranged hierarchically based on the building's predicted longevity and rate of change will increase its adaptability (structure, circulation routes and access, envelope, technical services and installations, space plan and furniture) (Nakib, 2010). Some spaces and building components change over time, making the building redesign able. Figure 26 connects stakeholders, scale, time, and layers to design strategies. Each strategy has a defined type of change, a decision maker, and a built environment scale. The strategies work on different cycles and building layers (Schmidt III, R., 2009). First, "adjustable" refers to a building's versatility. This changes the brand's souls by modifying furniture, connections, and module systems. Versatility is the ability to change the internal space of a building using modern service systems and changeable panels. Refit, the ability to change building components, considers detachable, degradable, mobile, movable, and collapsible components. And convertibility, which determines building uses/functions. Buildings need internal and external changes. The building's scalability strategy requires changes in four core layers: space, service, skin, and structure. Movable strategy explains location change (Anupa Manewa, C. P., 2013). Less risk, higher return from 1 to 6.




(Fig.25) - Adaptable redesign strategies that apply layer independencies. Source: (Adaptable future, 2012 & Schmidt III, R., 2009)

The adaptable redesign for old building should include main spaces that are both **trans functional and multifunctional**, allowing for a wide range of purposes as well as the production of unique, unpredictable activities based on the experiences and space needs of the users (Nakib, 2010). In addition to the **mobility** through using partitions and furniture that are light, mobile, demountable, reusable and recyclable. A design that supports the **elasticity and divisibility** that support the building to extend vertically or horizontally and can be divided into multifunction.

Also, for the sub and supporting spaces should be **fluid and continuous** the design of storage and its location must be arranged within the main spaces carefully. Of equal importance, the buffer zones that allow absorbing of the overflowing caused by the frequent change of close spaces. The buffer spaces should have their own function which can change according to the needs. In addition to the circulation routes should be **alive, animated, and interactive** and should be able to host many activities without dead ends and bad circulations. That within the minimum changes and interventions for the existing structure. These redesign strategies can be applied by the following techniques:

- Versatility
- Modularity
- Divisibility and Elasticity

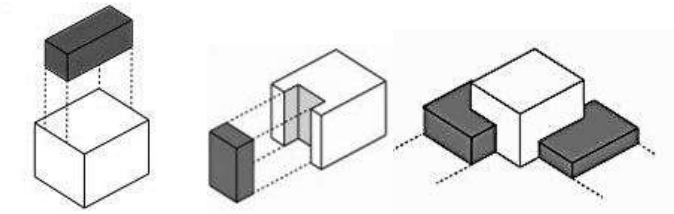
Unitary space is the opposite of versatile space, which are the spaces that multipurpose. While unitary space is only ideal for one function, versatile space can accommodate a variety of uses. It is important for the building to include spaces that can accommodate different activities easily. Function has certain relation with three factors of a space: size, shape, and quality. And for the functions that occurs in a series of spaces, linkage between them plays an important role. For the **size**, versatile space contains functions requiring similar size. As an example, an open workplace could be made into a smaller space by adding some partitions. Additionally, by putting a wall in the middle of a larger bedroom that was properly planned, two smaller bedrooms might be created in an apartment. Every function has a certain **shape** within the space as the meeting room has common shape which is the rectangular shape to support the long meeting tables so, versatile space could satisfy functions requiring similar shapes without changing itself. On the other hand, the quality is another important factor of space-function relation. The **quality** of a space concerns lighting, ventilation, sunshine, temperature and so on. Versatile space contains functions requiring similar space qualities (Peng Yigang 1983 & Stephen Kendall., 2002). By changing the **connection** between several areas, versatile space may support various functions. A large building's floor plan can be divided in different ways, such as into closed rooms connected by a corridor for office use or into a series of rooms connected one by one for exhibition. The function is different when changing the linkage.





A design technique known as "modular architecture" or "modularity in design" separates a system into smaller components known as modules that can be independently produced and then used in multiple systems. The benefits of modular design are the flexibility in design and reduction in costs in addition to the combination of the advantages of standardization with those of customization. It is significant to use the modular approach in architectural designs as it characterized by upgradability, serviceability, flexibility. Also, modules can bd replaced or added without affecting the rest of the system. This system can be efficient in buildings that have few similar functions that can be designed by one module and its flexibility with other modules. As using the same module in multiple configurations enabling a large variety of designs without using any component types (Cohen, Jean-Louis., 2014 & Holtta-Otto, Katja., 2005 & Jodidio, Philip., 2004 & McCluskey, Alan., 2000).

Divisibility and Elasticity of spaces can be applied by three techniques mentioned by (Brooker,G. and Stone, S., 2004). Brookner and Stone developed three techniques of building reuse based on the extent of integration between the host building and the new elements added to it. These strategies are intervention, insertion, and installation (see fig. 27). Installation is that the old and new buildings elements exist independently, and the new elements are located within the boundaries of the existing building. The new element design may be influenced by the existing building, but they are not necessarily compatible with it. Upon removing the installations, the existing building may revert to its original state. Insertion is a new, independent element that is suited exactly to the existing. The element is constructed to fit and is located within the boundaries of the existing building also. And finally, the intervention technique which is a major transformation undergoes to the existing so that it can no longer exist independently. The old and the new additions are completely integrated.



(Fig.26) - Installation, insertion and interventions techniques, Source: Elina Amiri., 2020.

***Indoor adapting***

High performance buildings reflect an interest in the overall quality of the indoor environment. They provide supportive environmental conditions, such as thermal comfort and sufficient indoor air quality, visual comfort, and adequate auditory quality in addition to the interior design tactics that can be applied through adaption process.

*Interior space design techniques*

This tactics reflects the aspects of the building structure, such as how it sounds and feels. It is a method of organizing aspects and supporting with the adaption plan. They express how we use the building and give unique personalities to locations. But this is depending on the owner requirements and the building conditions. Tactics divided into 6 sections and each concentrate on a different aspect of use elements in remodeling and their relationship with the building according to (Brooker, G. & Stone, S., 2004) which can achieve through:

a) Lighting: lights can affect the experiences of spaces on the way the designer need, it is a necessary element to control the spaces and the form. Natural and artificial light can achieve different experiences, spotlights also, affecting the quality of movement through lightening guidance within the spaces and also highlighting and emphasis on important architectural and iconic elements.

b) Surface: materials of surface can show the character of the building as the surfaces are the most contacted elements to the user. Through different materials and their properties as brick, steel, iron, concrete, glass, or transparency objects designer can create different modes and experiences.

c) Openings: there are many functions for openings in spaces rather then it is a source of lightening and movement, it can act like extension of a journey in a space, circulation guide, boarders between public and private areas and a frame for picture like-view.

d) Movements: movements in buildings expresses the access between spaces and areas in the building. It can be illustrated through reusing projects in stairs, ramps, corridors, bridges, can link between spaces and levels, and can be a focal point in the building.

e) Plans: they are the elements that create the spaces in the building. It can be used in the adaption process horizontally or vertically, inside or outside, permanent or temporary, visual or acoustic protection, divide spaces through walls, floor, screens and skins.

f) Object: they have a variety of shapes and scales, and it can be used inside spaces or outside to get the attention through something. As an example: small pieces of furniture, large sculpture, pivotal points objects, furniture type that support the function of the space and objects that can express the human scale.

Paying more attention to the interior environmental factors of spaces can improve workplace quality of life by enhancing overall physiological and psychological well-being. Such as





the visual comfort that include lighting quality (e.g., illuminance or intensity of light that impinges on a surface, glare, and light spectrum), visual contact with the outside, and the availability of natural illumination. In addition to the acoustical quality is achieved through absorbing noise through the building envelope. At equal importance also the material selection of new adapted elements in building.

*Visual quality*

Daylighting provides a rich spectrum that increases eye clarity when managed by building openings, glass types, and the design of reflecting surfaces. Its dynamic variations throughout the day provide visual stimulation while also keeping us connected to the outer world. These can be achieved through building adaption process through these techniques according to (City of New York, 1999):

a) Daylighting apertures: using of glazing systems and shading devices that are suitable to the orientation and the space use.

b) Light shelves: Extend window light throw using light shelves louvers, and through suitable room surface reflectance and colors.

c) Diffusers: Choose diffusers that reduce glare while appropriately illuminating ceilings and walls to generate a visual field similar to that of natural daylight.

d) Views: Relocate new function spaces organization and floor layout that gives each occupant adequate visual access to the outdoors and to the general organization of the building.

e) Color: Provide lamps with high color rendering index.

*Acoustic quality*

A good acoustic environment keeps noise levels low enough so that it does not interfere with activities within the designated space. There are three architectural issues to consider: sound isolation, noise and vibration control in building services rooms, and room acoustics. The intensity of noise and vibration from adjacent sources and activities will determine the sound and vibration isolation needs for a specific space. To achieve positive acoustic quality in a room, spatial configuration must be designed for appropriate noise patterns through two important techniques (City of New York, 1999):

a) Control Noise at the Source: through relocating the new functions spaces that needs more quietness in places such that external noise sources can be reduced by distance or by topographic features or walls, select mechanical and plumbing devices, ductwork, and piping that generates less noise, and if the building has already good

servicing work, their spaces can be well isolated in addition to avoiding allocating mechanical equipment above or adjacent to noise-sensitive spaces.

b) Reduce noise along the transmission path: separate between noise-producing and noise-sensitive spaces by such as corridors, lobbies, stairwells, electrical/janitorial closets, and storage rooms, This will reduce the need for more complex acoustic separation solutions, also consider using sound-rated acoustic doors with acoustic barriers around them, in addition to avoiding the allocation of outside air intake or exhaust air discharge openings near windows, doors, or vents where noise can re-enter the building as well as using sound-isolating rectangular ducting, to reduce noise in ductwork.

*Material selection*

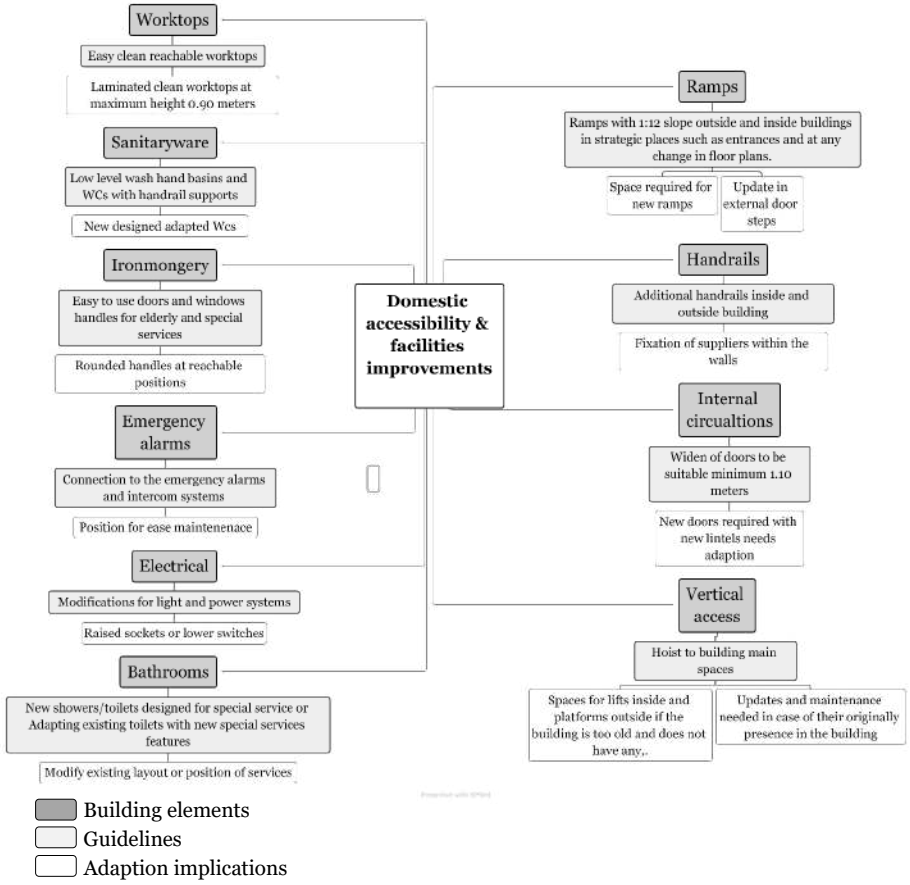
Environmental and health considerations must be taken when selecting materials and products for high performance buildings, in addition to more criteria such as cost, durability, performance, and aesthetics. Because of the difficulties involved in determining appropriate materials, advisors should be knowledgeable with the important health and environmental risks related with various material types. This dynamic and expanding discipline incorporates new materials assessment ideas such as embodied energy and product life cycle assessment. Selected materials should have limited or no chemical emissions, which provide poor indoor air quality, also they must not contain highly toxic compounds, durable and have low maintenance requirements, have recycled content easily reused and easily recycled and also Contain no CFCs, HCFCs, or other ozone depleting substances obtained from sustainable harvesting practices (such as certified wood products from local resources and manufacturers with low embodied energy (City of New York, 1999).

***Domestic special service and facilities improvements***

John Miller, a Member of the Centre for Accessible Environments (CAE), has defined an access audit as: A walkthrough survey to evaluate a facility's accessibility and usability by disabled people who may work in or visit the building. specific recommendations for modifications/improvements. Also, the designer for any adapted building needs checklist for special improvements as (a) Who are the disabled people – are there any restrictions, what range of disabilities need be covered? (b) Are there separate routes or areas for visitors and staff – is the audit required to be the same in both areas? (c) What criteria are to be used to assess the building, (d) Do the recommendations need to be costed and/or prioritized? and (e) Is the means of escape in case of fire to be considered.








(Fig.27) - Special accessibility and facilities improvements, illustrated by the author, Source: (Douglas, 2006)

## 3.6 Adaption strategies through services retrofitting

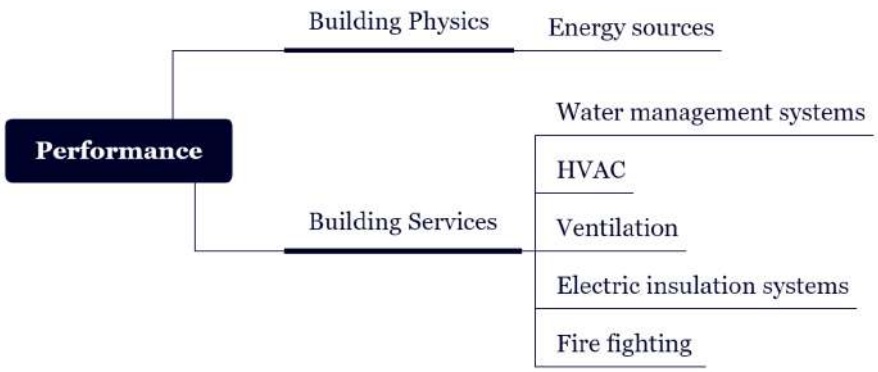
### 3.6.1 Technical general retrofitting strategies for building services

Without the suitable adaptation of technical building components, architectural adaptability cannot be achieved (Nakib, 2010b). Servicing and technical installations are regarded as a key factor in adapting buildings (Kronenburg, 2007) and should be designed for durability, expandability, replacement, recyclability, maintainability, energy and material efficiency, and sustainability. Therefore, the following recommendations,

which are primarily based on the work of Geraedts (2001, 2008), must be followed in case of updating services systems or retrofitting it.

- Utilize dropped ceilings, raised floors, central cores, etc. to make technical components and installations easily accessible. This allows for straightforward maintenance and upgrade without disruption just to accommodate future HVAC, power, lighting, and fire protection system modifications.
- Avoid ducts and pipes embedded in the other systems of the building (structure, walls, floors, or ceiling).
- Also, for facilitating the maintenance and repairing, make a distinction between communal and individual installations.
- Adopt prefabricated and standardized components and promote modular coordination (design and construction based on a fixed module) to facilitate easy replacement and recycling.
- Use durable, recyclable, efficient and sustainable components.

**3.6.2 Classification of performance adaption elements and sub elements**




(Fig.28) – Building performance adaption strategies main and sub elements, Source: Author





**3.6.3 Performance adaption strategies**

***Energy sources***

Various energy sources are available today. Designers should first invest on conservation techniques, then work to achieve an appropriate, integrated balance of solar heating, daylighting, energy entrained within the earth. This integrated approach to whole building design reduces the production of greenhouse and preserves natural resources; and slows the depletion of fossil fuel reserves. Energy sources are listed in the preferred order of deployment, based on their capacity to reduce environmental impact from emissions (City of New York, 1999).

*Renewable energy sources*

a) In place of exterior wall and roof panels (building integrated PV) are photovoltaic (PV) panels that generate electricity for the building
b) Daylighting techniques that complement or replace conventional lighting.
c) Solar energy heating technologies. Large institutional buildings, such as lobbies, corridors, and atriums, are suitable for passive solar heating.

***Water systems management***

*Water supplies*

Since drinking water is a food, the Drinking Water act must be followed in every way. If the recommended limit values for the water's components are exceeded at the building's draw-off points (e.g., due to contamination from old lead pipes), the causes must be identified and eliminated. Modern drinking-water systems must generally be designed and installed in accordance with the international standards. As after 0–50 years, a drinking-water system must be completely refurbished, and partial refurbishment may be required for systems 30–40 years old. The condition of the system is determined by randomly removing sections of the distribution piping and examining them for encrustation and corrosion. Here are some international standards according to DIN 1988, DIN EN 1717, DIN EN 806, and DIN 50930. The data sheets of the DVGW (German Technical & Scientific Association for Gas & Water) (Petzinka, 2022):

a) Connection to public main: In the case of any adaption, residential and commercial properties should be equipped with a room for incoming services in accordance with DIN 18012, all services on the street side of the building if one does not already exist.
b) Water treatment: Filters protect the building's installations from contamination. Installation of dosing units can protect against corrosion, furring, and excessive release of heavy metals. However, because these devices release chemicals into the system, they should not be retrofitted until the drinking water has already been contaminated.

c) Distribution pipework: Existing pipework must be inspected for leaks, materials, dimensions, and compliance with the applicable regulations and standards. As Extremely large pipe diameters cause water to remain in the pipes for a longer period of time, which increases metal concentrations in drinking water.

d) Routing of pipework: the direct connections between drinking water and other types of water is prohibited and must be immediately severed. Also, it is recommended should not be any connections between hot and cold drinking water. Existing installations must be checked to ensure compliance with these requirements.

e) Always locate the drinking-water supply pipe below all other pipes to prevent corrosion of the other pipes in the case of condensation.

f) Materials: In older structures, the majority of water pipes are made of galvanized steel, copper, and occasionally lead. The material must be selected based on the local water supply's characteristics and the desired operating temperature.

- **Galvanized steel pipes:** Pipes that have been bent must be replaced because the zinc coating on the inside can flake off, leaving the pipe vulnerable to corrosion. Lead and cadmium in drinking water can be caused by contamination in the zinc coatings of older galvanized steel pipes.
- **Copper pipes:** Copper pipes have a high degree of flexibility, making them ideal for refurbishment projects. When the pH of the drinking water is below 7.4, however, copper pipes should be avoided because excessive surface corrosion is likely to occur.
- **Lead pipes:** There are lead pipes in buildings constructed before 1935. It is impossible to comply with the maximum lead concentration values specified in the Drinking Water Act without replacing all lead pipes.
- **Plastic pipes:** In the early 1960s, PVC pipes were introduced for the first time. These pipes typically consist of unplasticized PVC-U, PE-HD or PE-LD and are only suitable for use with cold water.

g) Using of gray water: grey water contains dirty and excessively soiled kitchen wastewater. Once treated, it can be used for flushing toilets instead of drinking water. But greywater systems need additional, elaborate cleansing components. Additionally, grey-water systems require separate drainpipes. These systems have only existed for roughly ten years, and there are relatively few in use. Due to the requirement for separate waste-water piping, retrofitting such a system is very difficult and expensive.





*Water drainage*

We can divide wastewater into black water, grey water, and rainwater. The system of public sewers is either a combined or a separate system, and where a separate system is used, wastewater and rainwater must be drained separately from a building plot. Here are also some international standards according to DIN 1988, DIN EN 1717, DIN EN 806, and DIN 50930. The data sheets of the DVGW (German Technical & Scientific Association for Gas & Water) (Petzinka, 2022):

a) Connection to the public sewage system: In buildings constructed prior to 1940, connecting drains are too small for modern needs, have become at least partially clogged, and have developed leaks over time. In accordance with the applicable Federal State Building Regulations (LBO), the local authority may require that drains be routinely inspected for leaks. Leaks can be detected through vacuum or pressure testing.

b) Drainage pipe work: The sanitary appliances drain through branch discharge pipes into vertical discharge stacks, which are typically ventilated via a vent pipe located above the roof level. The discharge stacks drain into drains that are typically installed beneath the foundation and are no longer accessible. The connection to the public sewer system is made via a drain from the property line or an inspection chamber.

c) Routing of pipework: The drains are installed beneath the basement floor slab or in the ground. If drains below the ground slab are the source of problem issues, it may be simpler and less expensive to lay new discharge pipes throughout the building and connect them to a buried drain outside the building than to renovate the existing system.

d) Rainwater drainage: If the rainwater is to be utilised, it must be collected in a storage rank and pumped as necessary throughout the building in case of high raining regions but as an area like Egypt collecting and draining rainwater correctly is important.

***HVAC systems***

*General guidelines*

Most of old buildings do not have HVAC systems, and even building had, they are old and do not environmentally friendly. Mechanical systems must collaborate with the building's layout, orientation, envelope, lighting strategies, electrical equipment, and site characteristics to reduce reliance on fossil fuel energy and increase the use of renewable energy. Here are some technical general strategies regarding HVAC systems for old building adaption according to (City of New

York, 1999). Considering all the building architectural features when selecting HVAC alternatives and sizing the systems is very important in cost and efficiency. For the same importance is the system zoning, to avoid overload energy and cost, such as using separate HVAC systems to serve areas with different hours of occupancy and special occupancies such as computer rooms requiring 24-hour operation, spaces with different exposures. In redesigning and relocating space's function, consider independent mechanical rooms on each floor to reduce ductwork and enhance the balance of delivered air. In addition to evaluating various sizes and models of chillers to determine which unit(s) will meet demand requirements most effectively with avoiding usage of use CFC/HCFC refrigerants as such refringent are harmful on the environment.

*Cooling*

As the research concentrate more on the hot regions area, and adapted the case study of Egypt especially, so cooling rooms adaption guidelines and standards with be illustrated deeply through the following systems according to (Petzinka, 2022).

a) Capillary tube mats illustrated in figure 30: Various systems exist for cooling without mechanical ventilation in conjunction with a central chiller plant, should such a system be necessary for an adaption projects. Those systems that circulate cold water via cooling elements Capillaries and pipes are ideally suited for installation in an existing structure. In addition to standard components, capillary tube mats can be plastered over after being attached to the underside of a structural floor or a suspended over the ceiling. They must be connected to the Coldwater system of the chiller plant. And can be used for heating as well because it can be integrated into the hot-water heating system of a building.

b) Split air-conditioning units: They are compact and well-suited for retrofitting individual building sections. However, their high energy consumption makes them inefficient, and the exterior components significantly not recommended for facade's aesthetic appeal. This type of unit can usually be used for heating and cooling.

c) Decentralized ventilation and air-conditioning: they are suitable for adaption projects as they do not require large air ducts and from the energy viewpoint; their water consumption is low. They can be individually controlled by users, which is a distinct advantage in small scale building. They can be added to an existing structure by integrating them into a spandrel panel, raised access floor, or suspended ceiling, these units. The system needs a water supply as well as an expelled-air outlet and a fresh-air inlet, which must be considered during the adaption. they are not suitable for use in highly polluted inner-city areas although it has such a filter.





d) Central air-conditioning: these systems require large duct cross-sections for transporting the required air volumes, which makes it difficult or impractical to install such systems in existing buildings. There are two systems which are the twin duct air conditioning and the single one which is better from energy point of view. If the clear ceiling height of the existing building can be increased during refurbishment, the existing low-pressure system can be replaced with a high-pressure system, allowing for a 75 percent reduction in duct cross-sections which can reduce in cost of system adaption with zero-CFC products.

e) Solar cooling systems: Low water consumption and the use of solar energy result in a high correlation between external heat loads, cooling needs, and the performance influenced by incident solar radiation in such a system.

(Fig.29) - Capillary tube mats, Source: (Petzinka, 2022)

***Ventilation***

Interior ventilation must be ensured for hygiene reasons. An individual's need for hygienic air depends on the surrounding conditions and their activities. There are mainly two main systems of ventilation according to (Petzinka, 2022) which are:

*Natural ventilation*

In order to prevent damage to building components and to minimize ventilation heat losses, it is important to ensure that the enclosing thermal envelope is airtight when performing adaption to the existing building. Natural ventilation via the windows is readily accepted by users. Rooms without windows must be ventilated in another ways. Rooms located away from the facade may be ventilated by thermal currents created by warm waste air. The replacement fresh air for these rooms is provided either by a separate shaft or by rooms adjacent to the façade.

Consider incorporating natural ventilation strategies into the design of HVAC and exterior wall openings in order to reduce reliance on mechanical ventilation during transitional seasons (City of New York, 1999).

*Solar ventilation*

There are also the functional solar ventilation systems (such as solar chimneys), some of which include solar air preheating. Most rely on specialized mechanical air handling. Such systems can be integrated into existing structures.

*Extract systems*

They are usually installed in the kitchens and bathrooms. Permanently and without user intervention, extract systems guarantee optimal indoor air quality. They offer an alternative to natural ventilation through the windows and can result in significant energy savings.

*Ventilation systems with and without heat recovery*

Only modern structures feature ventilation systems. If a building is to be equipped with a controlled ventilation system, supply and extract ducts must be installed. Such a system permits precise control of the fresh-air and exhaust air flows for individual rooms and the entire building.

Existing ventilation systems must be checked in existing projects to determine its condition, the ventilation ducts, and the air outlets, as well as the system's compliance with the requirements. Those ventilation ducts that can be visually inspected from the exterior should be inspected for leaks using a smoke test. All leaks must be sealed, and components or routing that contribute to unfavorable airflow must be replaced or altered.

***Electrical insulation systems***

Existing electrical installations can be maintained and repaired in accordance with obsolete standards. However, if parts of a system are replaced or added, the entire section must be updated to adapt to the most recent codes of practice. The wire cross-sections utilized in electrical installations constructed prior to 1950 are typically insufficient for today's electrical power demands. Installations from before 1940 frequently contain distribution and safety components that should be replaced immediately, and installations from before 1930 may contain inoperable distribution and safety components. Regarding the connection to the main public grid, there should be no gas and water pipes within 1 m of the incoming electricity supply (Petzinka, 2022).

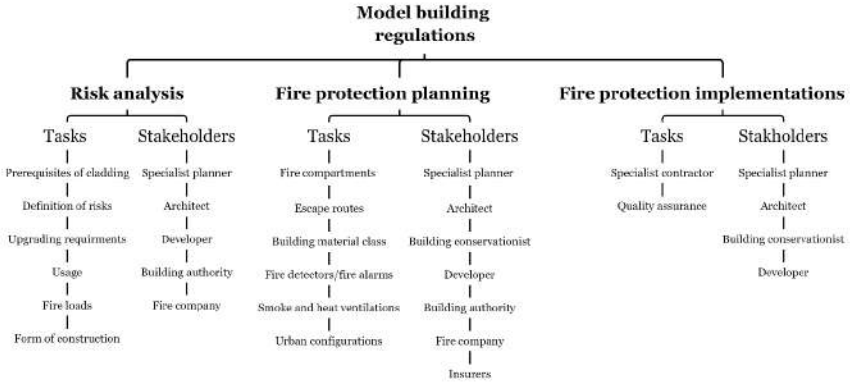
*Fire fighting*

In terms of fire protection, many existing structures are deficient. For the result of not protected escape routes, flammable materials within the building, and subsequent modifications to the building. Typical fire protection deficiencies are the escape and rescue routes do not match the specifications, Fire compartments are subdivided originally based on current usage, poor fire





resistance in components and separating components and the impossibility of employing proper fire-fighting new techniques. During the planning phase, solutions should be developed within the scope of a fire protection concept and should specify any existing risks and the measures required to mitigate risks.




(Fig.30) - Systematic approach to drawing up fire protection concepts for existing buildings, Source: (Krause, 2022)

# Chapter 4: Design of framework

## 4.1 Introduction

This chapter introduces the relationship between the sustainable adaption aspects and sustainable reusing strategies. The first step in the framework is identifying the relationship between architectural aspects and others, as the architectural aspect is the field scope of the research, the most used in research studies, and the other aspects can be achieved through it but not the visa versa. Using a matrix to relate aspects to each other with a numbering and grouping system (see table 4-13).

The second step, identifying which strategies scales can achieve those architectural aspects, as an example respectful intervention to the architectural essence of the building and its surroundings aspect can be achieved through the exterior scale strategies and having multi-functional spaces for hosting different functions aspect can be achieved through space layout scale strategies.

And after identifying the correlation, how can we test building applicability for those strategies? A simple evaluation tool was proposed which assigns scale and elements of strategies with their building shearing layers of change, indicators for their achievement and means of verification, 0% cannot be achieved, 50% cannot be totally achieved, and 100% for the total applicability for this strategy. And the best case, of course, is to be 100%. The framework is tested and applied on the real ground through 3 methods, which are: reviewing international reference cases; professional field consultants' interviews; and application of the framework to a local real-case study.

First, select a case study, which is the Al-Tahir complex building for more than one reason. and then selecting three successful reference cases like the case study, which have similar scale, in live areas, conversation of use from offices to hotels, and are sustainably adapted. After that, a phone structured interview with Mostafa Abu-Lela, who is the business development manager of SIGMA properties (S.A.E), which is a property management company in Egypt specialised in developing old buildings, with about 25 years of experience, and Professor Mohamed Reda





Abdallah, who is an academic professor at Cairo University and director of the building technical rehabilitation centre in the university.

## 4.2 Framework objectives

The framework at the end of the chapter illustrates the correlational sustainable aspects for the spaces and the performance with adaption strategies assuring the creation of an environmentally adaptable flexible design that achieve the following:

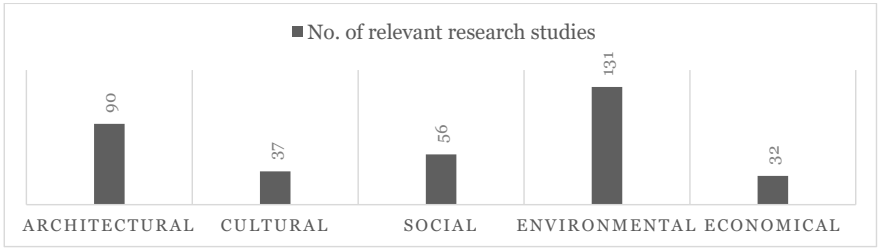
1. Adaptable and flexible design exterior and interior spaces for future changes connected to sustainable architectural aspects.
2. New technical systems related to the environmental aspects that achieves the followings:
    a. Reduction in energy and resources for the new systems.
    b. Reduction in the construction, refurbishment, and demolition waste flow due to resources efficiency.
3. Preservation of the embodied energy present within the existing and in-use structures from vanishing due to the demolition stage.

Extension of the lifespan of building structure as well as its value.

## 4.3 Framework methodology

This framework connects sustainable aspects with design guidelines for adaptive reuse of existing buildings. (a) Reviewing sustainable aspects related to adopting buildings to new uses through (Arafa, et al., 2021), which provides a comprehensive overview, has been used to describe the effectiveness of adaptive reuse of old existing buildings and improving AR projects from reviewing jury reports of two highly acclaimed awards in the Netherlands (NRP Golden Phoenix award) and Europe (Europa Nostra). Which The jury announces nine NRP winners in transformation and 39 Europa Nostra winners in conservation. Douglas, 2006, only considered projects that changed their original function. These criteria and aspects can guide AR to a successful outcome. (b) According to different sources and awards, relevant aspects are: (Social-Cultural-Environmental-Economical-Innovation-Architectural). (c) Examining how architectural elements affect each other, (d) Examining building design guidelines from four perspectives: exterior adapting/form/site, space design, interior adapting, and special design requirements; (e) defining relationships between aspects and guidelines. Most studies agreed on the five sustainability aspects for adaptive reuse: architectural, cultural, environmental, social, economic, and innovative. Many studies describe architecture as functional and physical.

According to, the environmental and innovation aspects are technological, legal, cultural, and political (Conejos, 2013).




(Fig.31) - Number of relevant studies for adaptive reuse sustainable aspects, drafted by the author, Source: (Conejos, 2013)

It is observed that the architectural aspect and the environmental one is the most mentioned aspects in the relevant studies (see figure 32), the reason for that will be discussed deeply under the title (The relation between the aspects) in this chapter.

## 4.4 Relation between architectural aspects and the other aspects

Reviewing different literature provides an overview of the aspects that directly affect the process of building adaptive reuse. Those aspects are the cultural, social, environmental, innovative, economic, and architectural ones. Those aspects revolve around two main axes, which are the people and the surrounding environment. Listing and connecting aspects to each other supports the aim of the chapter, which is the correlation between aspects and guidelines of the adaptive reuse process. First, the correlation between different aspects must be identified. The correlation is analysed by identifying the degree of connectivity between the architectural aspects and the other aspects. Firstly, it is observed that there is a strong direct relationship between the architectural aspects and the cultural ones. Analysis of the different parts shows that people, their stories, and their experiences in the space are at the heart of how well both the cultural and architectural parts work. The improvement of the physical and design aspects and preserving the historic and cultural aspects of the reused buildings play a parallel role in improving the effectiveness of the reused heritage buildings. But this direct relationship depends on the old function and the cultural value of the building. Restoring the building's architecture and site culture does not depend on the old function of the building, as there are many old functions that don't need to be recalled or restored in the new function or design. However, the building's value, history, and location may play a role. Aspects such as clear presentation of the original function of the building in the new design from complementary redesigns grouping and reversibility of the new additions and is easily distinguishable from the original fabric. Reversibility grouping

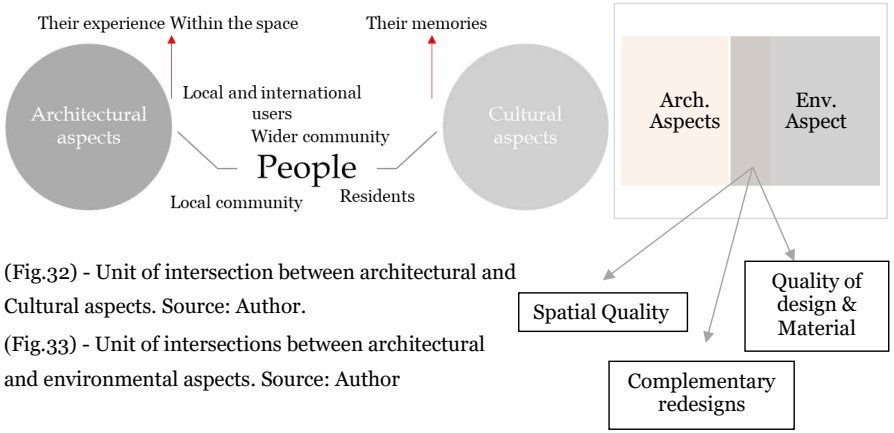




depends on the old function of the building and whether the development needs to focus on it or not. In addition to the appropriate balance of original and new function aspects Balance can be achieved through the design and a common part between the old and the new function, as an office building converts to a complex hotel with an administration part.

(Table 4-13) - Relation between Architectural aspects and Cultural. Source: Author

| Architectural Aspects | | Sublimation (Cultural aspects) | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Authenticity (originality) and Integrity | | | | | | | Intrinsic value | | | Local identity | | Cultural and knowledge capital production | | | | | | Traditional Skill | Mutual cooperation | Cultural Vibrancy |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| Joinable spaces | 1 | | | | | | | | | | | | | | | | | | | | | | |
| | 2 | | | | ■ | | | | | | | | | | | | | | | | | | |
| Quality of design, material, execution | 3 | ■ | | | | | | | | | | | | | | | | | | | | | |
| | 4 | | | | | | | | | | | | | | | | | | | | | | |
| | 5 | | | | | ■ | | | | ■ | ■ | | | | | | | | | | | | |
| | 6 | | | | | | | | | | | | | | | | | | | | | | |
| | 7 | | | | | | | | | | | | ■ | | | | | | | | | | |
| Physical and Visual Linkage | 8 | | ■ | | | | | | | | | | | | | | | | | | | | |
| | 9 | | | | | | | | | | | | | | | | | | | | | | |
| | 10 | | | | | | | | | | | | | | | | | | | | | | |
| Complementary redesigns | 11 | | | | | | | | | | | | | | | | | | ■ | | | | |
| | 12 | | ■ | | | | | | | | | | | | | | | | | | | | |
| | 13 | | | | | | | | | | | ■ | | ■ | | | | | | | | | |
| | 14 | | | | | | | | | | | | | | | | | | | | | | |
| | 15 | | | | | | | ■ | ■ | | | | | | | ■ | | | | | | | |
| | 16 | | | | | ■ | | | | ■ | ■ | | | | | | | | | | | | |
| | 17 | | | | | | | | | | | ■ | | ■ | | | | | | | | | |
| | 18 | | | | | ■ | | | | ■ | ■ | | | | | | | | | | | | |
| | 19 | | | | | | | ■ | ■ | | | | | | | ■ | | | | | | | |
| | 20 | | | | | ■ | | | | ■ | ■ | | | | | | | | | | | | |
| | 21 | | | | | | | ■ | ■ | | | | | | | ■ | | | | | | | |
| | 22 | | | | | ■ | | | | ■ | ■ | | | | | | | | | | | | |
| | 23 | | | | | | | ■ | ■ | | | | | | | ■ | | | | | | | |
| Spatial quality and zones | 24 | | | | | | | | | | | | | | | | | | | | | | ■ |
| | 25 | | | | | | | | | | | | | | | | | | | | | | |
| | 26 | | | | | | | | | | | | | | | | | | | | | | |
| | 27 | | | | | | | | | | | | | | | | | | | | | | |
| | 28 | | | | | | | | | | | | | | | | | | | | | | |
| | 29 | | | | | | | | | | | | | | | | | | | | | | |
| | 30 | | | | | | | | | | | | | | | | | | | | | | |
| | 31 | | | | | | | | | | | | | | | | | | | | | | |
| Multi-Functional spaces | 32 | | | | | | | | | | | ■ | ■ | | | | | | | | | | |
| | 33 | | | | | | | | | | | ■ | ■ | | | | | | | | | | |
| | 34 | | | | | | | | | | | ■ | ■ | | | | | | | | | | |
| Reversibility | 35 | | | | ■ | | | | | | | | | | | | | | | | | | |
| Multiple access points | 36 | | | | | | | | | | | | | | ■ | | | | | | | | |




(Fig.32) - Unit of intersection between architectural and Cultural aspects. Source: Author.

(Fig.33) - Unit of intersections between architectural and environmental aspects. Source: Author

(Table 4-14) - Relation between Architectural aspects and social aspects. Source: Author

| Architectural Aspects | | Social aspects: Landscape quality and atmosphere | | | | | | | Wider community | | | | | | | | Local community | | | | | | | | Safety | Well being & Health | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| Joinable spaces | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Quality of design, material, execution | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 7 | | | | | | | | | | | | | | | | | | | | | | | | ■ | | | | |
| Physical and Visual Linkage | 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 9 | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | |
| | 10 | | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Complementary redesigns | 11 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 12 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 13 | | | | | | | | | | ■ | | | ■ | ■ | | | | | | | | ■ | | | | | | |
| | 14 | | | | ■ | | | | | | | | | | | | | | | | | | | | | | | | |
| | 15 | | | | | | | ■ | | | | ■ | ■ | | | | | | | | | | | | | | | | |
| | 16 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 17 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 18 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 19 | | | | | | | ■ | | | | ■ | ■ | | | | | | | | | | | | | | | | |
| | 20 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 21 | | | | | | | ■ | | | | ■ | ■ | | | | | | | | | | | | | | | | |
| | 22 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 23 | | | | | | | ■ | | | | ■ | ■ | | | | | | | | | | | | | | | | |
| Spatial quality and zones | 24 | | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ |
| | 25 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 26 | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | |
| | 27 | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | |
| | 28 | | | | | | | ■ | | | | | | | | | | | | | | | | | | | | | |
| | 29 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 30 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 31 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Multi-Functional spaces | 32 | | | | | | | | | | ■ | | | ■ | ■ | | | | | | | | ■ | | | | | | |
| | 33 | | | | | | | | | | ■ | | | ■ | ■ | | | | | | | | ■ | | | | | | |
| | 34 | | | | | | | | | | ■ | | | ■ | ■ | | | | | | | | ■ | | | | | | |
| Reversibility | 35 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Multiple access points | 36 | | | | | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | |





Secondly, from the correlation analysis, it is observed the direct relation between the cultural and social aspects, so the architectural connection is indirect with the social, which is an important aspect. As the jury are experts in the field of architecture and heritage, emphasizing some criteria by providing a diverse range of aspects has been considered as showing the priority and relevance of them in dealing with heritage buildings (e.g., social value creation).

As a challenge, is the relationship between preserving the heritage and cultural aspects of old buildings with an innovative aspect dimension. That is indicated with the review of the awards aspects through using technology to recall the history of the building, but this is also a variable aspect depending on the history of the building. From the research point of view, the innovation aspect is related to the environmental one through adapting the building with innovative low-cost systems and materials. As the environmental aspect is related to the architectural aspect in one main grouping, which is the spatial quality group.

The creation of a pleasant atmosphere, peaceful and structured spatial organization, acoustic comfort and visual peace, and appealing new interventions can relate directly to making the heritage building comfortable and energy efficient, and the usage of environmentally sustainable and traditional technologies and design solutions within the environmental aspect.

In the scientific literature, pursuing environmental sustainability is often reported as a necessary criterion for considering AR projects to be effective. However, in the awards, little attention is devoted to environmental sustainability. The practise of reusing heritage buildings is considered environmentally sustainable, but this is not enough.

In addition, the importance of job creation, economic spillovers, and financial self-sustainability received the most attention in the economic aspect. This shows the focus of the rewards on improving the socio-economic aspects of the local scale via AR projects.

(Table 4-15) - Concluded main axis. Source: Author

| **Conclusion mentioned main points** |
|---|
| 1. Main axis of adaptive reuse projects aspects. |
| 2. Relation between the architectural aspect and the cultural. |
| 3. Variable relation between the architectural aspect. |
| 4. Relation between Cultural and social aspects. |
| 5. Preserving the heritage within the innovative dimension. |
| 6. Spatial quality grouping as an approach between architectural and environmental |
| 7. Relation between environmental and innovative aspect |
| 8. Economic aspect. |

Based on observed conclusion from (figure 13), the architectural and the environmental aspects are most important aspects among the other, and as it is illustrated above in the relation part between aspects the connection between the architectural aspects and the others, based on

that architectural and environmental aspects are studied deeply and connected to the suggested guidelines towards existing buildings adaptive reuse. The next part from the literature knowledge, the relation between improvements, all are illustrated within the sustainable architectural aspects. And for technicalities design buildings physics and buildings services guideline are illustrated within sustainable environmental aspects.

(Table 4-16) - Architectural aspects groups Vs Env., Eco., and innovation groups matrix, Source: Author.

| Architectural Aspects | | Environmental | | | | | | Economical | | | | | | | | Innovation | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Energy Efficency | GHG emissions reduction | | | | | Attractiveness for creative, cultural, and innovative enterprises | | | Circular cultural tourism | Job creation | Economic Spillovers | Self sustainability | | Using digital and innovative technologies | | Diff. Stakeholders | | Replicable models in different aspects | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Joinable spaces | 1 | | | | | | | | | | | | | | | | | | | | | |
| | 2 | | | | | | | | | | | | | | | | | | | | | |
| Quality of design, material, execution | 3 | | | | | | | | | | | | | | | | | | | | | |
| | 4 | | | | | | | | | | | | | | | | | | | | | |
| | 5 | | | | | | | | | | | | | | | | | | | | | |
| | 6 | | | | | | | | | | | | | | | | | | | | | |
| | 7 | | | | | | | | | | | | | | | | | | | | | ■ |
| Physical and Visual Linkage | 8 | | | | | | | | | | | | | | | | | | | | | |
| | 9 | | | | | | | | | | | | | | | | | | | | | |
| | 10 | | | | | | | | | | | | | | | | | | | | | |
| Complementary redesigns | 11 | ■ | | | | | | | | | | | | | | | | | | | | |
| | 12 | ■ | | | | | | | | | | | | | | | | | | | | |
| | 13 | ■ | | | | | | ■ | | | | ■ | | | | ■ | | | | | | |
| | 14 | ■ | | | | | | | | | | | | | | | | | | | | |
| | 15 | ■ | | | | | | | | | | | | | | | ■ | | | | | |
| | 16 | ■ | | | | | | | | | | | | | | | | | | | | |
| | 17 | ■ | | | | | | | | | | | | | | | | | | | | |
| | 18 | ■ | | | | | | | | | | | | | | | | | | | | |
| | 19 | ■ | | | | | | | | | | | | | | | | | | | | |
| | 20 | ■ | | | | | | | | | | | | | | | | | | | | |
| | 21 | ■ | | | | | | | | | | | | | | | | | | | | |
| | 22 | ■ | | | | | | | | | | | | | | | | | | | | |
| | 23 | ■ | | | | | | | | | | | | | | | | | | | | |
| Spatial quality and zones | 24 | | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | |
| | 25 | | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | |
| | 26 | | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | |
| | 27 | | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | |
| | 28 | | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | |
| | 29 | | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | |
| | 30 | | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | |
| | 31 | | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | |
| Multi-Functional spaces | 32 | | | | | | | ■ | | | | ■ | | | | ■ | | | | | | |
| | 33 | | | | | | | ■ | | | | ■ | | | | ■ | | | | | | |
| | 34 | | | | | | | ■ | | | | ■ | | | | ■ | | | | | | |
| Reversibility | 35 | | | | | | | | | | ■ | | | | | | | | | | | |
| Multiple access points | 36 | | | | | | | | | | | | | | | | | | | | | |





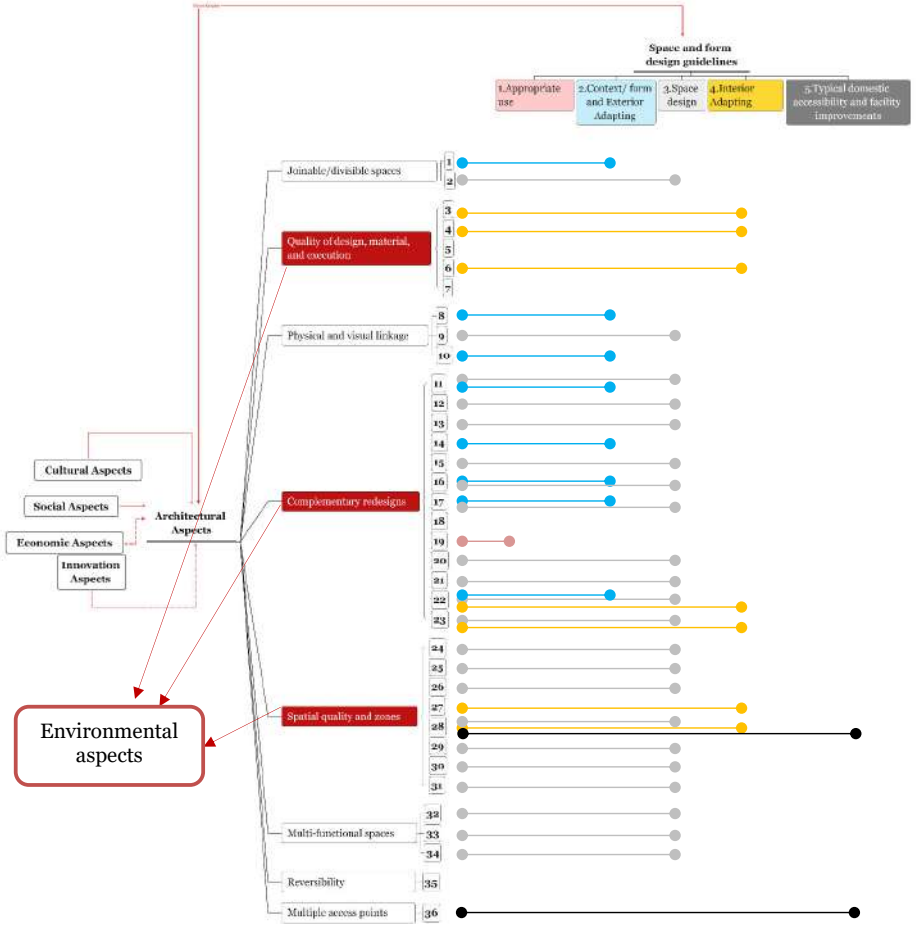
## 4.5 The relation between architectural aspects and adaption strategies scales

It is observed from reviewing architectural aspects that values and preservation must be highly appreciated within the new designs. The balance between original and new designs, the hybridization of heritage and contemporary values, as well as the appropriate meeting of historic and new parts of buildings, are highlighted as positive aspects, especially in the Europa Nostra award. The flexibility in the layout of the exterior larger areas via adjustable and transparent design is a significant aspect related to the context and exterior adapting regarding adaptive reuse projects. as well as the balance between the structure of the building and the activities of its users Joinable spaces are a result of this relationship. Also, as a highlight of the interior design adaptation of the building, the improvement of the existing building through the high quality of the new design and materials within the execution and construction is important. And as mentioned in the structural safety within old buildings in a gap, securing the structural elements of the building as well as installing essential protective elements is a factor that affects the safety of the old building. Interior design can improve the structural safety of a building both internally and externally.

Physical and visual linkage aspects Although grouping is related to both exterior and interior adaptation, it is a variable aspect. The connection of the old existing building and the new design in a new story, highlighting the values of the heritage building via the new design, the clear presentation of the original function of the building in the new design from complementary redesigns the reversibility of the new additions and easily distinguishable from the original fabric from the reversibility grouping are a variable aspect depending on the owner's perspective and the desire for historical recall of the building. Many buildings are reused for the purpose of changing the function totally but preserving the cultural value of the place and increasing building lifetime. As well as the improvement of the interaction of the heritage building with the surrounding natural landscape, this is also a variable aspect related to the surrounding features. But improvement in the connection of the spaces via the new additions is a must for the purpose of the new function and the space requirements.

Complementary redesigns and spatial quality and zones In both aspects, grouping is connected to exterior and space design guidelines through complementing the original design via the addition of new design. The successful recalling of a dramatic meeting of the old and new parts of the old building's architectural elements; high-quality preservation and design without replicating anything that has come before via the exterior and interior design; and well-integrated and respectful new modern additions to the existing old building These two specified grouping aspects are the most highly connected to the environmental aspects, especially the spatial quality group. creation of a pleasant atmosphere, acoustic comfort, visual peace and an appealing new

sustainable intervention. Both reviewing the two awards consider it important to demonstrate the effectiveness of the AR projects by having multi-functional spaces available for having flexibility and hosting a wide range of users through designing building spaces with the strategies mentioned in the next section of guidelines (Arfa et al., 2022). to bring the old building back to life with truly imaginative use of the spaces and increase the functionality of the existing building. And finally, for the domestic accessibility and disability facilities, multiple access points aspects grouping with offering accessibility to visitors with disabilities is an important factor as most of the old buildings are not designed to new disability codes and requirements.




(Fig.34) - Relation between sustainable architectural aspects and strategies scales. Source: Author

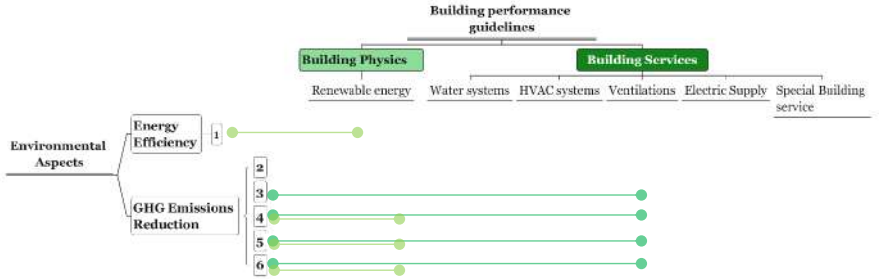




## 4.6 Relation between performance strategies scales and environmental aspects

The building's thermal and moisture balance, and consequently the interior environment, are always affected by building adaption. Reducing heat transfer from inside to outside during the winter and vice versa during the summer especially in hot areas as Egypt, is the objective of an energy efficiency upgrade. Also enhancing the building's airtightness is another important factor in addition to adding thermal insulation. To provide a comfortable interior environment, conserve energy, and protect the structural integrity of the building, both actions should be coordinated with the appropriate heating/cooling and ventilation systems. So, a good building adaption through retrofitting can be achieved through that (Petzinka, 2009). It is important to make sure that all the building system services that it cannot work without them is achieving sustainable aspects and function well. Building performance guidelines are illustrated by dividing them into two elements which are the building physics. Building physics is the element responsible for reducing energy through renewable energy sources that are combatable with the environmental and economical aspect. The guidelines mentioned for this part achieve the aspect, making the heritage building comfortable and energy efficient.

And the second element which is the most important is building service. Building service guidelines introduces all building needed systems to perform well as water management systems, HVAC, electrical insulation, firefighting and even the ventilation systems. All are illustrated deeply through guidelines part. And the guidelines standards mentioned for these systems achieve GHG emission reduction grouping aspects which are usage of sustainable and local materials with a low carbon footprint, usage of environmentally sustainable and traditional technologies and design solutions, making the old building a circular building, Development of innovative and nature-based technologies for the building, as a model for the sustainable transformation of other old adapted buildings and finally making the heritage building as sustainable as possible.




(Fig.35) - Relation between environmental aspects and building performance scales. Source: Author

(Table 4-17) - Sustainable aspects that achieved through applying adaption strategies. Source: Author

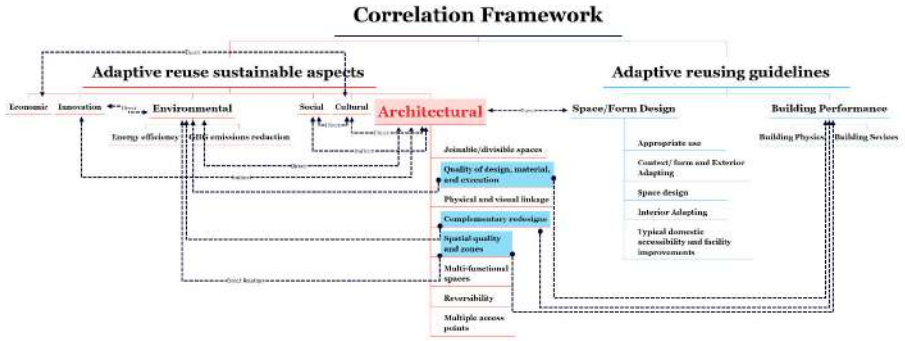
| Strategies scales | Strategies sub scale | Strategy | Achieved aspects |
|---|---|---|---|
| **Exterior adapting strategies** | Site layout | | 17. Complementing the original design with new multi-purpose facilities designed in a contemporary style |
| | Building addition | | 1. Bringing the building's structure to a human scale |
| | | | 16. Effective preservation through new modern additions |
| | | | 22. New modern additions to the existing building that are well-integrated and respectful |
| | Urban and historical context | | 8. Connection of the existing building and the new design in a new story |
| | | | 11. Highlighting the values of the existing building via the new design |
| | | | 14. Interventions that are respectful of the architectural essence of the building and its surroundings |
| | Environmental quality | | 10. Improvement of the interaction of the existing building with the surrounding natural landscape |
| | Building | Independent system-based layers | 15. Innovative design solutions to meet user needs while maintaining the architectural integrity and history of the space |
| | | | 20. The successful evocation of a dramatic meeting of the existing building's old and new parts |
| | | | 22. New modern additions to the existing building that are well-integrated and respectful |
| | | | 24. Creating a variety of atmospheres |
| | | Elasticity and Divisibility | 21. High-quality preservation and design with no attempt to imitate what has come before |
| | | | 23. Using to supplement the original design innovative methods |
| | | Integrating with the environment | 11. Highlighting the values of the existing building via the new design |
| **Space layout adaption** | Spaces | Multifunctional spaces | 17. Complementing the original design with new multi-purpose facilities designed in a contemporary style |
| | | | 33. Having multi-functional spaces for a wider range of visitors and locals to host different functions |
| | | | 34. Improvements to the existing building's functionality |





| | | | |
|---|---|---|---|
| | | Mobility | 2. Adjustable, transparent, and delicacy in the design of the layout of the larger areas |
| | | Space density optimization | 29.Openness |
| | | | 30.Simplicity and tranquility |
| | | Modularity | 12. Appropriate balance of original and new functions |
| | | | 16. Effective preservation through new modern additions |
| | | | 28.Appealing new intervention |
| | | | 31. Clear orientation in the new design |
| | Sub spaces | Fluidity and Continuity of spaces | 9. The new additions improve the connection of the spaces |
| | | | 26. Spatial organization that is both peaceful and structured |
| | | Absorption of overflowing | 25. Creating a pleasant environment |
| | Circulation | | Alive, animated, and interactive circulation routes |
| **Interior adaption** | | | 22. New modern additions to the existing building that are well-integrated and respectful |
| | Design techniques | | 3. Building enhancement through the high quality of the new design and materials |
| | | | 4. Excellent design execution |
| | | | 23. Using to supplement the original design innovative methods |
| | Visual Quality | | 28.Appealing new intervention |
| | Acoustic Quality | | 27. Acoustic comfort and visual peace |
| | Material Selection | | 3. Building enhancement through the high quality of the new design and materials |
| | | | 6. Securing the building's structural elements and installing necessary protective elements |
| **Special Accessibility** | | | 36. Accessibility for visitors with disabilities |
| | Building physics | | 4 (environmental). Making the existing building a circular building |
| | | | 5 (environmental). Development of innovative and nature-based building technologies as a model for the long-term transformation of other historic structures |
| | | Energy Sources | Renewable energy sources |
| | Building services | | 1 (environmental). Making the existing building comfortable and energy efficient |
| | | | 2 (environmental). Utilization of low-carbon, sustainable and local materials |

| | |
|---|---|
| | 3 (environmental). Environmentally sustainable and traditional technologies and design solutions are used |
| | 6 (environmental). Making the heritage building as environmentally friendly as possible ($CO_2$ neutral) |




(Fig.36) - Correlation framework between sustainable aspects and sustainable strategies. Source: Author.

The architectural aspect is the main key. Also building performance strategies actually can achieve large number of architectural aspects which highly connected and related to the environmental aspect.

## 4.7 SUSTAINABLE FEASABILITY EVALUATION TOOL

For the sustainability adaption feasability check, a simple evaluation tool is proposed based on previous chapters generating aspects, strategies, and concepts. Combining between the related factors that affect building adaption. Shearing layers of change to identify which layer will be changed through this adaption strategy, 1. Site, 2. Structure, 3. Access, 4. Skin, 5. Service, 6. Space plan, 7. Stuff and 8. Souls. Then the strategies scales, elements, and sub elements that their feasability will be checked. And after that indicator which can determine whether this strategy is achieved or not and means of verifications for how this strategy can be is applied from point of data collection view. The preliminary analysis and multi-disciplinary are the main factors in identifying the applicability of those strategies. From the analysis determination of the evaluation score, which 0% this strategy cannot be applied, 50% cannot be fully applied and 100% for the full feasability. The building is sustainably adapted if 50% or more of those sustainable strategies can be applied through the adaption process.

(Table 4-18) - Evaluation tool. Source: Author

| Shearing layers of change | | | | | | | | Strategies | Elements | Sub elements | Criteria |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | | |
| ● | | | | | | | | **Space/form design strategies** | Exterior adapting | Site layout | Outdoor recreational areas |
| ● | | | | | | | | | | | Earth forms |
| ● | | | | | | | | | | | Courtyard pavements |
| ● | | ● | | | | | | | | | Design landscaping |
| ● | | | | | | | | | | | Recycling operations |
| | | | ● | | | | | | | Facade | Modular system |
| | | | ● | | | | | | | | Minimum changes |
| | ● | | ● | | | | | | | | Keep Existing openings |
| | ● | | ● | | | | | | | | Versatile envelop |
| | ● | | ● | | | | | | | Building addition | Harmonization |
| | ● | | ● | | | | | | | | Dominance |
| ● | | | ● | | | | | | | Urban and historical context | Legislative reviews |
| ● | | | ● | | | | | | | | Architectural style |
| ● | | | ● | | | | | | | | Cultural features |
| ● | | | | ● | | | | | | | Existing infrastructure |
| ● | ● | | | | | | | | | | transportation system |
| ● | | ● | | | | | | | | Parking, Impervious Surfaces | Parking, Impervious Surfaces |
| ● | | | | | | | | | | | Plant life |
| ● | | ● | | | | | | | | Alternative transportation | |
| ● | | | | | | | | | | Environmental quality | |





(Table 4-19) - Continue evaluation tool part 2. Source: Author

| Indicator | Means of verifications | Evaluation Applicability % of considerations | | |
|---|---|---|---|---|
| | | 0% | 50% | 100 % |
| Regulations, Usage, availability of proper spaces | Interviews, observation, drawings | | | |
| Good infrastructure | Interviews | | | |
| Usage & spaces | Interviews & observations | | | |
| Existing landscape design | Site visit observations | | | |
| Site spaces | Site, building visit observations | | | |
| Façade design | Site observations & Drawings | | | |
| Usage | Owner requirements & existing spaces drawings | | | |
| No add or change in facade | Existing spaces and facade drawings | | | |
| Applicability of structure system | Requirements of spaces | | | |
| Blend in with the context properties | Context and site visit, observations & regulations | | | |
| Integration with original building | Regulation, proper adaptive design & Usage | | | |
| Approval of formal parties | Context regulations | | | |
| Blend in with the context properties | Context and site visit, observations & regulations | | | |
| Connection to another site activates | Mapping, site visits & regulations | | | |
| Connection to many services/facilities | Interviews | | | |
| To what extent connection to city | User experience & transportation maps | | | |
| Opportunities to nearby parking can be used | Interviews & site visit observations | | | |
| Heat island effect | Design & Simulation | | | |
| New facilities' introduction strategy | Regulations check &suppliers' providing | | | |
| Adding or change landscape elements | Site observations, new design requirements | | | |

(Table 4-20) - Continue evaluation tool part 3. Source: Author

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ● | | | | Space design strategies | Building Spaces Subspaces circulation | Adaptability |
| | | | | | ● | | | | | | Versatility |
| | | | | | ● | | | | | | Modularity |
| | | | | | ● | | | | | | Divisibility and Elasticity |
| | | | | ● | ● | ● | | | Interior adapting | Design techniques | |
| | | | | ● | | ● | ● | | | Visual quality | |
| | | | | ● | | ● | ● | | | Acoustic quality | |
| | | | | ● | | ● | ● | | | Material selection | |
| ● | | | | ● | ● | ● | ● | | Domestic special service and facilities improvements | | |
| ● | ● | | | ● | | | ● | **Services performance strategies** | Energy sources | Renewable energy sources | |
| | | | | ● | | | ● | | Water management systems | Water supply | |
| | | | | ● | | | ● | | | Water drainage | |
| | | | | ● | | | ● | | HVAC | Cooling | |
| | | | | ● | | | ● | | Ventilation | Natural ventilation | |
| | | | | ● | | | ● | | | Extract systems | |
| | | | | ● | | | ● | | Electrical installations | | |
| ● | ● | | | ● | ● | | | | Fire fighting | | |





(Table 4-21) - Continue evaluation tool part 4. Source: Author

| | | | | |
|---|---|---|---|---|
| Minimal changes with achieving new usage requirements, fixability of spaces & fluid and continuous of spaces and subspaces | Interview, building layout drawings, building visit, observations & new usage requirements. | | | |
| | | | | |
| | | | | |
| | | | | |
| The unique personality of building with the new use | Interview, building layout drawings, building visit, observations & new usage requirements. | | | |
| Percentage of using artificial lightening during the day | New usage requirements, Building drawings & Simulation | | | |
| Noise level affecting main spaces | Simulations | | | |
| Durability, performance & aesthetics after long time | Testing & observations | | | |
| No. of disabled people use the building | Interviews for requirements & Redesign facilities' | | | |
| Embodied energy of the building | Calculations, simulation strategies design | | | |
| Recommended water values of water component | Measurements | | | |
| Building drainage efficiency, connection installations & Main connection to public | Interviews & Observations | | | |
| Cooling capacity, cost and energy efficiency | Calculations & Simulations | | | |
| Percentage of natural air inside building | Natural ventilations rate needed & HVAC design | | | |
| | | | | |
| Standards installations | Existing connection, Space layout & User requirements | | | |
| | Existing, building capacity, new usage and space layout | | | |

## 4.8 International feasability of adaption process and strategies

### 4.8.1 Introduction

The construction of hotels is frequently viewed as an integral component of downtown revitalization. A vital component of a mixed-use downtown, a thriving hospitality industry attracts a variety of users and promotes vibrancy during a greater number of daytime and night-time hours. Due to some factors such as their size, layout, and location, obsolete office buildings are frequently ideal for hotel conversions. This type of conversion has developed into a national pattern.

This part examines adaptive reuse projects in downtown areas that converted historic office buildings into hotels. Four case studies are presented, focusing on the process, preservation, and design issues associated with rehabilitating the buildings in accordance with the Secretary of the Interior's Standards for Rehabilitation, as well as the scope of physical requirements required to make conversion of a historic office building to a hotel use feasible. And, for testing the feasibility of the framework introduced in the previous part of the chapter by applying it in references case already successfully adapted. Selecting the references case with same criteria as the case study of the thesis. The references case are hotels which are adapted to hotels, they have the same scale and type. The reference cases respect the ten guidelines for The Secretary of the Interior's Standards for the Treatment of Historic Properties which are intended to aid property owners, architects, developers, and preservation consultants during the rehabilitation process. The Guidelines include Recommended approaches, treatments, and techniques to ensure compliance with the Standards for both the interior and exterior. The guidance emphasises a hierarchy of treatments proportional to the remaining architectural materials and features' integrity. Existing "character-defining" materials and features must be "identified, retained, and conserved" as the primary goal of all work. The following step is to "protect and maintain" the historically significant materials and features using "the least degree of intervention. Limited replacement, preferably in kind, may be made (Catherine, 2005). The Pennsylvania State Historic Preservation Office is the first step of the process and typically interacts with the project team the most. Thus, the (SHPO) encourages applicants to contact their office early on because it serves as the primary point of contact with the property owner and the architect, provides the necessary forms and regulations, and assists property owners through site visits and technical assistance. The required forms are initially submitted to the SHPO, which then reviews and advises the project team. The SHPO then forwards them to the NPS (National Park Service) for review, feedback, and ultimately approval. Nonetheless, this work must be performed according to the Standards. The Standards are applied to the project through communication with the SHPO and NPS.





### 4.8.2 Case study one: The Girard trust company dome and tower buildings

***Building data and usage***

In homage to the Roman Pantheon, the Girard Trust Company Dome Building was constructed in Philadelphia Pennsylvania. Furness, Evans and Co.McKim, Mead and WhiteMcKim, Mead and WhiteHillier Group are the building architects (George, 2012). The Dome Building cost $4 million to construct between 1908 and 1953 using only the finest materials. White Georgia marble was used to great effect on the exterior and interior brick walls, with Pavernazza marble panels serving as accents. The cost of 9,000 tonnes of marble was $500,000. According to the original floor plan its old usage is offices for bank. For the main banking floor, bank offices and a vault flanked the columns on the southern, western, and northern sides, while the entrance was located on the eastern side as it is illustrated in. At the northwest corner of South Broad and Chestnut Streets and the southwest corner of South Broad Street and South Penn Square, the marble-clad 30-story steel frame Trust Company skyscraper stands out among its high-rise neighbours. The Tower Building, completed in 1931, provided banking and tenant office space. The Dome Building is listed as significant, and the Tower Building is listed as contributing (Catherine, 2005). After a successful adaption of both the Dome and Tower Buildings, the Ritz-Carlton, Philadelphia, a five-star hotel brand owned by Marriott International, opened in May 2000. The hotel has 330 guest rooms, a luxurious Penthouse, over 20,000 square feet of meeting space, and two ballrooms. It provides "a new level of contemporary luxury, style, design, and cuisine to leisure and business travelers." 38 Two restaurants, the Grill and the Pantheon, a cigar lounge, as well as the Rotunda, the lobby lounge, offer a range of dining options. A fitness center and spa are also available to guests. Elements which made the bank and office tower is a conversion successful project: a combination of large public spaces, distinct circulation systems serving the buildings, and a natural separation between guest rooms and meeting spaces (Catherine, 2005).

(Fig.37) - Dome and tower building, Source: (Catherine, 2005)

***Main conversion changes***

Here are the main changes in building elements and the function that affect it's change in use from office building to a five-star hotel according to (Catherine, 2005):

- The exterior masonry of the buildings received the necessary repairs, pinning, repointing, the application of sealants, and cleaning, based on the results of appropriate tests.
- A select number of window openings were modified to accommodate an emergency exit and a new loading dock.
- A brand-new grand staircase made of Carrara marble was constructed to link A brand-new grand staircase made of Carrara marble was constructed to link.
- It was necessary to install a new shuttle elevator to provide access to all the programme spaces. Others, such as the original President's private elevator to the left of the entrance colonnade, were closed off or removed. The two-building had to be reconnected at the main level. Access to all the programme spaces necessitated the addition of new features, The Tower Building is four feet shorter than the base-raised Dome Building. Prior to construction, there was no public connection between the Tower and Dome Buildings, which was necessary for the two structures to function as a hotel.
- Marble, tile, and plaster were cleaned and restored throughout the interior of the building to remove nearly a century's worth of dirt that had accumulated. Efforts were made to preserve marble flooring and wainscoting, but significant damage necessitated replacement. Under the mezzanines, decorative plaster ceilings were exposed and restored.
- Providing handicap accessibility between the two main levels of the buildings necessitated a new 50-foot-long ramp running directly from the Tower Building's entrance.

***Main challenges***

There are two main significant changes in the project that shows are how can be adaption decision takes place among stakeholders and towards the right for the building. The first change is related to the tower building windows. Standard 2, 5 and 6 of the Secretary of the Interior's Standards for Rehabilitation specifies that "the historic character of a property must be retained and preserved." 92 Windows are essential to the visual character of a historic building and can also play a significant role in determining the overall integrity and style of a structure; therefore, they must be carefully considered in any adaption. To determine the appropriate course of action for the windows on floors 3 through 30 of the Tower Building, a window survey and evaluation





was conducted. Each window's functionality and condition were evaluated. The windows were found to be deteriorated nearly all of them contained rust. Due to their general deterioration, repetition, and economic benefits, the architect suggested replacement. Such an adaption projects must address structural and performance standards, including energy efficiency, solar control, wind deflection, and water and air infiltration. Four benefits were identified as justification for the replacement:

a) Existing details, profiles, and sightlines could be replicated without difficulty.

b) Operation and maintenance simplicity

c) Absence of interior condensation and air/water infiltration

d) Reduce project expenses. As the cost to restore the existing windows was estimated to be $1,332,828 while the cost to replace them was estimated to be $942,180, representing a difference of $390,648.

The replacement was approved, but the architect was tasked with ensuring that the details closely matched the originals.

The second challenge is related to the building canopy. One important matter stands out The Ritz-Carlton administration desired to install a sidewalk canopy on South Broad Street in front of the Dome Building. As one of the essential elements of a five-star property is the ability to pick up or drop off guests in a manner that provides them with basic protection from rain, snow, or other inclement weather. The architect submitted multiple designs, but the NPS stated that "a shelter of any design material in front of the temple-front Dome would diminish its historic appearance and character". The proposed canopy was denied because it did not comply with Standard 2, which requires the retention and preservation of a property's historic character. During the review process for the Broad Street canopy, the SHPO and NPS expressed their approval for a canopy on the other Square. This canopy's approved design was subsequently implemented.

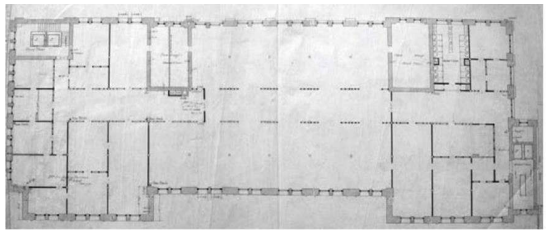
### 4.8.3 Case study two: READING TERMINAL HEADHOUSE

***Building data and usage***

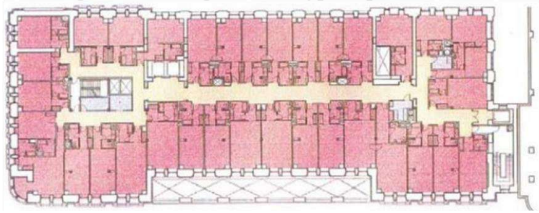
Reading terminal headhouse is located at the northwestern corner of 12th and Market Streets, Philadelphia Pennsylvania also. It was an administration building for the main railway station. However, as automobile dependence increased, train travel began to decrease. After the war, the Reading expected an increase in passenger numbers and modernised the trains and terminals accordingly. In 1947. Unfortunately, the expected recovery did not occur, and train travel continued to decline. As the Reading continued to lose money, it is planned to convert the Terminal into a mixed-use development consisting of stores, a hotel, a bus depot, and a parking garage to complement the Market Street East plan of 1966. In the Headhouse, an expansion of the

Philadelphia Marriott, located just to the west, introduced as a reusing for the building. The Headhouse features 210 luxury concierge rooms with "upgraded amenities and access to the Concierge Lounge,"129 9,000 square feet of meeting and event space, and a fitness centre.

(Fig.39) - Reading terminal hall building.
Source: (Catherine, 2005)



(Figure 40) - Original 1897 typical plan. Source:



(Fig. 38) - Typical plan of guest rooms after the adaption, Source: (Catherine, 2005)

***Main conversion changes***

- On the exterior base, A strategy was adopted as a cost-saving measure and because the lack of the proficiency for making this old level of details on the building. Using of new sheet metal cornice and installing it to resemble the original shape one and cover the old deteriorated one.
- On the interior, the original cast iron columns and bases were repaired as well as the plaster ceiling.
- New elevator access to guest room floors three through nine was installed. As well the installation of four egress doors, an entrance door and storefront window for a retail space for the need of life safety requirements.

***Main challenges***

The treatment of the 16-foot-wide corridors on the upper floors of the Headhouse had the greatest impact on the project, as they were the only remaining interior "character-defining" features. The width of the corridors, as well as the partitions, glass panels, and various mouldings, created a challenge.





From the standpoint of historic preservation and the interior secretary standard, "Complete replacement of the office floor corridors weakens the project as a whole." The regeneration of the original elements provides some indication of the original arrangement. But Marriot refused from an economical point of view. Dry wall is used in place of plaster, and the proportions are slightly incorrect. it is unfortunate that the original configuration could not be preserved in their entirety on one floor to give a true representation of the building's historic appearance.

(Fig.42) - Old usage for administration corridors. Source: (Catherine, 2005)

(Fig.41) - Corridors after the adaption for guest rooms. Source: (Catherine, 2005)

### 4.8.4 Concluded remarks and Lessons learned

Four reference cases are reviewed; two of them are illustrated in detail in the previous part. It is observed that the selected new use must be compatible with the building in question, or alternatively, the building must be compatible with the project, and the standards must be adhered to. The new use of the building must have minimal alterations to its distinctive materials, features, spaces, and spatial relationships. Each building is unique and must have its "character-defining spaces" identified, evaluated, and preserved. In addition to the contextual conditions surrounded by the building Because the buildings are located on main streets, there is no space around them to be designed as a landscape element in the majority of the reviewed reference cases. But in all cases, they preserve the architectural identity of the area and the building as well. The exterior challenges revolve around two main elements, which are the building windows and the addition of canopies or signage. As the windows of the building are considered a main factor for adhering to the exterior shape and character of the building and the interior design, ventilation, and energy efficiency inside the spaces. It is observed from all the cases that all building windows need replacement as this strategy is more cost-saving than the retrofitting of them with the respect of the modular system with minimal changes while keeping the existing wall opening. The second exterior challenge is related to the building addition. As for the hotels, the need for such shading for the main entrance is important even though it will change the main building façade. Designers try to make them compatible with the main building design and also as a standalone element so that if it is replaced or removed in the future, it cannot affect the building. That achieves the harmonization concept for building additions.

For the interior adaptation, it is observed that using all the strategies listed inside the table below, architects use light partitions in dividing spaces and preserve the adaptability of the building for the future. But also, this is dependent mainly on the suitability of the building to be reused for a function that does not need many changes, as that is the main concept for adaptive reuse theory. Materials have the dominant importance in the adaption process, as they are rich old buildings from the inside, so architects try to recall the original materials by painting and ceiling/flooring repair to keep the historical configuration of the building.

Domestic special services and disabled facilities have more importance in the adaption through the interior of the building and the exterior. Ramps needed are built, in addition to the elevators and toilets setup for them. For the building services, it is observed that for all the reference cases, architects adapt the only needed services for the new uses without any additions that affect the environment. In all cases, common adaptation strategies include the installation of new elevators and stairs, as well as the adaptation of fire safety and firefighting through the installation of escape stairs and egress doors suitable for the building's new use.As well as the quality of ventilation through the replacement of windows. But for the other services, as much as it can work, they keep it. So, the side of the environmental efficiency strategies in all cases does not pay attention to the cost and the priority of preserving the original.

For the adaption process and the stakeholders, there must be a standard to be achieved, whether these standards are international for adapting old buildings. Governmental entities are responsible for reviewing the new design and approving it or from the new use design requirements that are approved by the owner. Such hotel use has specific requirements and standards that need to be achieved in the reuse of the building.

So, for basic needs without new additions, Conservation of interior spaces' adaptability is a must. Adaption of needed building services without new environmental configurations and cost-saving for the project with minimal changes are the main common features among the reviewed cases.

(Table 4-22) - Strategies achieved from reference cases. Source: Author.

| **Strategies** | | **Reference case** | |
|---|---|---|---|
| **Strategy scale** | **Element** | **1** | **2** |
| **Exterior adapting** | Outdoor recreational areas | ✓ | |
| | Earth forms | | |
| | Courtyard pavements | | |
| | Design landscaping | | |
| | Recycling operations | | |
| **Façade** | Modular system | ✓ | ✓ |
| | Minimum changes | ✓ | |
| | Keep Existing openings | ✓ | |
| | Versatile envelop | | ✓ |





| | | | |
|---|---|---|---|
| **Building addition** | Harmonization | ✓ | ✓ |
| | Dominance | ✓ | ✓ |
| **Urban and historical context** | Versatile envelop | | |
| | Architectural style | ✓ | ✓ |
| | Cultural features | | |
| | Existing infrastructure | | |
| | Transportation system | | |
| **Parking, Impervious Surfaces** | Parking, Impervious Surfaces | | |
| | Plant life | | |
| **Alternative transportation** | | | |
| **Environmental quality** | | | |
| **Building, Spaces, Subspaces circulation** | Adaptability | ✓ | ✓ |
| | Versatility | ✓ | ✓ |
| | Modularity | ✓ | ✓ |
| | Divisibility and Elasticity | ✓ | ✓ |
| **Interior adapting** | Design techniques | ✓ | ✓ |
| | Visual quality | | |
| | Acoustic quality | | |
| | Material selection | ✓ | ✓ |
| **Domestic special service and facilities improvements** | | ✓ | |
| **Performance services** | Renewable energy sources | | |
| | Water supply | | |
| | Water drainage | | |
| | Cooling | | |
| | Ventilations | ✓ | ✓ |
| | Electrical installations | | |
| | Fire fighting | ✓ | ✓ |

## 4.9 Local feasibility of adaption process and strategies

After checking the feasibility of framework strategies and process on the international level through reference cases reviewed in the previous part, the Most common strategies used on the local level checked in addition to the process for generating proposed initial action plan at the end of the research. This is done through interviewing two of the professional architects, one of them works in one of the biggest consultant organizations for building adaption in Egypt. Architect Mostafa Abu-Lela is the business development manager of SIGMA properties (S.A.E), Sigma Properties is a property management company specialized in developing and reutilizing old buildings to turn them into key pieces of urban infrastructure for about 25 years of experience. A phone call semi structured interview is done for about 45 minutes to understand the situation and the process of existing building adaption in Egypt. The other is a structured interview done with Professor Dr Mohamed Reda Abdallah, who is an academic professor at Cairo University and director of Engineering center of archeology and environment. Interviews questions and objective's themes illustrated at the appendix table 30.

### 4.9.1 Interviews concluded remarks and main points

Dr. Mohamed confirms on the keen interest of the Egyptian city to invest on old heritage buildings as an approach for preserving history perspective and neglecting the other existing building which is the main research gap. Here are the main points related to the research process and framework that conducted from analysing interview answers between the two:

- The government has always the good intention towards adapting old building, but there are always priorities that slowdown the process.
- For identifying the appropriate use of the building, there are two approaches in the real world which are the first is studying all building features and conditions as (the main streets, entrances, no of floors and structural condition, etc…) and then identify the use. The second is studying what the market needs and how can the building be adapted to achieve that. But building have the same of importance of its surrounding area also, how to reach the building, which zone it lied in and what the environmental features around.
- Human comfort and preserving building cannot be conflicted. International standards must be achieved through preserving the building
- The economic aspect is the most important for the adaption process in Egypt, then the social aspect then the environmental which can be achieved through architectural solutions and configurations.
- Dealing with new environmental configuration through the adaption process is not common in Egypt, as a cost and minimal changes wise. But enhancing existing systems to the nowadays condition is important, as an example; replacing windows with double glazed for the noise and installation of VRF or VRV HVAC systems for building environment and preserving elevation. As well as checking the other building services for adaption permission.
- Structural supporting in a must through the process and building additions is not common for old existing building, if there are any additions made within the years to the original building, it must be removed.
- There are no Egyptian standards codes for building adaption but hire the experienced for this process is common.
- For the process, firstly collecting all building data and stakeholders, then the market studies which identify building use, funding of the project, drawings details, then business plan, permission of drawings and new function, start the project and finally marketing.





# Chapter 5: Case study Analysis

## 5.1 Introduction

The conventional design process, which follows a linear progression from design to construction to occupancy, is driven by cost, schedule, and quality requirements. The adaptive and sustainable reuse of a historically significant old building requires the consideration of the interrelationships between environmental aspect, cultural aspect, and life cycle cost implications within the built environment. This requires an integrated process that brings together all the relevant parties for complementary knowledge enhancement and effective decision-making (Donald F. Fournier and Karen Zimnicki, 2004). The integrated framework combining sustainable aspects with sustainable adaptive building strategies that introduced from literature review through previous chapter is applied on a case study to test the applicability of adaption and function change of an old existing building in the Egyptian context.

## 5.2 The study objective

This case study as it is illustrated through research design in chapter one is the most suitable for this research because it allows the exploration of the following elements:

(a) The concept of buildings adaptive reuse in the Egyptian context is still relatively new and needs further investigation, development, and awareness.

(b) Expertise and experiences for professionals involved in those unique project is important and what it is their vision regards the process.

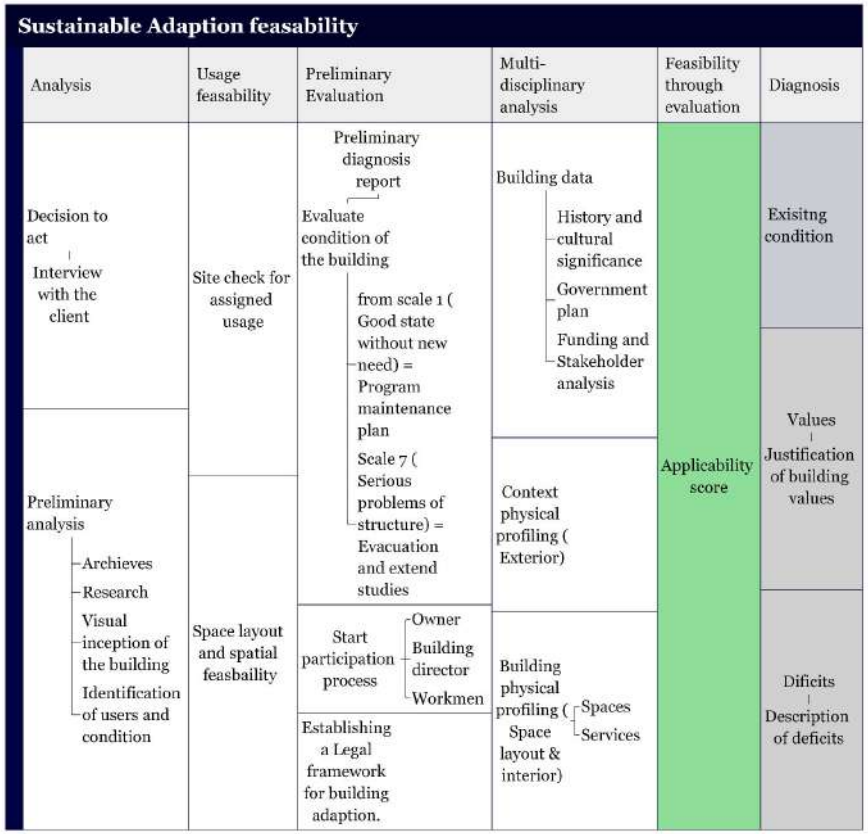
(c) Knowledge for adaption reuse and retrofitting design guidelines related to sustainable development goals.

So, the main aim of the case study is to test the sustainable adaptation applicability of Al-Tahrir building for changing its function and enhancing its performance to meet technological goals.

The main aim is applied through some main objectives such as identifying multidisciplinary analysis programmes for the building; mapping of deficits and values with their justifications and descriptions; evaluating building sustainable adaption applicability through a framework introduced from reviewing literature; and helping decision making for future building to be sustainably adapted in the Egyptian context.

## 5.3 Case study analysis and feasability check framework

(Table 5-23) - Case study feasability check framework. Source: Author




## 5.4 Introduction to case study

The Tahrir Complex, in the centre of the capital, Cairo, is one of the most famous and oldest historical buildings in Tahrir Square. The Egyptian architect Mohamed Bey Ismail designed it in 1948 to collect all government civil official services in one place to save the heavy expenses that





the state had to pay because of renting many real estates for its services on the one hand and provide the citizen's effort. However, prior to 1951, any Egyptian citizen had to go through several official bodies in various locations to finalize the official papers (Abdo, 2021). It has a strategic location in the heart of the old town, not far from the Nile-river and a few steps from old Khedival Cairo, which has significant buildings with unique architectural styles, cultures, and history. In addition, the building is surrounded by a lot of Egyptian features that increase its value as the Egyptian museum, which includes thousands of unique Egyptian pieces. The building has historical and symbolic value to the Egyptian people, as it is the most famous governmental landmark in downtown Cairo in Tahrir Square.

## 5.5 Decision to act

The idea of developing and rehabilitating the complex and exploiting it for tourism came after the decision to inaugurate the new administrative capital and the transfer of most of the Egyptian government offices, interests, and departments based in downtown Cairo to the new capital, saying, after Egyptian President Abdel Fattah El-Sisi's decision No. 459 of 2020 (Abdo, 2021). They began by removing the character of public benefit from a number of state-owned facilities and transferring their ownership to the sovereign fund of Egypt, including the land, and building of the Liberation Complex on an area of 3,055 acres. The Ministry of Planning and Economic Development revealed that after a number of meetings were held with the developers, the Tahrir Complex, after its development will became a mixed-use place that includes a hotel part, and an administrative and commercial part, while preserving the historical character of the building (Akhbar Alyom gate, 2021).

## 5.6 Preliminary analysis

### 5.6.1 Visual inception of the building

Visually, the inception of the building to be adapted is very important as a first step before going deeply into the analysis. So, as the first step in the framework, archival reports, researchers and a visit to the building was arranged on March 22, 2022. It was fully evacuated as the government and the state agencies began implementing the plan to evacuate the Tahrir Complex in downtown Cairo, within the plan to develop Khedive Cairo and re-use the building, as its activity will be changed from a complex of government departments to a multi-activity "tourist, administrative, and commercial" building. On March 5, 2021, the various departments in the government departments began the evacuation of the complex, where the front yard of the complex witnessed the gathering of cars transporting administrative offices and papers for departments and moving them to their new places. Governmental sources confirmed to Youm7 journal that it is scheduled to cut off the facilities from the huge building "Al-Tahrir Complex" in

November 2021 and that all offices will be transferred to hand over the complex completely free of movables and employees. As the building must be empty by the end of 2021 (AlYoum 7 journal, 2021). So, on March 22, the building was empty, and all services were disconnected from the building except five rooms for the security. There was a lot of security around the building as it is an important national building in the heart of the city.

### 5.6.2 Identification of users and building condition

This part introduces the building's condition before the evacuation of the building, the existing condition for many years with its public administrative function. Users are from the local public who must make their official papers in most of the administrative departments in the building. Every day, about 25000 to 30000 public users use the building, and there is no periodic maintenance to the building, which led to the building's bad condition for many years, as it is illustrated in the following in figure 44.


(Fig.43) - Internal photos from the building. Source: Al-Nagar, 2016)

Despite the apparent development operations aimed at beautifying the building from the outside, as it is considered the old downtown main image, the complex internally needs a lot of work to develop and rehabilitate its employees, establish a modern communication system, and structure the daily dealings between citizens and employees. water leakage from the back pipes of the building and increased humidity in the ceilings of most floors of the complex, which threatens to collapse. In addition to the neglecting of the cleanliness of the building, throwing garbage on the stairs of the complex, and the spread of street vendors inside building rooms at the time of complex usage (Al-Nagar 2016), this was continued for a lot of years without any maintenance, which left the building in a really bad condition before the development and evacuation plan in 2021. From also a visit that was held in 2016 by the author, overcrowding, traffic congestion and traffic facilitation were from the main problems of the building, suffering from bureaucracy, maltreatment, corruption, negligence, and waste of public money. The condition of the building, which is held in March 2022, is fully empty. All the services are disconnected from it. There are no users, just the security. There are parts of the building that have been taken as a sample to be tested before the adaptation process. The consultant that is responsible for the building extracts





samples for most of the building's structural systems such as stairs, ceilings, and floors, as well as testing the overall structural system and foundations of the building. All public toilets feature was removed and disconnected from sewage pipes, as well as the furniture of the room is relocated in the new places for the departments.

## 5.7 Conversion of use feasability check

### 5.7.1 Office buildings adaption potential

The adaptive reuse of office buildings is more feasible than that of most non-residential structures. However, the size, condition, and structural configuration of these buildings are not always suitable for adaptive reuse as housing or factories. Typically, they are converted to a new commercial purpose. Office work practises are currently more dynamic. It is essential that the workspace be adaptable. Due to their typical multi-story design and regular floor layouts, office buildings lend themselves to reuse as hotels. Many significant urban areas, such as Edinburgh, have increased their hotel supply by converting vacant office buildings into hotels. The adaption potential for high rise end/mid-terraced or corner building that used for offices are highly have an adaption potential to hotel, flats, and new use offices (Douglas, 2006).

Due to their size, layout, and location, defunct office buildings are frequently ideal candidates for hotel conversions. This type of conversion has developed into a national pattern. The floor plates of certain office buildings are frequently easy to convert into guest rooms.

### 5.7.2 Hotel design and adaptive reuse

During a time of uncertain economic conditions and increased competition, adaptive reuse – the transformation of ageing or historic structures into memorable and appealing hotels – is an increasingly popular strategy (Habeeb, 2013). Today, hotel owners and developers are not the only ones proposing historic buildings as revenue generators; customers, who are hooked on the concept of unique travel experiences, are also driving this trend. Each hotel project in the historic building is unique and requires its own blend of compromise, ingenuity, and skill. However, all successful historic renovations share common elements, as well as a consistent set of measures that should be taken to preserve architectural detail and effectively link history and hospitality. Such a strategy necessitates a nuanced understanding of how to combine the old and new, a sophisticated technical and architectural skill set, and an in-depth understanding of how to accommodate cultural and community context.

Recovery or adaptive reuse of historic buildings into hotels is a massive undertaking that necessitates specialized skills for completion. Therefore, the formation of heterogeneous expert teams is indispensable for recognizing the building's worth and significance to the community. Coordination with conservation agencies and social organizations, soliciting community input, and researching old photographs – to ensure fine-tuned historical detail – can lay the groundwork

for successful revitalization, which will preserve the cultural and architectural character of the location while also meeting the technical and operational needs of modern hospitality (Klumbis, 2005).

## 5.8 Preliminary evaluation process

### 5.8.1 Initial diagnosis report

Despite the governmental plan towards the building, researchers should investigate considering their studies regarding old existing buildings. Maybe the building could not be sustained for more years towards the new function and needs to be conserved only as a heritage building. It may also be sustained for more than its age and can be adapted twice. For the diagnosis report, buildings can be put as a first step in categories four and five from the adaptation levels that are mentioned in figure 44, which are buildings that have serious problems of adaptation. As was mentioned previously, the problems with the main services such as sewage, firefighting, and technical service. In addition to that, it has great value for the community and the government, considering that studies have to be continued into the multidisciplinary analysis. Studying the building deeply from all the aspects: the architectural aspect, environmental, social, cultural, and economic. What is the accurate government plan for the building, the stakeholder analysis, and the funding options? In addition to deeply studying building services and facilities.

### 5.8.2 Participation process

Deep multidisciplinary adaption analysis needs participation parties for further investigations. As an initial investigation for the building, an old workman who is responsible for servicing the building at its usage is needed for a tour of the whole building and its floors, rooms, services area, and stairs to be deeply observed and photographed for the analysis. This needs permission from high parties as the building is now a local national building which is owned by the city. So, permission must be taken from the Chief of West Cairo district now. In addition, since he was the director of Al-Tahrir building for 40 years, these participation parties are very important for investigating the building.

At the same level of importance is the owner itself for discussing the main plan and requirements brief towards building adaption. The Minister of Planning and Economic Development and Chairman of the Board of Directors of the Sovereign Fund, which the fund owns Al-Tahrir building, to discuss more about the overall area plans, complex main development plans and funding issues.

### 5.8.3 Legal framework

As it is illustrated in (table 5-23), it is important in the initial steps to setup a framework indicating next steps and working as a reference for other researchers. Starting with the use





feasability check then the multidisciplinary analysis for the building in all aspects, followed by the diagnosis, which can identify strengths and weaknesses for building adaption from values and deficits mapping, which will be extracted from the building deep analysis process. In equal importance, values and deficits should be illustrated with justifications and descriptions. Values and deficits are identified from more than one point of view, from outside and inside the building; they are identified from the author's perspective, the building workmen's perspective, and the owner's perspective, who is the government and the city. After that, the framework that combines sustainable adaption with the strategies is tested on the building to assure its sustainable applicability with recommendations for the future building adaption.

## 5.9 Analytical approach of al-tahrir complex building

### 5.9.1 Building data

(Table 5-24) - Al-Tahrir complex data. Source: Author based on different references

| | |
|---|---|
| **Owner** | Before: Government agencies<br>After: The Egyptian Sovereign Fund |
| **Designer engineer** | Mohamed Kamal Ismail. |
| **Location** | Downtown Cairo, Egypt. |
| **Function** | The largest administrative public service complex in Egypt. |
| **Established** | 1951. |
| **Total area** | 12,500 square meters. |
| **Construction cost** | Close to 2 million LE at the time it was built. |
| **Design concept** | Tahrir Square was being in relationship with L'Étoile in Paris. Al-Tahrir Complex shaped like ship from eastern facade. Northern side In Tahrir square it took the shape of an arch array with Tahrir square. |
| **Architectural style** | Modern style of architecture that combines originality and sophistication. Using Marble and granite in construction that were imported from Italy. |

(Fig.44) - Al-Tahrir complex, 2022. Source: (Wikipedia, 2022)

### 5.9.2 History and cultural significance

The Tahrir Complex opened in its current form in 1951 during the reign of King Farouk. The building was built with a ship-like structure, on an area of 28,000 square meters, and 14 floors high, comprising more than 1,300 rooms. It is known it as an integral part of Cairo's heritage, and a symbol of its architectural symbols. During the last decade, the complex acquired another symbolism that stems from its location, as it became part of the memory of the massive demonstrations that Egypt witnessed during the so-called 25th revolution of January 2011, which took Tahrir Square as its center. This was repeated with the demonstrations of the 30th of June 2013. The downtown area of Cairo has witnessed extensive development and modernization over the past years, which included the removal of heavy advertisements and decorating the facades of real estate with cosmetic lighting, while Tahrir Square was opened in its new form, with an obelisk and four statues of Pharaonic rams in the middle of a procession celebration The royal mummies last April (Shosha, 2021).

### 5.9.3 Government plan/Owner requirements

A structural interview held on 2 June 2022 with the one who is responsible of Al-Tahrir complex document Mrs. Aya Waly, secretary at Dr. Hala Saied, Minister of Planning and Economic Development and Chairman of the Board of Directors of the Sovereign Fund which is





the fund owns Al-Tahrir building., Salah Salem St, Cairo, Egypt. For more deeply details about the city plan towards the complex and the development of downtown through these interview questions:

Egypt is a country rich in many assets, including untapped assets, referring to the Tahrir Complex, which was transferred to the Sovereign Fund of Egypt. It assigned the rehabilitation and development of the Tahrir Complex in the downtown area - the most famous government building in downtown Cairo - to an American alliance after winning the best financial and technical offer with a total investment of more than 3.5 billion pounds (222.7 million dollars) to develop the building to be of mixed use (hotel - commercial - administrative - cultural), while developing the downtown area and turning it to a foreign investment which this development can enhance many documents issued during the interview, it summarized in the following point:

- After the government started the work of the development plan for the downtown area, which includes the rehabilitation of the Tahrir Complex building, due to the fact that the downtown area has witnessed over the past 40-50 years many residents and companies have left buildings in the area, in exchange for an increase in the number of shops, and with new investments in the area, it will attract new users, which will increase the value of these properties. The redevelopment of the downtown area attracts local and foreign investments to exploit real estate in the area to create diversified investments. In addition to the rehabilitation of the downtown area and Khedive Cairo, to make it a heritage area that attracts tourists. All these changes can put downtown Cairo on the world tourist map, which include a lot of old and unique building (Waly 2022).
- According to the proposal, changing its name to **CAIRO HOUSE**, the building will be divided into a large commercial mall on the first floors, in addition to the conversion of the middle are in the building into a group of various public functions such as banks and restaurants and the last floors are being transformed into a tourist hotel overlooking the square, the Egyptian Museum, and the Ministries Square and overlooking the Nile, which will be a tourist attraction. It was agreed with the Ministry of Planning and the Sovereign Fund of Egypt to transform the building into a multi-investment complex to ensure a continuous return, whether from the hotel component or the commercial component of the building. It will include meeting spaces and an interface for holding international meetings and events and will be an important tourist destination for Egyptians and foreigners. He pointed out that the upper floor will be developed so that the visitor can view and enjoy Cairo from the top (Waly, 2022).

- The development of the complex aims to expand the base of available investment opportunities and maximize the utilization of the state's exploited and untapped assets. allows to diversify sources of financing to increase the competitiveness and productivity of the economy (Waly, 2022).

### 5.9.4 Funding and stakeholders' analysis

Contracts are signed between the Sovereign Fund of Egypt and the American Alliance, in the presence of the Egyptian Prime Minister, Minister of Planning and Economic Development, also the Chairman of the Board of Directors of the Sovereign Fund of Egypt and Ayman Soliman, CEO of the Sovereign Fund of Egypt.

The American alliance consisting of 3 companies, which won the process of developing and rehabilitating the Tahrir complex and the surrounding area, has its vision to develop the ancient building in the centre of Cairo, considering its experiences in the development of ancient buildings in Europe and America. The American alliance includes the "Global Features Group", the "Oxford Capital Group", and the "Al-Otaiba Investment Company", which is an Emirati company. There was also a committee that included the Ministries of Tourism, Antiquities and Housing to set initial standards, and the international expert houses were sought to study the best uses of the Tahrir Complex building. Several scenarios were developed by the Ministry of Tourism and Antiquities to re-use the 14-storey Tahrir Complex building after it was completely evacuated, as part of the ministry's plan to develop and raise the efficiency of the field in cooperation with the ministries of planning and housing.

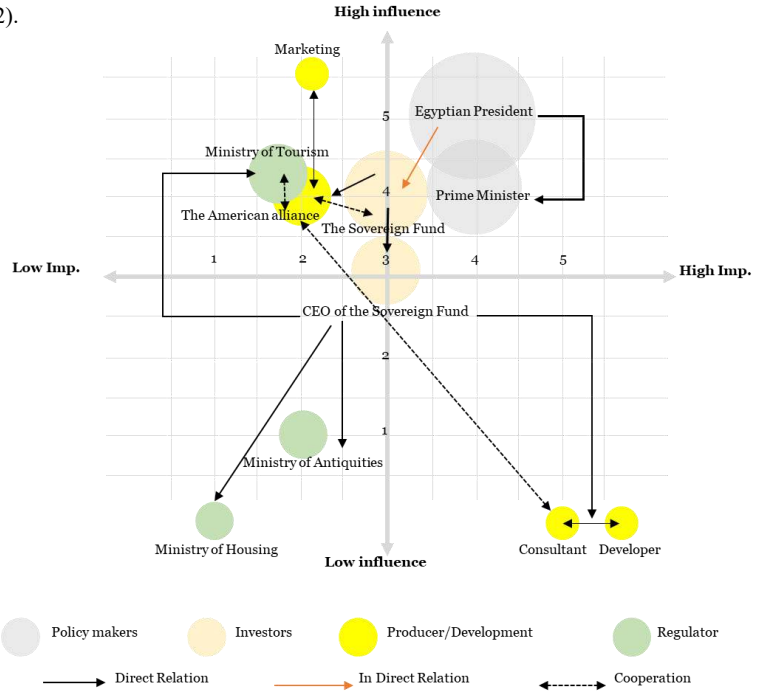
(Table 5-25) - Identification of stakeholders, their interests, importance and influence, Source: Author

| Stakeholder | Interest | Effect | Importance of stakeholder for success of the project | Degree of influence of stakeholder over the project |
|---|---|---|---|---|
| **Egyptian President Abdel Fattah El-Sisi** | 1 | 5 | Very important | Very influential |
| **Egyptian Prime Minister** | 1 | 4 | Very important | Signif. influence |
| **Minister of Planning and Economic Development and Chairman of the Board of Directors of the Sovereign Fund of Egypt.** | 4 | 3 | Very important | Moderate influence |
| **CEO of the Sovereign Fund of Egypt.** | 4 | 3 | Moderate imp. | Mod. influence |
| **The American alliance.** | 5 | 2 | Very important | Some influence |
| **Ministry of Tourism.** | 4 | 2 | Very important | Some influence |
| **Ministry of Antiquities.** | 3 | 1 | Some important | Little influence |
| **Ministry of Housing.** | 2 | 1 | Little important | No influence |
| **Consultant** | 3 | 1 | Critical player | No influence |



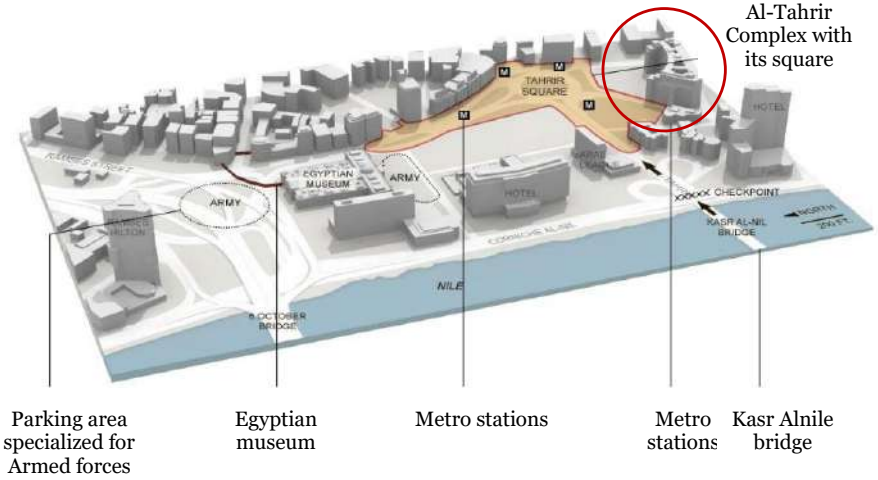


The total investments that will be pumped into the development process amount to more than 3.5 billion Egyptian pounds. It is planned to open the project as one final stage within two years, followed by the final operation. They aim to start development in the first half of 2022, and a large part of the engineering studies have been completed before the development process (Waly, 2022).




(Fig.45) - Influence Vs Importance stakeholder's map. Source: Author

### 5.9.5 Context Physical profiling characteristics




(Fig.46) - Building context features. Source: Author based on different sources and site visits.

From site visit observation around the building, it is observed that the building is in a distinctive area surrounded by several hotels, next to the Egyptian Museum and near the Nile. As it is one of the main squares for downtown Cairo. From the west it is surrounded by the Nile, the American university in Cairo lies on the east, Al-Tahrir square from north and ministries area from the south. About 2 mins walking is the downtown of Cairo which is known for its historically significant building and the unique styles, in addition to the live streets which have coffee shops, cloths shops, food, drinks and a lot of pedestrian paths (Author, 2022).

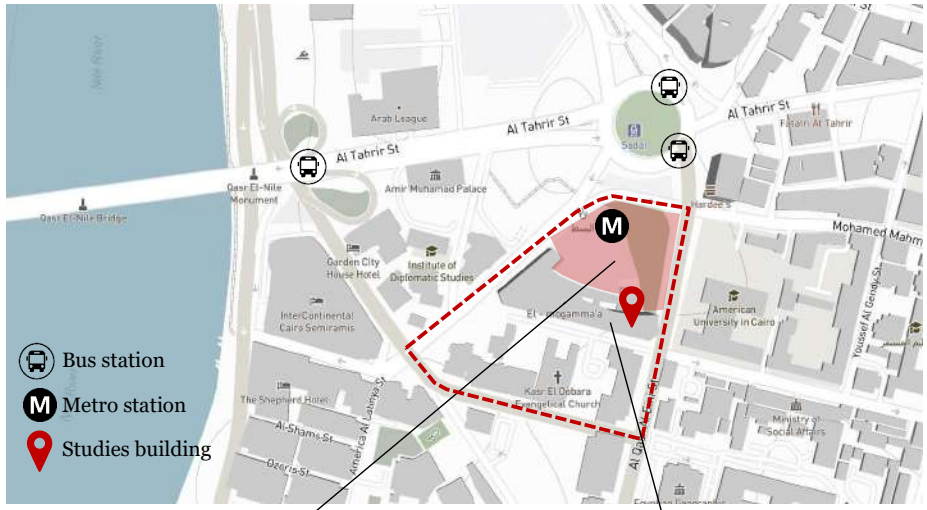
### 5.9.6 Building physical profiling

Per the un-structure interview held with the building director, Al-Tahrir complex building was built in 1950 with 350000 dollars as a cost at its construction time. The building height is about 55 meters including 14 floors. Its area is about 5000 meters square and 12500 with the outdoor area including paths and in front plaza. The building has 5 entrances, one of them is the main one faces Al-tahrir square, 2 others on Magmaa Al-tahrir street. (See figure 50) faces the Egyptian museum and the other 2 on Al-Qasr Al-Eini street. facing the American university in Cairo. For its old use, the main entrances use as the public entrance for users ana employees, the two which face AUC are closed and the two faces the Egyptian museum one for the emergency and the other for the Deputy Governor. It includes 1309 room, 90% of them uses as an administration offices and 10% as services room for the building. The building has 10 elevators and 4 main stairs cores (Abd-Aal, 2022).



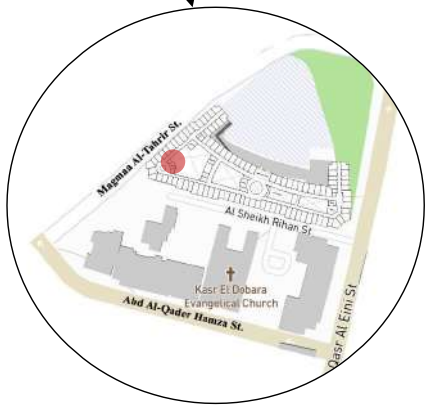


### 5.10 The analysis through the evaluation




(Fig.47) - Building plan with with Al-Tahrir square. Source: Author by site observations and map box mapping

(Fig.48) - Outdoor area, Source: Wikipedia




(Fig.49) - Masterplan. Source: Author

### 5.10.1 Site layout

Regarding site layout features adaption feasibility most of its element are identified through three main methods of data collection which are the personal site observations, measurements on maps and interviews regarding the regulations. So, it is observed from the site visit on 26 March 2021, that the building has a large outdoor area, as illustrated in figure (49&50), which is

approximately 9500-meters squared of landscape and hardscape elements. According to an interview conducted on the same day with Osama Abd-Aaal, the current Chief of West Cairo district and Director of Al-Tahrir building, this area in front of the building was specialized for the public and users of the Al-Tahrir complex in its previous use (Abd-Aal, 2022). So, this area can be used as an incorporated recreational area outside the building of the new use. can be used as an outdoor setting area, a water fountain, and a kid-friendly area with adjustments for the area to be safer. In addition to designing landscaping elements that optimize selection and positioning of plants for sun and shade, they create environmentally friendly outdoor spaces if the new use needs that, but if the existing landscape elements are good enough to be used and have their existing infrastructure and drainage systems, this outdoor space is considered an important square image regarding the development of the downtown, so the government puts effort into maintaining it. The building has different levels and massing differentiation in the last levels from the ninth floor to the twelve-floor used as terraces for employees in the old administration uses, as per the interview with the building director, and can also be used as recreational outdoor areas and roof gardening as a new use for the hotel (Abd-Aal, 2022).

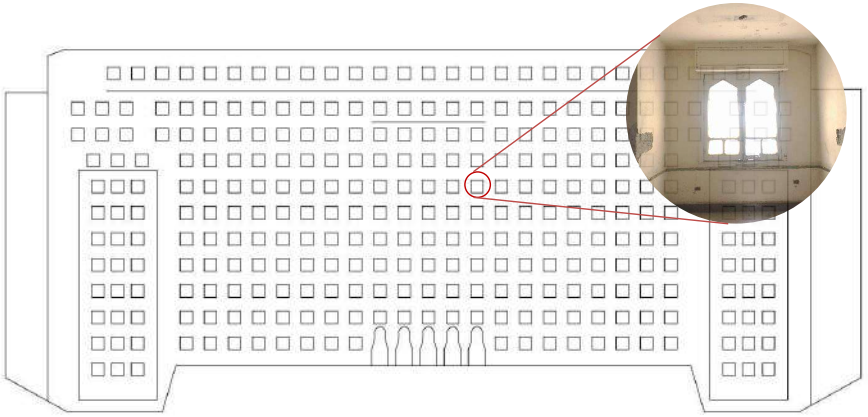
Regarding the presence of rooms for recycling operations and servicing, including collection, storage, and access for collection vehicles on the site, the building does not have proclitic buildings around the main one. But the building has excess service rooms on the ground floor with access from main streets and far away from the public main entrance. There are two rooms that are highlighted in red circle in figure 50. They are used to be furniture rooms for the old administration's use. Every supply material related to the building enters the building from these two rooms (Galal, 2022). They have access to the main street, Magma al-Tahrir St. So, for the site layout evaluation, outdoor recreational areas, earth forms, courtyard pavements, and designing landscape are elements that are 100% applicable to sustainable adaptive design but have a 50% applicability for recycling operations elements, as effective rooms from the building will be taken away for the purpose of site recycling. These are the applicability of adaptive sustainable reuse with minimal changes. Any additions to the original configuration regarding the site layout must have standards and regulations approval.

### 5.10.2 Façade

According to site visit observations of the building and façade design drawings, the façade has a modular design appearance. Each office room is 3.60 metres long and has a 1.60-meter-wide window in the centre, with about 3.25 metres horizontally and 3.50 metres vertically between the centre of each window. The last floors of the building have a different depth than the other floors.







(Fig.50) - Building main façade. Source: Drawings from the archival data drafted by the author. The interior photo, Source: Author

The modular system and the presence of a lot of windows in the elevation without solid masses help in lightening every space in the building, so the building may not need changes regarding the openings. In addition to that, the façade has the versatility to adapt to different spaces as it matches the modular spaces inside the building and the modular structure system. Maybe the façade needs to be renewed with the painting of the walls using the nano technology painting or spaying with water technique as mentioned by Architect Mostafa Abo-Lela in its interview. They are using this technology nowadays to recall the original appearance and materials of the original building. Also, light is a main element in this façade because it has a simple modular design. The lightning technique is already used in the development of the square and the surrounding buildings. So, 100% for the façade adaption evaluation for the new use of other similar uses.

### 5.10.3 Building additions

Harmonization and dominance are mentioned in the literature guidelines part as they are the two important building addition elements. In the case of the Al-Tahrir complex building, additions are not easily allowed to the original building. As per the interview held with the owner, who is the secretary of the Chairman of the Board of Directors of the Sovereign Fund, the main plan for developing downtown is to recall the original buildings and urban context. So, all additions to the building are removed, even the signage of the commercial spaces. The building director ensures this, as they need at some time to use the building terraces as an addition to administration rooms. They already built them by light structure, but the government destroys them (Abd-Aal, 2022). Lightening was used to emphasise the original old design. Light structural additions may be made, but they must be compatible with the surrounding context and not erase the original identity. As an example, for using the outdoor spaces of the building, light structure

shading must be used to prevent users from direct sun light. The proposed design for the complex made by the American organizations, designed light shades for the use of the roof and in front outdoor areas as illustrated in figure 58, but it needs to be studies with the context of the surroundings.

(Fig.51) - Proposed new function design for the building. Source: The American organization (Oxford capital group) edited by the author

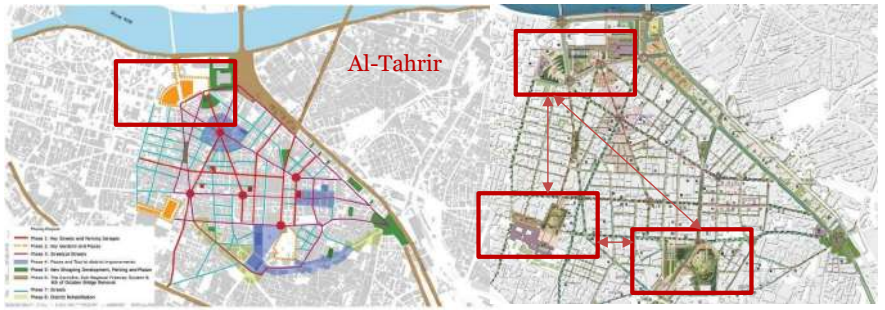
### 5.10.4 The urban and the historical context

Mr. Osama Abd-Aal, the Chief of West Cairo district declared from the interview question, that the project aims to restore the area to its former state, in the time of the Khedive as the development of the downtown Cairo. Which includes the unification of the storefronts, the removal of protrusions and encroachments on the road and sidewalks, and the study of traffic, pedestrian paths, and wheels (Abd-Aal, 2022). Developing Khedive Cairo in the area between Tahrir and Opera Squares, passing through Talaat Harb and Mustafa Kamel Squares. As illustrated in figure 59 the development illustrated masterplans showing the developing of downtown Cairo including Al-Tahrir square, it's plazas and building as main attractions points. President Abdel Fattah El-Sisi directed the implementation of the national project to develop Khedive Cairo and restore it to its





original status to be a center of tourism attraction and to preserve its real estate and buildings as a rare-style real estate wealth, as part of the plan. So, converting Al-Tahrir complex building function from administration to commercial hotel is applicable to the development of the area (see figure 53).

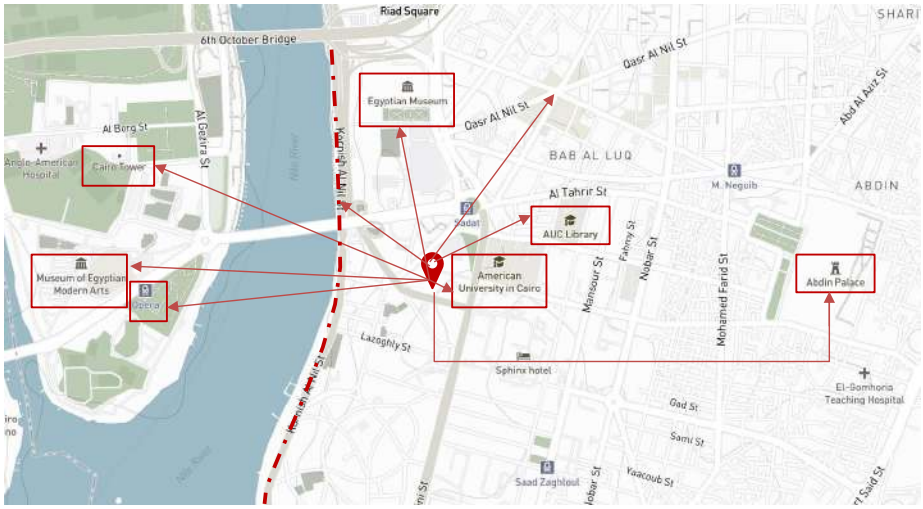



(Fig.52) - Downtown government plans. Source: SWA firm edited by the author

SWA is a landscape architecture, urban design, and planning firm, with a network of seven studios worldwide that responsible for the redevelopment of the downtown Cairo with the coordination that carried out between the Agency and various authorities, such as the Ministry of Housing, Utilities and Urban Communities, and the Cairo Governorate (Abd-Aal, 2022). It is showed from the illustrations that Al-Tahrir complex and its front plaza will be one from the main attractions point in the development. Also, the main touristic tour of the downtown Cairo passes through the building which have unique architectural style that must be preserved and presented.

As illustrated in figure 54 and per the regular site observations, visits and the using satellite maps the building site surrounds by different point of attractions, activates, and uses that are important for any touristic attraction areas. There are heritage buildings as the Egyptian museum, The Egyptian Museum is one of the largest and most famous international museums, located in the heart of the Egyptian capital "Cairo" on the northern side of Al-Tahrir Square. In addition to Abdin palace, it is one of the most famous historical palaces of Egypt. It witnessed many events from the royal era until the emergence of modern Cairo. As well it is a rare historical masterpiece in the form that turned it into a museum that reflects the luxury in which the palace was built. On the other side from the Nile of Cairo tower located, it is the most iconic building in Cairo. The cultural side of the activates includes the American university in Cairo and its library as well as the Opera. The building in about 2 mins walking from downtown Cairo which has a lot of commercial areas including cloths, food, coffee shops and pedestrian paths along with the unique buildings.

With the same importance is the Nile River, Mamsha Ahl Misr now is opened which is the longest pedestrian pathway on the nile including a lot of activates.




(Fig.53) - Context activates and points of attraction surrounding the Al-Tahrir complex. Source: Map box for mapping, site observations and drafting by the author

Per the author transportation experience to the building, the building considered connected to the city by mainly one mean of transportation which is the Metro (Underground). The building has in its front plaza a station (Al-Sadat station) highlighted on figure 48 which is connected to all the other underground metro lines, so all users can be easily access the building through the underground metro. But there are not enough bus lines that connected the building to the whole city, only two stations in Al-Tahrir square which their buses not connected to most of the city. The reason is the presence of Abd Al-Moneam Ryad main buses station around 5 minutes' walk from the studies building. In addition to the car accessibility to all the building entrances.

But for the other sustainable means of transportation as the walking and biking, there is not an option. The streets are not good for biking and walking infrastructure, as the sidewalks are not designed for walking and biking paths.

So, for the evaluation part, 100% applicability for the legislative reviewing, architectural style, cultural features, existing infrastructure and 50% to the transportation systems.

### 5.10.5 Parking, Impervious Surfaces, and Heat Island Effects

As reducing the number of impervious surfaces, causing a lower microclimate temperature of the site, lowering building energy consumption. As a first step studying the parking opportunities around the building before adding new. Per the owner requirements, the





development will include more than 450 luxury hotel rooms, The hotel will also include a large meeting and event space of 7900 square meters, including the largest rooftop venue in Cairo. In addition to the indoor and outdoor venue for events and weddings, to provide an additional 1400 square meters of large meeting space. The first two stories will be used as a large commercial complex (Waly, 2022).

As per the Egyptian standard parking code, 0.60 parking lot needed for every hotel room including all hotel activities as restaurants, events avenue, and meeting rooms. And 3 parking lots for every 100 meters square for commercial uses inside the building.

(Table 5-26) - Parking plots calculations. Source: Author & Egyptian parking code

| Requirements | Parking lots needed according to Egyptian code | Total no of lots needed |
|---|---|---|
| **450 hotel room** | 0.60 | 270 parking plots |
| **App. 10000-meter square commercial area** | 3 for every 100-meter square | 300 parking plots |
| **Total parking plots needed for the complex** | | 670 parking plots |

The government specialized the two main parking which are Al-Tahrir parking and Omar Makram garage, that they can be used as parking for Al-Tahrir complex hotel. Al-Tahrir garage designed by Arab Consulting Engineers «Moharram – Bakhoum on 4 underground floor can absorb 1800 car (Al-Mokwlon Al-Arab, 2022). In addition to Omar Marakm garage which can absorb about 500 car (Al-Mokwlon Al-Arab, 2022). They are large area comparing to the complex but further studies needed to compare it with downtown area with the development of Al-Tahrir building.


(Fig.54) - Parking opportunities around the building. Source: (Waly, 2022) by Map box mapping

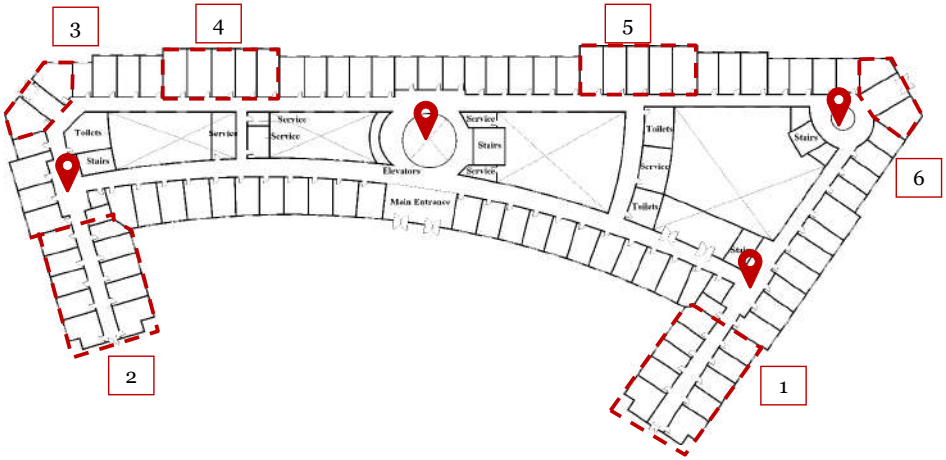
### 5.10.6 Alternative transportation

The government introduces the new bike (CAIRO BIKE) system as a development for the downtown Cairo which is characterized by linking it to an electronic system supported by a mobile application, and the bikes are supported by GPS, to track the bike and prevent its theft, and the system can calculate the time and distance travelled by the bike. The bicycle stations work with solar energy and air internet to support mobile application services and electronic payment services for the cost of cycling. The Governor of Cairo indicated that the state seeks to encourage citizens to reduce the use of private cars to reduce congestion and reduce pollution by providing an appropriate means of transportation to help him in this (Al-Khlfawy, 2022).

### 5.10.7 Environmental quality

The area from googles satellite as it is showed, the urban and heat island effect pressurize on the area of the downtown Cairo it is the most heart of the city. The areas around the building may have an opportunity to for developing the environmental quality and increase plantation. From site observations and building visit, the area Infront of the building includes only 30 tree which is not enough for 9500-meter squares of landscape land. Each tree occupies area of 2-meter square. Human needs 0.0144 meter squared of green and bushy space to satisfy the Oxygen requirement of one day.

### 5.10.8 Building spaces




(Fig.55) - Al-Tahrir Complex ground floor. Source: Building archival drawings drafted by the author using Autodesk REVIT 2019

Per the site visit, observation and mapping on 22 March 2022 and interviewing the head of workmen Mr Gala for documenting existing condition of the building. The building considers a





typical administration module, which include about 1400 room, each room is about 3.60 meter in width and between 8 and 9 meters in long. The building includes 5 entrances, 2 are typical, the other 2 are typical also and the main entrance is larger and unique to absorb the users of the building. There are 4 main course including stairs and elevator. In addition to two toilets cores with service rooms. Four courts opened to the sky are the most featured inside the building used as the main source of light to the inside corridors. These courts on the ground floor includes service rooms for electricity, water, fight fighting and garbage (see figure 56).

Spaces are subtracted from the typical floor in the last floor for terraces composition and mass shaping as it illustrated in figure 49.

All the service room are on the heart of the building accessed from the courts and lighted from it as it illustrated in the ground floor plan of the building.

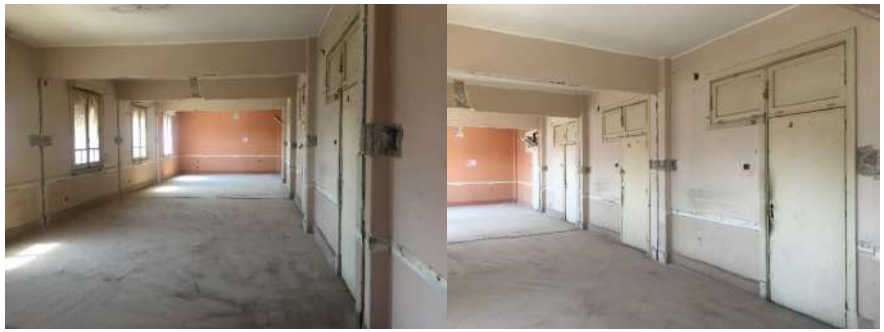
The modularity of building spaces can achieve more than one from the adaptable sustainable space design strategies.

The building can achieve more than one adaptable strategy because of the modular system it was built one. The flexibility, refutability and Convertibility are the three adaptable design strategies that can be achieved through the adaption. As those building elements can be achieved through the adaption process which are the using of movable walls between spaces that be readapted to new function rather than guest rooms, the availability of creation of different modular room sizes, wider corridor width as there is courts along all the corridors and rooms with large depth comparable with guest rooms standard depths, storage spaces and excess service points in the heart of the building.

The modular system of the building can also achieve modular performance design through the easing of the coordinated systems, the standard shapes, access points and dry connections.

And the convertibility can be achieved through the multi-functional spaces, ceiling and flooring spaces and excess service capacity.

The highlighted modular nodes on boundary of the building 1,2,3,4,5 and 6 on figure 56 can be used as multifunctional spaces in floors and guest rooms in floors. In addition to the ability of dividing them with movable wall to change its function according to the use. They already use this technique in the existing state to largen some administration offices in some floor and other floor those spaces kept as a single office room as illustrated in figure 57. So, size and shape of the spaces can be changed and adapted through the modular spaces.



(Fig.56) - Using modular system for largen spaces as an existing condition. Source: Author, 2022

The building has also many connections that acts as a good point in fluidity and continuity of Spaces and different activates. There are mainly 4 connecting point through the whole building highlighted with the location point of the ground floor (Figure 56). The left wing of the building may be enhanced through the adapting with another connecting point between spaces.

(Fig.57) - Connecting transitional existing spaces. Source: Author, 2022

The Divisibility and Elasticity of spaces which (Brooker, G. and Stone, S., 2004). Brookner and Stone developed three techniques of building reuse based on the extent of integration between the host building and the new elements added to it. These strategies are intervention, insertion, and installation. They can be applied in the framework of recalling the original building not adding to regarding to the Egyptian regulations experience that architect Mostafa Abou-Lela talk about. Maybe it can be achieved through the large spaces inside the building to adapt different experiences as letting guests adapt their rooms as they need by new movable techniques furniture.





### 5.10.9 Interior adapting

All the interior design techniques that mentioned in chapter 2 can be applied on the interior of the building. The building is not a heritage or a unique one from the inside to recall it's experience. So, the architect needed experience through the interior can be applied through the lightening, surface, openings, movements, plans and objects, especially with the lightening as the building has different colourful windows that lightening the corridors from the interior courts.

(Fig.58) - Interior shots for the windows in the corridors, stairs, and main dome court. Source: Author, 2022

From building observations and documenting unique elements by photographing, it is observed the good condition of corridors windows with the colourful lights for daylight, as well as the glass brick that used in stairs cores windows in as illustrated in the second photo. In addition to the openings in the main court dome. Regarding the plans and objects of the building, the spaces have curvature experience from the original space layout design that can create a good experience for the corridors and transitional areas (see figure 59).

Visual quality through daylighting provides a rich spectrum experience that increases eye clarity when managed by building openings and glass types (City of New York, 1999). As illustrated in the ground floor plan in figure 62, the building has 4 large courts regards the building spaces which give appropriate daylighting needed to the internal building spaces. Also, all the rooms include windows that area occupies more than 8% of the room area according to the Egyptian building code. But the two first floor including the internal spaces of the ground floor corridors do not have the enough day lightening because of the height of the building and the addition of service room that accessed from the ground floor in the courts floor. This makes the ground floor without lightening completely dark in the daylight and needs a lot of artificial light.

Concerning the acoustic quality of the building, its location is from the living area in Cairo, which is condensed with people, cars, and a lot of services. Physical noise can be measured. For example, it is estimated in decibels or phonons. For example, the speech of a normal individual is estimated at 50 to 60 decibels, and the noise from a horn and skull is equal to 100 decibels. The intimate suspender has intimate clothing up to 20 db. It caused a problem caused by its equal areas of nervousness and hearing defects. A study conducted by the Egyptian Ministry of Health

in 1988 in Cairo and its suburbs, the area around residential areas (8 hours per day) was measured in the downtown of the country with people and shops. It was proved that the noise ranged between 58 decibels in quiet residential areas and 73.5 decibels in crowded residential areas in the evening, and in the middle of the city it ranged between 64.5 and 69.2 dB (Specialized National Councils, 1988). And regarding the noise inside the building, it is a good point for all the services to be located on the ground floor, as its main use regarding the owner's programme will be the commercial zone, but these rooms must be well isolated also to not affect the visitors. as well as the machines that will be needed for the HVAC system above the roof. Isolation needs to be considered between machines and roof activities.

From building observations, as it was used as a public building, cheap materials were used, and it was not maintained over time. Painting, granite in the entrance, ceramic in the offices, and MDF wood used in the manager's offices are the main materials used. But they are highly deteriorated because of the high number of users per day. So, building materials must be replaced and renewed to fit the new luxury use and provide rich experiences through the spaces, especially if the building does not have unique materials to be preserved and recalled through the interior. The building does not have unified materials colours, as each administration department made its renewing material colours as illustrated in figure 60.

(Fig.59) - Interior shots for building main used materials with different colours. Source: Author, 2022

### 5.10.10 Domestic special service and facilities improvements

Mentioned in chapter 3 special improvements strategies needed for disables according to (Douglas, 2006). The existing condition of the building does not have none of them according to the site observations and interviews done with the director. Two of those strategies are easily handled which are the ramps and the vertical circulation. There is no difference between the building and level of landscape and the building includes 10 elevators in each core that are accessible to all the floors even the roof. From the site measurements, all the doors have the same





clear opening size which is 1.00 meters. So, installation of some related improvements needed as additional handrails, electrical modifications, emergency, ironman gory, sanitaryware's and worktops. But bathrooms have bad condition regarding all the users, there is no special cubical for handicapped and their special sanitary ware as it is not designed while the building constructed.

### 5.10.11 Service system

***Water management systems***

Regarding the building supply water to the public toilets according to building observations and director interview. The system mainly has water from the main public pipe in the direction of the Tahrir square, the water goes directly from the main pipe to the pumps that exists on the ground floor and then pumped to 14$^{th}$ floor through pipes exists in the court and go down to supply each floor. As well the drainage system collects waste from all the floors whether it is grey water or solids through different pipes exits in the court to manholes on the level of the ground floor to the main points of city public drainage system. The same system also for drinking water but through different pipes (see figure 63).

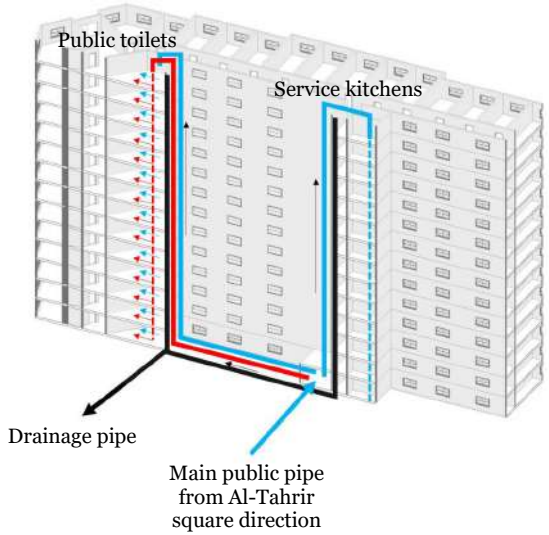
There are no water treatments in the whole system as well the filters, it is an old system from the building construction time and does not have periodically maintenance overtime. There are no direct connections between drinking water and other types of water, which is a good point, but all the pipes need maintain and replacing.

The pipes used for water supply system is galvanized steel pipes and not changed from the time of the building construction ass illustrated in figure. The pipes used from transferring water which pumped to the floors changed one time within the building age to PVC pipes and coated in a white colour as illustrated in figure. The pumps are old machines but in a good condition.

A different pipe is used for roof drainage system but without recycling options. All the pipes are exposed in the court, the system in not embedded anymore. Over the time leakage and blocking out at different time occurs to the systems because of the pressure on the old pipes, as about 25000 user use the building daily.

(Fig.61) - Al-Tahrir building existing pumps room. Source: Author, 2022

(Fig.60) - Exposed public toilets pipes in the court. Source: Author, 2022

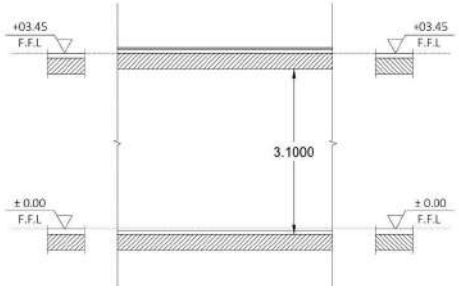



(Fig.62) - 3D section for Al-Tahrir building for supply water and drainage system. Source: Author

***HVAC systems***

The building originally in the design does not have an HVAC system, there is no rooms, machines, and ducts. Users overtime uses one unit system in some rooms mainly for mangers offices as illustrated in figure 64. But they are not allowed to install the outdoor machine on the main elevation because of the façade faced Al-Tahrir square. There is no suspended ceiling installed in the building even on the ground floor, as it is the main entrance floor. As per the archival drawings the clear height if the spaces are 3.10 meters from face to bottom of the structural slabs.

(Fig.64) - Installation of one unit cooling system. Source: Author




(Fig.63) - Section for Al-Tahrir building existing clear heigh. Source: Archival drawings illustrated by the Author.



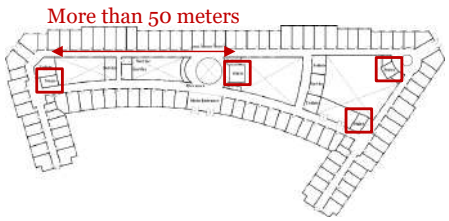


***Electrical installations***

The building has an electrical system that was built from the day of the construction which is 1951 and do not changed overtime. The system mainly consists of main cables that take from the city public lines in the direction of Al-tahrir square also to the electrical room exists on the ground floor and from it distributing of each floor then. All the system cables lines installed in a raised floor under the ground floor and then go vertically to all the floors. Every floor has a three electrical key unit that control all the floor rooms.

***Fire fighting***

Regarding firefighting and life safety of the building, the new usage which is the hotel has different requirements rather than the administration usage. But here is some observations and data from site visit and interviews held. The firefighting system for the whole building is the basic old one. The system exists on the ground floor in such a court room. This room has mechanical pumps that take water from the main public line without a tank and distribute it to firefighting boxes exist in each floor. each floor has mainly one firefighting box, which are not enough for all these number of rooms in each floor. Also, the rooms do not have fire alarms and fire detectors. Walls are the typical brick 0.25 meters thick without fire rated options as well as the all the doors of the building. The distance between the stairs and escape routes are approximately according to the Egyptian code except the left wing of the building, a large distance between the two escape stairs related to the distance identified from the Egyptian code as illustrated in figure 66. In addition to all the stairs does not have the requirements of escape stairs and needs updating.




(Fig.65) - Al-Tahrir building distance between escape stairs. Source: Author

(Fig.66)Existing firefighting, electrical and garbage system units. Source: Author

***Garbage chute system***

The building has garbage chute system from the day of construction, two inlet units in each floor exists in the main corridors of the building collects the garbage in a room inside the court. And an Egyptian organization collects it two times per day in after or before the working hours employees.

# Chapter 6: Conclusion

The evaluation through the analysis that is done through the previous chapter in summarized through (table 13). This evaluation table of the case study shows the feasibility on Al-Tahrir complex to be sustainably adapted through the reusing and retrofitting strategies through complaining strategies tested, their elements, sub elements, criteria, indicator of these strategies achievement, means of verifications and the main layers of change that will affect through the adaption process.

(Table 6-27) - Al-Tahrir complex feasibility of sustainable adaption. Source: Author

| Shearing layers of change | | | | | | | | Strategies | Elements | Sub elements | Criteria | Indicator | Means of verifications | Evaluation Applicability % of considerations | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | | | | | 0% | 50% | 100% |
| ● | | | | | | | | **Space/form design strategies** | Exterior adapting | Site layout | Outdoor recreational areas | Regulations, Usage, availability of proper spaces | Interviews, observation, drawings | | | |
| ● | | | | | | | | | | | Earth forms | Good infrastructure | Interviews | | | |
| ● | | | | | | | | | | | Courtyard pavements | Usage & spaces | Interviews & observations | | | |
| ● | | ● | | | | | | | | | Design landscaping | Existing landscape design | Site visit observations | | | |
| ● | | | | | | | | | | | Recycling operations | Site spaces | Site, building visit observations | | | |
| | | | ● | | | | | | | Facade | Modular system | Façade design | Site observations & Drawings | | | |
| | | | ● | | | | | | | | Minimum changes | Usage | Owner requirements & existing spaces drawings | | | |
| | ● | | ● | | | | | | | | Keep Existing openings | No add or change in facade | Existing spaces and facade drawings | | | |
| | ● | | ● | | | | | | | | Versatile envelop | Applicability of structure system | Requirements of spaces | | | |
| | ● | | ● | | | | | | | Building addition | Harmonization | Blend in with the context properties | Context and site visit, observations & regulations | | | |
| | ● | | ● | | | | | | | | Dominance | Integration with original building | Regulation, proper adaptive design & Usage | | | |
| ● | | | ● | | | | | | | Urban and historical context | Legislative reviews | Approval of formal parties | Context regulations | | | |
| ● | | | ● | | | | | | | | Architectural style | Blend in with the context properties | Context and site visit, observations & regulations | | | |
| ● | | | ● | | | | | | | | Cultural features | Connection to another site activates | Mapping, site visits & regulations | | | |
| ● | | | | ● | | | | | | | Existing infrastructure | Connection to many services/facilities | Interviews | | | |
| ● | ● | | | | | | | | | | transportation system | To what extent connection to city | User experience & transportation maps | | | |
| ● | | ● | | | | | | | | Parking, Impervious Surfaces | Parking, Impervious Surfaces | Opportunities to nearby parking can be used | Interviews & site visit observations | | | |
| ● | | | | | | | | | | | Plant life | Heat island effect | Design & Simulation | | | |
| ● | | ● | | | | | | | | Alternative transportation | | New facilities' introduction strategy | Regulations check &suppliers' providing | | | |
| ● | | | | | | | | | | Environmental quality | | Adding or change landscape elements | Site observations, new design requirements | | | |



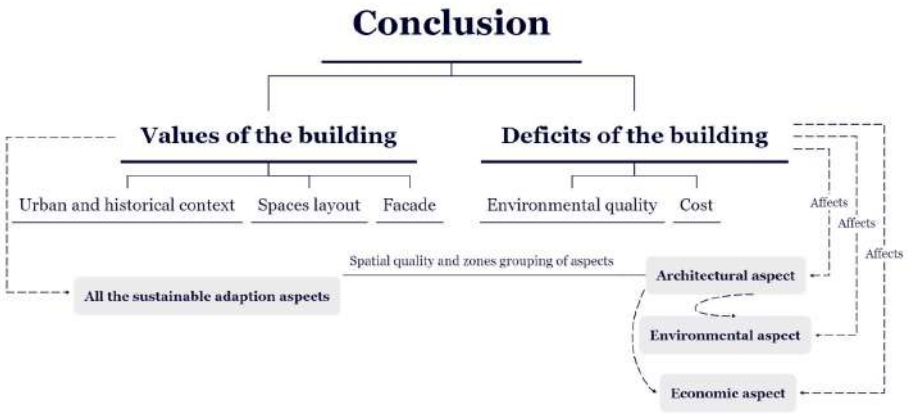


| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | ● | | | | | Space design strategies | Building Spaces Subspaces circulation | Adaptability | Minimal changes with achieving new usage requirements, fixability of spaces & fluid and continuous of spaces and subspaces | Interview, building layout drawings, building visit, observations & new usage requirements. | | | |
| | | | | ● | | | | | | | Versatility | | | | | |
| | | | | ● | | | | | | | Modularity | | | | | |
| | | | | ● | | | | | | | Divisibility and Elasticity | | | | | |
| | | | | ● | ● | | | | Interior adapting | Design techniques | | | The unique personality of building with the new use | Interview, building layout drawings, building visit, observations & new usage requirements. | | |
| | | | | ● | | ● | ● | | | Visual quality | | | Percentage of using artificial lightening during the day | New usage requirements, Building drawings & Simulation | | |
| | | | | ● | | ● | ● | | | Acoustic quality | | | Noise level affecting main spaces | Simulations | | |
| | | | | ● | | ● | ● | | | Material selection | | | Durability, performance & aesthetics after long time | Testing & observations | | * |
| ● | | | | ● | ● | ● | ● | | | Domestic special service and facilities improvements | | | No. of disabled people use the building | Interviews for requirements & Redesign facilities' | | * |
| ● | ● | | | ● | | | ● | | **Services performance strategies** | Energy sources | Renewable energy sources | | Embodied energy of the building | Calculations, simulation strategies design | | |
| | | | | ● | | | ● | | | Water management systems | Water supply | | Recommended water values of water component | Measurements | | * |
| | | | | ● | | | ● | | | | Water drainage | | Building drainage efficiency, connection installations & Main connection to public | Interviews & Observations | | * |
| | | | | ● | | | ● | | | HVAC | Cooling | | Cooling capacity, cost and energy efficiency | Calculations & Simulations | | * |
| | | | | ● | | | ● | | | Ventilation | Natural ventilation | | Percentage of natural air inside building | Natural ventilations rate needed & HVAC design | | |
| | | | | ● | | | ● | | | | Extract systems | | | | | * |
| | | | | ● | | | ● | | | Electrical installations | | | Standards installations | Existing connection, Space layout & User requirements | | * |
| ● | ● | | | ● | ● | | | | | Fire fighting | | | | Existing, building capacity, new usage and space layout | | * |

The building is applicable for converting its use and can be feasible for the sustainable adaption strategies that achieve sustainable aspects. As more than 50% of the strategies can be applicable as it showed in table 13. As the red colour indicate for the 0% applicability of these strategies, the orange colour for the 50%, the green colour for the 100% applicability of these sustainable strategy and the green colour with the star symbol that is lead to the applicability of these strategy with but high cost.

## 6.1 Al-tahrir complex deficits and values

As a conclusion from the analysis and the evaluation done through the previous chapter. The building has deficits and values that can affect its adaption sustainability. So, reviewing of these deficits and values and their connection to the sustainable aspect is important.




(Fig.67) - Values vs Deficits of the case study analysis. Source: Author

The values of the building that concluded from the analysis and the evaluation can be summarized in three main elements which are the urban and historical context, space layout, and façade. Those are the main building strengths that mainly support the adaption decision on the redevelopment of the building.

The site applicability of the building overcomes the building applicability from the analysis and the evaluation process. The building internally does not have significant and unique features to be recalled or preserved, as it is a public office building that did not have the needed attention from the government at its lifetime, but the site did. The location of the site among the downtown of Cairo with all the opportunities and strengths increases the score of the site and layout applicability which puts the building in the applicability field of the sustainable adaption. Legislative reviews, surrounding cultural features, existing infrastructure and transportation system sustainable strategies are from the higher values of the building, because of its site value, importance of context around it as it mentions in the previous chapter analysis of the case study. The accessibility of the building from all over Egypt also affected its values. Feasibility of most the exterior sustainable strategies on the building can achieve the physical and visual linkage between the building and its surroundings through the connection of it and its new use and highlighting its value through the new function. That can create the presentation of the historical, contemporary functions, the cultural and artistic aspects of the building. As well as the respectful interventions to the architectural essence of the building and its surroundings can having a major positive effect on the surrounding area.





The building spaces layout also added to its value and increase its feasibility and future adaptability score through the versatility, modularity, divisibility, and flexibility. Adaptation requires adaptability. Which It's a building's ability to absorb small and large changes (Grammenos and Russell, 1997). And the building achieves the three adaptability criteria:

- Convertibility: Changing use (economically, legally, technically).
- Expandability: Volume or capacity increases (the latter can be achieved by inserting an additional floor in a building, which does not increase its volume).
- Flexibility: Allowing minor or major shifts in space planning to improve layout.

Those achieve the most important architectural aspects which are the appropriate balancing between the original and new function and help in increasing the understanding of the existing building which lead to preserving the unity of the building. Having multi-functional spaces for hosting different functions for a wider range of visitors and locals can be achievable and backing fire in the social aspect from the building will become an interesting place for everyone, attracting the wider communities through public and private, as well as adding a new dimension to the tourism of the area which is the main goal from the redevelopment of the building. Those aspect affects mostly the economic aspect as achieving of more economic value through the diverse of activities.

The modularity of the spaces and the building overall can help in the structured spatial organization which has an important impact on the environmental aspect which can make the building a circular one and the usage of environmentally sustainable and traditional technologies and design solutions easily.

The environmental quality and the cost are the two main deficits for the building. From the analysis and the evaluation the building has 0% applicability for the environmental quality (review the reason in chapter 5), this can affect negatively the spatial quality as an architectural aspect such as the creation of a diversity of atmospheres, Creation of a pleasant naturally atmosphere and the visual peace which can directly affect the environmental aspect through the point of the development of an innovative and nature-based technologies for the building from the point of the GHG emissions reduction and affects also the comfortability and efficiency of the building energy.

The applicability of the sustainable performance services strategies can be achieved from the analysis and the evaluation but with a cost. According to (Douglas, 2006), the building needs a major type of adaption which involve major changes to the services and interior fittings but without any significant structural alterations. May include addition of raised floor, improvements to core areas and entrance halls, new lighting, internal shading with approximate time to carry out about 2-12 months costs about 500-700 euro/m2 according to 2005 prices.

(Table 6-28) - Cost feasability study for Al-Tahrir complex. Source: Author

| Floor area | No. of floor | Total area | Adaption cost (2005) | Total cost needed (2005) | Total cost needed (now) | Total investment |
|---|---|---|---|---|---|---|
| 5000 m2 | 14 | 70000 m2 | 600 euro/m2 | 588 million Egyptian pounds | **798 million** Egyptian pounds | **3500 million** Egyptian pounds |

From previous cost study related to the services adaption for the building, 22.8% of the total invest fund for the building needed for the services adaption to be performance well with nowadays technologies.

May be the needed cost for the building services fireback in two main aspects which are the economic and the innovative one. The cost and the environmental quality are two important factors but cannot affect the applicability of the building from the point of sustainable adaption point of view.

## 6.2 General concluded action plan

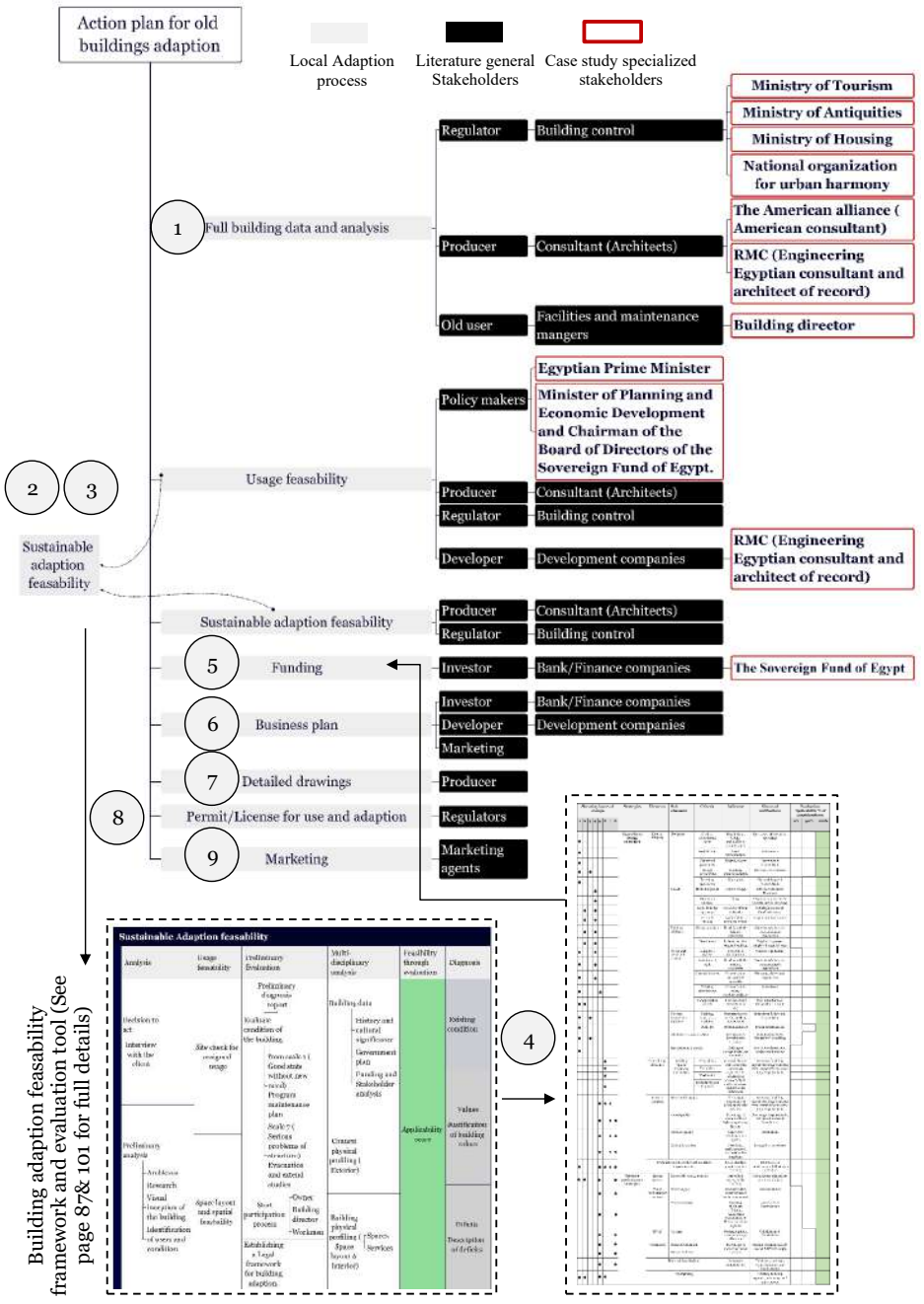
Old buildings adaption is a complex process that must done correctly to avoid any negative impacts on the environment, government funding and buildings lifetime.

The action plan mainly consists of two elements which are the local general steps that must be held in the building context, the one described in figure is for the Egyptian context, and identification of stakeholders, who are them, their influence and hierarchy.

The second step and third step are for usage and the sustainable adaption feasability, the new usage assigned from the government for the old building is the suitable usage or not as well as to what extent the old building is feasible to sustainable adaption strategies, those steps described in detail in chapter 4 and 5. After that funding options that will achieve the new usage requirements and adaption strategies has to be determined with a detailed business plan for the invest and return from the building after it's adaption. Architects and engineering consultant then have to work on the detailed drawings and building adaption program within the assigned fund and cost for the building license to the new usage and new adaption. The final steps mainly for the marketing and how to attract people to the old building with new usage.








(Fig.68) - General old buildings adaption action plan. Source: Author

# References


Abdallah, M., Muddana, L., & Clevenger, C. (2020). Upgrading Large Existing Buildings to Maximize Their Sustainability. *Journal of Architectural Engineering*, *26*(1), 04019029. https://doi.org/10.1061/(asce)ae.1943-5568.0000376

Adaptable Futures. (2012). [Online], http://www.adaptablefutures.com (Accessed : 27 August 2022)

Ahmed, A., Mateo-Garcia, M., McGough, D. and Gaterell, M. (2017), "Methodology for evaluating innovative technologies for low-energy retrofitting of public buildings", Energy Procedia, Vol. 112, pp. 166-175.

Aigwi, I. E., Phipps, R., Ingham, J., & Filippova, O. (2020). Characterisation of Adaptive Reuse Stakeholders and the Effectiveness of Collaborative Rationality Towards Building Resilient Urban Areas. *Systemic Practice and Action Research*, *34*(2), 141–151. https://doi.org/10.1007/s11213-020-09521-0

Albatici, R., Gadotti, A., Baldessari, C., & Chiogna, M. (2016). A decision-making tool for a comprehensive evaluation of building retrofitting actions at the regional scale. Sustainability, 8(10), 990. https://doi.org/10.3390/su8100990.

Al-Habaibeh, A., Hawas, A., Hamadeh, L., Medjdoub, B., Marsh, J., & Sen, A. (2022). Enhancing the sustainability and energy conservation in heritage buildings: The case of Nottingham Playhouse. *Frontiers of Architectural Research*, *11*(1), 142–160. https://doi.org/10.1016/j.foar.2021.09.001





Alhojaly, R. A., Alawad, A. A., & Ghabra, N. A. (2022). A Proposed Model of Assessing the Adaptive Reuse of Heritage Buildings in Historic Jeddah. *Buildings*, *12*(4), 406. https://doi.org/10.3390/buildings12040406

Al-Obaidi, K., Wei, S., Ismail, M., & Kam, K. (2017). Sustainable Building Assessment of Colonial Shophouses after Adaptive Reuse in Kuala Lumpur. *Buildings*, *7*(4), 87. https://doi.org/10.3390/buildings7040087

Antoine, C., Antoine, G., & Rofaïda, L. (2016). A meta model-based methodology for an energy savings uncertainty assessment of building retrofitting. International Journal of Metrology and Quality Engineering, 7(4), 402. https://doi.org/10.1051/ijmqe/ 2016016.

Anupa Manewa, C. P. (2013). Adaptable Buildings: Striving Towards a Sustainable Future. *People and the Planet 2013 Conference Proceedings* (p. 11). Australia: Global Cities Research Institute, RMIT University, Melbourne, Australia.

Arfa, F.H.; Lubelli, B.; Zijlstra, H.; Quist, W. (2022). Criteria of "Effectiveness" and Related Aspects in Adaptive Reuse Projects of Heritage Buildings. *Sustainability*, *14*, 1251. https://doi.org/ 10.3390/su14031251

Balasbaneh, A. T., Yeoh, D., Ramli, M. Z., & Valdi, M. H. T. (2022). Different alternative retrofit to improving the sustainability of building in tropical climate: multi-criteria decision-making. *Environmental Science and Pollution Research*. https://doi.org/10.1007/s11356-022-18647-8

Balest, J.; Lucchi, E.; Haas, F.; Grazia, G.; Exner, D. (2021). Materiality, meanings, and competences for historic rural buildings: A social practice approach for engaging local communities in energy transition. IOP Conf. Series: Earth Environ. Sci., 863, 012021.

Ball, B. L., Long, N., Fleming, K., Balbach, C., & Lopez, P. (2020). An open-source analysis framework for large-scale building energy modeling. *Journal of Building Performance Simulation*, *13*(5), 487–500. https://doi.org/10.1080/19401493.2020.1778788

Bellia, L., Borrelli, M., de Masi, R. F., Ruggiero, S., & Vanoli, G. P. (2018). University building: Energy diagnosis and refurbishment design with cost-optimal approach. Discussion about the effect of numerical modelling assumptions. *Journal of Building Engineering*, *18*, 1–18. https://doi.org/10.1016/j.jobe.2018.02.017

Bergman, D. (2012). Sustainable design: a critical guide, Princeton Architectural Press, New York.

Bosone, M., de Toro, P., Fusco Girarsd, L., Gravagnuolo, A., & Iodice, S. (2021). Indicators for Ex-Post Evaluation of Cultural Heritage Adaptive Reuse Impacts in the Perspective of the Circular Economy. *Sustainability*, *13*(9), 4759. https://doi.org/10.3390/su1309475

Bosone, M.; de Toro, P.; Girard, L.F.; Gravagnuolo, A.; Iodice, S. (2021), Indicators for ex-post evaluation of cultural heritage adaptive reuse impacts in the perspective of the circular economy. Sustainability, 13, 4759.

Brand, S. (1994). How Buildings Learn. New York: Viking.

Brooker, G. and Stone, S. (2004). Re-readings. Interior architecture and the design principles of remodeling existing buildings (London: RIBA Enterprises). P.11

Brooker, G. & Stone, S. (2004). Re-readings. Interior architecture and the design principles of remodelling existing buildings, RIBA Enterprises: London.

Bu, S., Shen, G., Anumba, C. J., Wong, A. K., & Liang, X. (2015). Literature review of green retrofit design for commercial buildings with BIM implication. *Smart and Sustainable Built Environment*, *4*(2), 188–214. https://doi.org/10.1108/sasbe-08-2014-0043

Bullen, P. A., & Love, P. E. D. (2011). Adaptive reuse of heritage buildings. Structural Survey, 29(5), 411–421.

Catherine S. Jefferson. (2005). Adaptive Reuse: Recent Hotel Conversions in Downtown Philadelphia. University of Pennsylvania.

Cambridge Dictionary. Available online: https://dictionary.cambridge.org/dictionary/english/innovation (accessed on 4 January 2021).

Cantell, SF. (2005). The Adaptive Reuse of Historic Industrial Buildings: Regulation Barrier, Best Practices and Case Studies, Master Thesis, Virginia Polytechnic Institute and State University, USA.

Caroon, J 2010, Sustainable Preservation: Greening Existing Buildings, John Wiley & Sons, Inc. , Hoboken, New Jersey.

City of New York, D. o. (April 1999). *High performance building Guidelines*. New York.

Cohen, Jean-Louis. (2014). "Le Corbusier's Modulor and the Debate on Proportion in France". Architectural Histories, 2(1):23, pp.1-14.



Conejos, S., Langston, C., & Smith, J. (2013). AdaptSTAR model: A climate-friendly strategy to promote built environment sustainability. Habitat International, 37, 95–103. https://doi.org/10.1016/j.habitatint.2011.12.003

Conejos, Sheila. (2013). *Designing for Future Building Adaptive Reuse.* [Doctoral dissertation, Institute of Sustainable Development and Architecture Bond University, Gold Coast, Australia].

D'Angelo, L., Hajdukiewicz, M., Seri, F., & Keane, M. M. (2022). A novel BIM-based process workflow for building retrofit. *Journal of Building Engineering*, *50*, 104163. https://doi.org/10.1016/j.jobe.2022.104163

della Spina, L. (2020). Adaptive Sustainable Reuse for Cultural Heritage: A Multiple Criteria Decision Aiding Approach Supporting Urban Development Processes. *Sustainability*, *12*(4), 1363. https://doi.org/10.3390/su12041363

Dell'Ovo, M., Dell'Anna, F., Simonelli, R., & Sdino, L. (2021). Enhancing the Cultural Heritage through Adaptive Reuse. A Multicriteria Approach to Evaluate the Castello Visconteo in Cusago (Italy). *Sustainability*, *13*(8), 4440. https://doi.org/10.3390/su13084440

Donald F. Fournier and Karen Zimnicki. (2004, May). *Integrating Sustainable Design Principles into the Adaptive Reuse of Historical Properties* (ERDC/CERL TR-04-7). U.S. Army Engineer Research and Development Center (ERDC).

Douglas, J. (2006). Building Adaptation, 2 ed., Elsevier: Oxford.

El-belkasy, M. I., & Wahieb, S. A. (2022). Sustainable Conservation and Reuse of Historical City Center Applied Study on Jeddah—Saudi Arabia. *Sustainability*, *14*(9), 5188. https://doi.org/10.3390/su14095188

Fasna, M., & Gunatilake, S. (2019). Overcoming barriers for building energy efficiency retrofits: insights from hotel retrofits in Sri Lanka. *Built Environment Project and Asset Management*, *10*(2), 277–295. https://doi.org/10.1108/bepam-01-2019-0010

Fausto, I.C.I.; Forner, E.F.; Lanzarote, B.S. (2020). The new entrance to the Camí d'Onda Air-raid Shelter in the historic center of Borriana, Spain. TECHNE J. Technol. Archit. Environ. 19, 290–297.

Foster G. (2020). Circular economy strategies for adaptive reuse of cultural heritage buildings to reduce environmental impacts. Resource Conserve Recycle 152(152):104507

Foster, G., Kreinin, H., & Stagl, S. (2020). The future of circular environmental impact indicators for cultural heritage buildings in Europe. *Environmental Sciences Europe*, *32*(1). https://doi.org/10.1186/s12302-020-00411-9

Galbiati, G., Medici, F., Graf, F., & Marino, G. (2021). Methodology for energy retrofitting of Modern Architecture. The case study of the Olivetti office building in the UNESCO site of Ivrea. *Journal of Building Engineering*, *44*, 103378. https://doi.org/10.1016/j.jobe.2021.103378

Galiotto, N., Heiselberg, P., & Knudstrup, M. A. (2016). Integrated Renovation Process: Overcoming Barriers to Sustainable Renovation. *Journal of Architectural Engineering*, *22*(1), 04015007. https://doi.org/10.1061/(asce)ae.1943-5568.0000180

George E. Thomas. (2012). Ritz-Carlton Hotel (Girard Trust Company), [Philadelphia, Pennsylvania], SAH Archipedia, eds. Gabrielle Esperdy and Karen Kingsley, Charlottesville: UVaP, http://sah-archipedia.org/buildings/PA-02-PH53 (Accessed: 23 October 2017).

Geraedts R. (2001). "Upgrading the Flexibility of Buildings" *CIB World Building Congress: Performance in Product and Practice*, 2-6 April 2001, Wellington, New Zealand.

Geraedts R. (2008). "Design for Change, Flexibility Key Performance Indicators" *1st I3CON Conference: Industrialized, Integrated, Intelligent Construction*, 14-16 May 2008, Loughborough University, Great Britain.

Gosling, J.; Sassi, P.; Naim, M.; Lark, R. (2013). Adaptable buildings: A systems approach. Sustain. Cities Soc, 7, 44–51.

Grammenos, F. and Russell, P. (1997). Building Adaptability: A View from the Future, 2nd International Conference on Buildings and the Environment, June 1997. Paris.

Gravagnuolo, A., Fusco Girard, L., Kourtit, K., & Nijkamp, P. (2021). Adaptive re-use of urban cultural resources: Contours of circular city planning. *City, Culture and Society*, *26*, 100416. https://doi.org/10.1016/j.ccs.2021.100416

Grin, J.; Rotmans, J.; Schot, J. (2010). Transitions to Sustainable Development: New Directions in the Study of Long-Term Transformative Change; Routledge: London, UK.

Guidetti, E.; Robiglio, M. (2021). The Transformative Potential of Ruins: A Tool for a Nonlinear Design Perspective in Adaptive Reuse. Sustainability, 13, 5660.



He, C., Hou, Y., Ding, L., & Li, P. (2021). Visualized literature review on sustainable building renovation. *Journal of Building Engineering*, *44*, 102622. https://doi.org/10.1016/j.jobe.2021.102622

Hinte E. V.; Neelen M. (2003). Smart Architecture, 010 Uitgeverij, Rotterdam.

Holtta-Otto, Katja. (2005). “Modular Product Platform Design”. Doctoral Dissertation, Helsinki University of Technology. Finland.

Ikiz Kaya, D., Dane, G., Pintossi, N., & Koot, C. A. (2021). Subjective circularity performance analysis of adaptive heritage reuse practices in the Netherlands. *Sustainable Cities and Society*, *70*, 102869. https://doi.org/10.1016/j.scs.2021.102869

IPCC. (2002). Fourth Assessment Report: Synthesis, published online 17 November 2007.

Javid, A. S., Aramoun, F., Bararzadeh, M., & Avami, A. (2019). Multi objective planning for sustainable retrofit of educational buildings. *Journal of Building Engineering*, *24*, 100759. https://doi.org/10.1016/j.jobe.2019.100759

Jiménez-Pulido, C., Jiménez-Rivero, A., & García-Navarro, J. (2022). Improved sustainability certification systems to respond to building renovation challenges based on a literature review. *Journal of Building Engineering*, *45*, 103575. https://doi.org/10.1016/j.jobe.2021.103575

Jodidio, Philip. (2004). “Paul Andreu Architect”. BIRKHAUSER-Publishers for Architecture, Basal. Switzerland.

Jones, L. (2008,). Environmentally Responsible Design: Green and sustainable design for interior designers, John Wiley & Sons, Inc., Hoboken, New Jersey

K. (2022). *Adapting Building for Changing Uses (02) by Kincaid, David [Paperback (2002)]*. Routledge, Paperback(2002).

Karunaratne, T. L. W., & de Silva, N. (2019). Demand-side energy retrofit potential in existing office buildings. *Built Environment Project and Asset Management*, *9*(3), 426–439. https://doi.org/10.1108/bepam-10-2017-0103

Kendall, S. and Ando, M. (2005). Theory and Methods in Support of Adaptable Buildings, in *Action for Sustainability–The 2005 World Sustainable Building Conference*, Tokyo, pp. 3017–21

Krause Harald. (2022). *Refurbishment Manual (Construction Manuals (englisch))* (1st ed.). Birkhauser Basel.

Kronenburg R. (2007). Flexible: Architecture that Responds to Change, Laurence King Publishing Ltd, Great Britain.

Kumar, R. (2005). *Research Methodology: a step-by-step guide for beginners*, 2nd edn, Sage Publications Inc., Thousand Oaks, CA

Latham, D. (2000a). Creative Re-Use of Buildings (Vol. 1: Principles and Practice). Shaftsbury: Donhead

Lee, J., McCuskey Shepley, M., & Choi, J. (2019b). Exploring the effects of a building retrofit to improve energy performance and sustainability: A case study of Korean public buildings. *Journal of Building Engineering*, *25*, 100822. https://doi.org/10.1016/j.jobe.2019.100822

Lehmann, S. (2012). Sustainable building design and systems integration: combining energy efficiency with material efficiency, in S Lehmann & R Crocker (eds), Designing for zero waste: consumption, technologies and the built environment, Earthscan, New York, pp. 209-46.

Leeuwarden declaration. 2018. Available online: https://www.ace-cae.eu/fileadmin/New_Upload/_15_EU_Project/Creative_

Li, Y., Zhao, L., Huang, J., & Law, A. (2021). Research frameworks, methodologies, and assessment methods concerning the adaptive reuse of architectural heritage: a review. *Built Heritage*, *5*(1). https://doi.org/10.1186/s43238-021-00025-x

Liu, Q., & Ren, J. (2018). Research on technology clusters and the energy efficiency of energy-saving retrofits of existing office buildings in different climatic regions. *Energy, Sustainability and Society*, *8*(1). https://doi.org/10.1186/s13705-018-0165-0

Lu, Y., Li, P., Lee, Y. P., & Song, X. (2021). An integrated decision-making framework for existing building retrofits based on energy simulation and cost-benefit analysis. *Journal of Building Engineering*, *43*, 103200. https://doi.org/10.1016/j.jobe.2021.103200

Luo, X., & Oyedele, L. O. (2021). A data-driven life-cycle optimization approach for building retrofitting: A comprehensive assessment on economy, energy and environment. *Journal of Building Engineering*, *43*, 102934. https://doi.org/10.1016/j.jobe.2021.102934

Ma, Z., Cooper, P., Daly, D., & Ledo, L. (2012). Existing building retrofits: Methodology and state-of-the-art. Energy and Buildings, 55, 889.



McCluskey, Alan. (2000). “Modularity: upgrading to the next generation design architecture”. Business and Media official website: http://www.connected.org/media/modular.html (Accessed: 23 October 2017).

McNamara, C. (1999). General Guidelines for Conducting Interviews, Authenticity Consulting, LLC, Retrieved from: http://www.managementhelp.org/evaluatn/intrview.htm (Accessed: 23 October 2017)

Motalebi, M., Rashidi, A., & Nasiri, M. M. (2022). Optimization and BIM-based lifecycle assessment integration for energy efficiency retrofit of buildings. *Journal of Building Engineering*, *49*, 104022. https://doi.org/10.1016/j.jobe.2022.104022

Moosa, H. M. I. (2018). Prevailing Value System Based Context, Adaptive Reuse.

*Resource dings*, *1*(2), 44. https://doi.org/10.21625/resourceedings.v1i2.322

Nakib, F. (2010). Toward an adaptable architecture guideline to integrate adaptability in building. In Building a Better World: CIB World Congress.

Napolano, L., Menna, C., Asprone, D., Prota, A., & Manfredi, G. (2014). LCA-based study on structural retrofit options for masonry buildings. *The International Journal of Life Cycle Assessment*, *20*(1), 23–35. https://doi.org/10.1007/s11367-014-0807-1

Nutt, B. (c1993). The Adaptive Reuse of Buildings, Paper presented at a Conference on Building Refurbishment. London: Publisher Unknown.

Owojori, O.M.; Okoro, C.S.; Chileshe, N. (2021). Current Status and Emerging Trends on the Adaptive Reuse of Buildings: A Bibliometric Analysis. Sustainability, 13, 11646. https://doi.org/10.3390/su132111646

Peng, Z., Zhao, S., Shen, L., Ma, Y., Zhang, Q., & Deng, W. (2021). Retrofit or rebuild? The future of old residential buildings in urban areas of China based on the analysis of environmental benefits. *International Journal of Low-Carbon Technologies*, *16*(4), 1422–1434. https://doi.org/10.1093/ijlct/ctab070

Persoon, T. (2019). The Value of Cultural Heritage; Delft University of Technology: Delft, The Netherlands.

Peter A. Bullen, (2007),"Adaptive reuse and sustainability of commercial buildings", Facilities, Vol. 25 Iss 1/2 pp. 20 – 31 http://dx.doi.org/10.1108/02632770710716911

Petzinka, K. F. M. (2022). *Refurbishment Manual (Construction Manuals (englisch))* (1st ed.). Birkhauser Basel.

Pieczka, M., & Wowrzeczka, B. (2021). Art in Post-Industrial Facilities—Strategies of Adaptive Reuse for Art Exhibition Function in Poland. *Buildings*, *11*(10), 487. https://doi.org/10.3390/buildings11100487

Piva, Mykalene J. (2019). Building Reuse as a Sustainable Practice in Architecture. University Honors Theses. Paper 668. https://doi.org/10.15760/honors.681

Pomponi, F., Farr, E. R., Piroozfar, P., & Gates, J. R. (2015). Façade refurbishment of existing office buildings: Do conventional energy-saving interventions always work? *Journal of Building Engineering*, *3*, 135–143. https://doi.org/10.1016/j.jobe.2015.07.003

Rached, E., & Anber, M. (2022). Energy retrofitting strategies for office buildings in hot arid climate. *International Journal of Low-Carbon Technologies*, *17*, 506–512. https://doi.org/10.1093/ijlct/ctac031

Ranawaka, I., & Mallawaarachchi, H. (2018). A risk-responsive framework for green retrofit projects in Sri Lanka. *Built Environment Project and Asset Management*, *8*(5), 477–490. https://doi.org/10.1108/bepam-10-2017-0088

Regelment NRP Gulden Feniks. 2020. Available online: https://www.nrpacademie.nl/upload/medialibrary/Reglement_NRP_GULDEN_FENIKS_2020. pdf (accessed on 16 December 2021)

Rizk Hegazy, I., & Seddik Moustafa, W. (2018). Sustainable Residential Sector in Egypt: Performance Estimation of a Grid-Connected Photovoltaic System for Dar Misr Housing Project as a Case Study. *Journal of Architectural Engineering*, *24*(3), 05018004. https://doi.org/10.1061/(asce)ae.1943-5568.0000312

Rodrigues, F., Matos, R., Alves, A., Ribeirinho, P., & Rodrigues, H. (2018). Building life cycle applied to refurbishment of a traditional building from Oporto, Portugal. *Journal of Building Engineering*, *17*, 84–95. https://doi.org/10.1016/j.jobe.2018.01.010

Russell, P.; Moffatt, S. (2001). Adaptability of Buildings, IEA Annex 31, Energy-Related Environmental Impact of Buildings; International Energy Agency (IEA): Paris, France.

Saifi, Y.; Yüceer, H.; Hürol, Y. (2021). Revisiting the Conditions of Authenticity for Built Heritage in Areas of Conflict. Heritage, 4,811–827.

Sanchez, B., Esnaashary Esfahani, M., & Haas, C. (2019). A methodology to analyze the net environmental impacts and building's cost performance of an adaptive reuse project: a case study of the Waterloo County Courthouse renovations. *Environment Systems and Decisions*, *39*(4), 419–438. https://doi.org/10.1007/s10669-019-09734-2



Scottish Civic Trust. (1981). New Uses for Older Buildings in Scotland, Report for the Scottish Development Department. Edinburgh: HMSO.

Schmidt, R., III; Austin, S. (2016). Adaptable Architecture: Theory and Practice; Routledge: Oxfordshire, UK.

Shahi, S., Esnaashary Esfahani, M., Bachmann, C., & Haas, C. (2020b). A definition framework for building adaptation projects. *Sustainable Cities and Society*, *63*, 102345. https://doi.org/10.1016/j.scs.2020.102345

Specialized National Councils. (1988). A Study of Noise Intensity and Its Impact on Greater Cairo and Its Suburbs. p. 66.

Tadeu, S., Rodrigues, C., Tadeu, A., Freire, F., & Simões, N. (2015). Energy retrofit of historic buildings: Environmental assessment of cost-optimal solutions. *Journal of Building Engineering*, *4*, 167–176. https://doi.org/10.1016/j.jobe.2015.09.009

Tokede, O., Udawatta, N., & Luther, M. (2018). Retrofitting heritage office buildings in the UK: a case study. *Built Environment Project and Asset Management*, *8*(1), 39–50. https://doi.org/10.1108/bepam-11-2016-0068

Torrieri, F.; Fumo, M.; Sarnataro, M.; Ausiello, G. (2019). An Integrated Decision Support System for the Sustainable Reuse of the Former Monastery of "Ritiro del Carmine" in Campania Region. Sustainability, 11, 5244.

United Nations. Global Status Report: Towards a Zero-Emission, Efficient, and Resilient Buildings, and Construction Sector. (2017). Available online: https://www.worldgbc.org/sites/default/files/UNEP%20188_GABC_en%20%28web%29 .pdf (accessed on 24 July 2021).

Vardopoulos, I., Tsilika, E., Sarantakou, E., Zorpas, A., Salvati, L., & Tsartas, P. (2021). An Integrated SWOT-PESTLE-AHP Model Assessing Sustainability in Adaptive Reuse Projects. *Applied Sciences*, *11*(15), 7134. https://doi.org/10.3390/app11157134

Vizzarri, C., Sangiorgio, V., Fatiguso, F., & Calderazzi, A. (2021). A holistic approach for the adaptive reuse project selection: The case of the former Enel power station in Bari. *Land Use Policy*, *111*, 105709. https://doi.org/10.1016/j.landusepol.2021.105709

Walter Costa, J. F., David Amorim, C. N., & Ribeiro Silva, J. C. (2020). Retrofit guidelines towards the achievement of net zero energy buildings for office buildings in Brasilia. *Journal of Building Engineering*, *32*, 101680. https://doi.org/10.1016/j.jobe.2020.101680

Wilkinson, S. J., James, K., & Reed, R. (2009). Delivering sustainability through the adaptive reuse of commercial buildings: the Melbourne CBD challenge. Proceedings of the Pacific Rim Real Estate Society 15th Annual Conference, Pacific Rim Real Estate Society (PPRES), (June 2008), 1–19.

Yung, E. H., & Chan, E. H. (2012). Implementation challenges to the adaptive reuse of heritage buildings: Towards the goals of sustainable, low carbon cities. *Habitat International*, *36*(3), 352–361. https://doi.org/10.1016/j.habitatint.2011.11.001

Yung, E. H. K., Chan, E. H. W., & Xu, Y. (2014). Community-Initiated Adaptive Reuse of Historic Buildings and Sustainable Development in the Inner City of Shanghai. *Journal of Urban Planning and Development*, *140*(3), 05014003. https://doi.org/10.1061/(asce)up.1943-5444.0000174

**ARABIC REFERENCES**

Ahmed Shosha. (2021). BBC News. Tahrir Complex: The symbol of the Egyptian bureaucracy that will become a popular destination for tourists. https://www.bbc.com/arabic/art-and-culture (Accessed: 7 May 2022).

Al-Khlfawy, Sayed. (2022). Al-Youm 7 Journal. You will hit the city center with a wheel and an hour with a pound.. 250 smart bikes linking metro stations, public transport and museums.. Determining calf tracks in Garden City, Zamalek and the Walk of the People of Egypt.. and a mobile and GPS application to prevent theft. https://www.youm7.com/story (Accessed: 7 May 2022).

Al-Mokwlon Al-Arab. (2022). Al-Tahrir Garage – Garage 1. https://www.arabcont.com/project-534 (Accessed: 3 August 2022)

Akhbar Alyom gate. (2021). Akhbar Al-yom. The Full details of the development of the editorial complex. https://m.akhbarelyom.com/news/newdetails/ (Accessed: 22 April 2022).

Aml Al-Nagar. (2016). Sada Al-Balad. In pictures... the "neglect" complex... the former liberation... the "mix" syringes are floating in the sewers... and the suffering of the citizens is "shapes and colors". https://www.elbalad.news/2142457 (Accessed: 24 April 2022).

Mahmoud Abdo. (2021). INDEPENDENT عربية. تحالف أميركي يقتنص تطوير "مجمع التحرير" في القاهرة. https://www.independentarabia.com/node/ (Accessed: 24 April 2022)



Sayed Al-khlfawy. (2021). AlYoum 7 journal. Evacuating the Tahrir Complex to re-use the building.. Transferring 27 government agencies and relieving pressure from downtown Cairo.. Sources: cutting off facilities on March 11th.. and changing the service activity of tourism, administrative and commercial establishments by building a hotel, restaurants, and shops. https://www.youm7.com/story/ (Accessed: 16 July 2012).

Wikipedia. (2021). Mogamaa Al-Tahrir. https://ar.wikipedia.org/wiki/%D9%85%D8%AC%D9%85%D8%B9_%D8%A7%D9%84%D8%AA%D8%AD%D8%B1%D9%8A%D8%B1 (Accessed: 15 July 2022).

**LIST OF INTERVIEEWS**

Abd-Aal, Osama. (2022). Interview with the Chief of West Cairo district now and Director of Al-Tahrir building formerly for 40 years. Interviewed by Yassmine Waheed on 22nd March and 20th June.

Abdallah, Mohamed Reda. (2022). Interview with an academic professor at Cairo university and the director of Engineering center of archeology and environment. Interviewed by Yassmine Waheed on 4th April & 21st of August.

Abu-Lela, Mostafa. (2022). Interview with the business development manager of SIGMA properties (S.A.E). Interviewed by Yassmine Waheed on 1st August.

D. F. Klumbis and W. Munsters. (2005). Developments in the hotel industry: design meets historic properties. URL: http://www.esade.edu/cedit2004/pdfs/23_Freund.pdf (September 22, 2014.)

Galal. (2022). Interview with the building chef of workmen. Interviewed by Yassmine Waheed on 22nd March and 18th June.

R. Habeeb. (2013). How to preserve architectural detail and effectively transform a historic building into a modern hotel. URL: http://www.hotelexecutive.com/business_review/3481/how-to-preserve architectural-detail-and-effectively-transform-a-historic-building-into-a-modern-hotel (May 15, 2014.)

Waly, Aya. (2022). Interview with the secretary at Dr. Hala Saied, Minister of Planning and Economic Development and Chairman of the Board of Directors of the Sovereign Fund. Interviewed by Yassmine Waheed on 3rd June.

# Appendices

**Appendix A**

**Interviews questions and objectives**

(Table 29) - Owner Interview questions themes. Source: Author

| No. | Objective | Questions |
|---|---|---|
| 1 | Outlining government efforts and strategies for adapting their buildings after relocating the function to the new administrative capital. | What is the clear plan for ministries and governmental building within Cairo after the relocation of them? |
| 2 | | How Al-Tahrir building development affect its context within Cairo Downtown? |
| 3 | | What the relationship between the development of the building and the Egyptian vision 2030? |
| 4 | Discovering building uses needed for the developments in Cairo and the reasons behind this need. | The main purpose from changing building main use to hotel and commercial context and the reason behind not developing it with the same use? |
| 5 | Identifying case study different local and international stakeholders and to what extent the building will be adapted from the assigned cost. | What is the estimated cost for the building development and from where this financial support? |
| 6 | | Who are the different stakeholders work on the development of the building? |
| 7 | Defining future development for downtown Cairo and the buildings relation to each other. | Which from the building context and surrounding buildings strongly affects it and should be put into considerations? |



(Table 30) – Professional and academic Architects interview questions and objectives. Source: Author

| No. | Objective | Questions |
|---|---|---|
| 1 | Identifying how much the government invest in reusing buildings | Evaluate government efforts for dealing with adaptive reuse projects. |
| 2 | Discovering how assessing new uses to old building settled | How to determine the optimal use for the building? |
| 3 | Investigating relevant aspects taken into considerations for adapting old buildings | Will the priority be for preserving the building or for the human comfort, requirements, and experiences? |
| 4 | | Which of these aspects is the most important for the process? (Economical-Social-Cultural-Architectural-Enviromental-Innovation) |
| 5 | Identifying the Egyptian mechanism with old building service adaption within the new technologies | How to deal with different types of building services within an old building with nowadays techniques (Systems as: Water management, HVAC, Firefighting, and electricity? |
| 6 | | Which systems preferable for dealing with building services? |
| 7 | | To what extent providing context requirements for the new use? (Parking-transportation-Services-Plantations, etc.) |
| 8 | Outlining standards regulations and coding for building adaption, and whether it is same as the new build. | How to deal with building needs new structural additions for the new use? |
| 9 | | Is there is Egyptian codes or standards for adapting building, and which codes you use for the adaption? |
| 10 | Outlining building adaption methodologies | Briefly, what the process of the building from adapting it to the working of the new use and the maintenance? |
| 11 | Identifying to what extent sustainable design approaches in Egypt takes place | To what extent using the green design approaches in adaption projects? |

(Table 31) - Al-Tahrir complex director interview questions and objective. Source: Author

| No | Objectives | Questions |
|---|---|---|
| 1 | Reviewing structural condition | Is there is any structural problems within the building columns, floors and foundations needed to be maintained? |
| 2 | Recognition building service systems and their installations age and condition for the retrofitting studies | What is the condition of stairs and elevators for the building? Whether is it an old model or new? |
| 3 | | What is the condition of different building services systems as Water systems, Firefighting, and electricity? From when they renewed and how often they are maintained? |
| 4 | | What is the HVAC system of the building and when it is implemented? |
| 5 | | Illustrate more building drainage system and how it be done as well as drinking water systems, which pipes types used within all water systems? |
| 6 | | Is the garbage system new or an old system built with the building? |
| 7 | Identifying design addition to the old one | Are there any considerations implemented for disabled people, and how can they interact with the building while it was running? |
| 8 | | Is there is any structural additions to the old building for a new need or use? |
| 9 | | What is the main old use of the terraces while it was running as an administration building? |
| 10 | List building problems to be taken into considerations | What are the problems that faces the building within services system while in the running state? |
| 11 | | The problems facing building site and surroundings. Traffic-Infrastructure-Car parking's-Owners-Pedestrians |
| 12 | | What are the discomfort sources from the building and outside it? |

## Acronyms