Palestine Polytechnic University

Deanship of Graduate Studies and Scientific Research

Master of Architecture – Sustainable Design

An Investment-Oriented Investigation of Environmental Office Buildings Application in Palestine: A Future Affordable Approach

Jana Radwan Tahboub

Supervisor

Dr. Bader Alatawneh

Thesis submitted in partial fulfillment of requirements of the degree

Master of Architecture – Sustainable Design

January, 2024

The undersigned hereby certify that they have read, examined and recommended to the Deanship of Graduate Studies and Scientific Research at Palestine Polytechnic University:

[An Investment-Oriented Investigation of Environmental Office Buildings Application in Palestine: A Future Affordable Approach]

[Jana Radwan Tahboub]

in partial fulfillment of the requirements for the degree of Master's in Architecture – Sustainable Design.

Graduate Advisory Committee:

Dr. Bader Alatawneh

Supervisor, Palestine Polytechnic University

Signature:_____ Date: 4/2/2024

Dr. Fajer Altawayha

Internal committee member, Palestine Polytechnic University.

Signature:_____ Date: 4/2/2024

Dr. Yara Saifi

External committee member, Al Quds University.

Signature:_____ Date: 04/02/2024

Thesis Approved by:

Dr. Nafeth NaserAldeen

Dean of Graduate Studies & Scientific Research

Palestine Polytechnic University

Signature:……..…… Date:…..……..……

An Investment-Oriented Investigation of Environmental Office Buildings Application in Palestine: A Future Affordable Approach

Jana Radwan Tahboub

ABSTRACT

In the dynamic landscape of Palestinian office buildings, characterized by a diverse and seemingly ad hoc construction approach, this master's thesis navigates the delicate balance between investment viability and environmental sustainability. The research employs a meticulously crafted, both qualitative and quantitative, systematic approach to pinpoint the convergence of investment-driven economic considerations and the environmental needs of building users. Against the socio-cultural backdrop of the Palestinian context, the study utilizes numerical data to compellingly showcase to investors and clients the feasibility of embracing elevated initial costs in exchange for extended payback periods. Incorporating Lean Six Sigma Methodology, the research transcends economic analysis, delving into socio-cultural insights that influence investment behaviors. Drawing from three selected office case studies in Hebron City, the research offers a nuanced exploration of scenarios where environmentally conscious design techniques are embraced. These case studies serve as illuminating reflections of prevailing investment behaviors in the region, providing a basis to validate the viability of environmentally oriented office buildings. The study's findings present a compelling case for the application of environmental design in Palestinian office buildings, affirming its feasibility. The implications and recommendations arising from this research are poised to significantly impact the decisions of designers, planners, and key stakeholders. Ultimately, the thesis empowers investors with the insights needed to make informed choices, enabling effective marketing of properties to potential buyers and future occupants. Embracing sustainability becomes not just a choice but a strategic advantage in the Palestinian real estate.

دراسة حول الناحية الاستثمارية لتطبيق المباني الإدارية البيئية في فلسطين: نحو مستقبل استثماري موفر

جنى رضوان طهبوب

الملخص

في سياق مباني المكاتب الفلسطينية، والذي يتميز بنهج بناء يبدو متنوعاً ولكنه عشوائي، تهدف هذه الدراسة للبحث في التوازن بين الجدوى الاقتصادية والجانب البيئي من الاستدامة. تستخدم الدراسة منهجاً منهجياً دقيقاً نوعياً وكمياً لتحديد نقطة التقاء الاعتبارات الاقتصادية الاستثمارية والاحتياجات البيئية لمستخدمي هذا النوع من المباني. في السياق الاجتماعي والثقافي لفلسطين، يسعى البحث لعرض الفارق المادي الناتج من الاستثمار البيئي وجدوى تقبل التكاليف المبدئية المرتفعة مقابل فترات سداد أطول للمستثمرين والعملاء عبر تقديم الحسابات اللازمة. تتجاوز الدراسة التحليل الاقتصادي وتمتد الى دراسة المحددات الاجتماعية والثقافية التي تؤثر في السلوكيات الاستثمارية، حيث يعتمد البحث منهجية سيجما لتقديم هذا التحليل. استناداً الى ثلاث حالات دراسية لمكاتب مختارة في مدينة الخليل، تقدم الدراسة استكشافا دقيقاً للسيناريوهات التي يتم فيها اعتماد تقنيات التصميم البيئي. تعتبر هذه الحالات الدراسية مؤشرا حول السلوكيات الاستثمارية السائدة في المنطقة، مما يوفر اساساً للتحقق من جدوى المباني المكتبية المصممة باعتبارات بيئية. تؤكد نتائج الدراسة إمكانية تطبيق التصميم البيئي في المباني المكتبية الفلسطينية وجدواها الاقتصادية. تكمن أهمية التوصيات الناتجة عن هذه الدراسة في قدرتها على التأثير بشكل كبير على قرارات المصممين والمخططين وصناع القرار، وتمنح في نهايتها الرؤى اللازمة لاتخاذ قرارات مستنيرة استثمارية وبيئية، مما يمكن من تسويق العقارات بفعالية للمشترين المحتملين ومستخدميها المستقبليين. تؤكد الدراسة على ان اعتناق الاستدامة يجب الا يكون مجرد اختيار بل هو ميزة استراتيجية في العقارات الفلسطينية.

DECLARATION

I declare that the Master Thesis entitled" An Investment-Oriented Investigation of Environmental Office Buildings Application in Palestine: A Future Affordable Approach" is my own original work, and herby certify that unless stated, all work contained within this thesis is my own independent research and has not been submitted for the award of any other degree at any institution, except where due acknowledgement is made in the text.

Student Name: Jana Radwan Tahboub

Signature: Date:

DEDICATION

With immense pride, I dedicate this work to my father, my enduring idol, and to my mother, who has embraced me with unwavering care and passion throughout.

To Alma and Rimi, my cherished little angels, I dedicate this work with the anticipation that one day you will read these words. May you grasp the significance of lifelong learning, understand the value of knowledge, and harness the power it holds. Your role as my profound inspiration is deeply cherished, and I aspire to be yours when the moment unfolds.

ACKNOWLEDGEMENT

The fruition of this work owes much to the invaluable collaboration of Dr. Bader Alatawneh, my exceptional supervisor who steered this project from conception to realization. Gratitude to Dr. Bader for his guidance and leadership that propelled this work to its optimal presentation.

I extend my appreciation to the Engineering Association, Hebron branch, for their boundless cooperation, and to Hebron Municipality for their remarkable guidance and assistance. Special thanks are also extended to all engineering offices, investors, clients, and office employees whose responsiveness and cooperation in providing essential information greatly contributed to this endeavor.

A heartfelt acknowledgment goes to my sister, Haya, who was my companion in every step of the fieldwork implementation of this thesis.

Table of Content

List of Abbreviations

TBL	Tripple Bottom Line
LEED	Leadership in Energy and Environmental Design
BREEAM	Building Research Establishment Environmental Assessment Methodology
LCA	Life Cycle Assessment
LCCA	Life Cycle Cost Analysis
SUE	Sustainable Urban Economy Model
POV	Point of View
ESG	Environmental, Social, Governance
QoL	Quality of Life
PESTLE	Political, Economic, Social, Technological, Environmental, and Legal
IEQ	Indoor Environmental Quality
IAQ	Indoor Air Quality
SBS	Sick Building Syndrome
WWR	Window-to-Wall Ratio
HVAC	Heating, Ventilation, and Air Conditioning
ASHRAE55	American Society of Heating, Refrigerating, and Air-Conditioning Engineers.
LED	Light Emitting Diode
WFR	Window-to-Floor Ratio
BIPV	Building Integrated Photovoltaic Cells
CFD	Computational Fluid Dynamics
PMV	Predicted Mean Vote
PPD	Predicted Percentage of Dissatisfied
PENRA	Palestinian Energy & Natural Resources Authority
KPI	Key Performance Indicators
TMV	Time Value of Money
ROI	Return on Investment
WTP	Willingness to Pay

List of Figures

List of Tables

Chapter 1

Introduction

1.1 Preface

Sustainability has witnessed widespread usage within research, particularly towards the close of the 20th century. However, few studies have embraced the Triple Bottom Line (TBL) approach when evaluating buildings and the construction market. TBL method is evaluating the aesthetics and sustainability of buildings including costs under the social inclusion. While the environmental facet of sustainability has received ample attention in research, only a handful of papers have delved into the correlation between environmental design techniques and their corresponding economic or socio-cultural assessments. Furthermore, research that comprehensively explores all three pillars of sustainability simultaneously has mainly been overlooked (Daugėlaitė and Engineering, 2023).

In Palestine, there is a noticeable inclination towards sustainable construction, with a concurrent rise in the number of office buildings erected. During the initial quarter of 2018 alone, a staggering 168 office buildings were granted licenses (as reported by the Palestinian Bureau of Statistics), and this number continues to ascend. This trend underscores the growing recognition of sustainable principles within the construction sector in Palestine.

Investigating the crossing effects of the three aspects of sustainability on the construction of office buildings in Palestine involves a sequence of correlated steps. The study begins with understanding the current trends and practices in constructing office buildings and whether they consider environmental sustainability without compromising investor's economic interests. Knowing the current trends will help allocate investors' economic considerations and how the latest influence the decision-making process during the planning and design phases of office buildings.

There are many green building certifications and sustainability frameworks that can be leveraged to align investors' economic interests and users' environmental needs (e.g., LEED, BREEAM, Qatar Pearl rating systems ...) (Alessandrini et al., 2022). Studies have stated that implementing environmentally friendly features and technologies in office buildings has financial benefits and

long-term cost savings(Tembo et al., 2023). Such benefits are valuable in the long-term cost analysis of real estate investment projects. Implying Life Cycle Assessment (LCA) and Life Cycle Cost Analysis (LCCA) to evaluate the economic and environmental impacts of office buildings over their entire life cycle will show benefits that outweigh the initial cost preferences (Laveglia et al.). Implies preliminary design considerations are not limited to environmental preferences and economic calculations alone. Such balancing has unmeasurable social effects on society and business prosperity (Ling et al., 2023).

This research investigates the benchmarks of applying three pillars of sustainability to the preliminary design phase of office buildings in Hebron City, Palestine, to finally propose a model that can be followed by designers, planners, decision-makers, and policymakers to help investors make the best investment decisions and be able to market their property to buyers and potential building's users.

1.2 Research Problem

The construction of office buildings has become increasingly prominent within the Palestinian region over the past few decades. These structures play a pivotal role in the growth and advancement of urban areas, as they have a direct connection to business performance. However, the construction process of such office buildings often necessitates a delicate balancing act. This involves satisfying the economic requisites of investors by addressing factors like cost-effectiveness, return on investment, and profitability, all while considering the environmental concerns of the building's users and the local community.

Achieving a sustainable equilibrium between these two facets is crucial in ensuring the enduring viability of office buildings while simultaneously mitigating adverse impacts on the environment. This equilibrium cannot be attained without precise numerical computations incorporating Life-Cycle Cost Assessment (LCCA) while factoring in the human element.

This research explores innovative strategies and approaches that foster a harmonious balance between the economic demands of investors and the environmental requisites of users during the preliminary design phase of new office buildings. This equilibrium encompasses fulfilling the

financial objectives of investors while effectively addressing the environmental considerations of building occupants and minimizing the building's ecological footprint.

Without a structured approach, the construction of office buildings could potentially disrupt businesses and the companies they house. The absence of environmental considerations could detrimentally influence employee performance and impede overall corporate growth.

1.3 Literature Review

Many recent studies have focused on construction methods and considerations related to office buildings. In the past two decades, this specific building type has garnered significant attention within research circles. However, until very recently, only a few research studies connected the economic aspect of these buildings with environmental considerations until 2021.

Abdel Ghaffar et al. conducted a significant study in Egypt in 2021, which holds paramount importance. This study introduces a Sustainable Urban Economy Model (SUE model) that establishes connections between the urban fabric, land use patterns, transportation, and street network design, all intertwined with economic sustainability. The researchers employed the Delphi method to engage urban experts in interviews, resulting in the identification of the seven most influential indicators: built-up to total space ratio, mixed-use ratio, built-up ratio, population density, floor area ratio, degree of accessibility, and public transportation (Ghaffar et al., 2021).

The primary inquiry addressed by this SUE model is centered around evaluating the economic sustainability of different urban forms. This question closely aligns with the primary focus of the present research, which seeks to establish connections between the environmental preliminary design phase and its corresponding costs within the market. However, it is worth noting that the paper's specific emphasis lies on urban forms and housing projects within the context of Egypt. This context varies economically and socio-culturally from the Palestinian context under consideration in this research. While there may be distinctions in the study's focal point and context in comparison to the present research, it is clear that there is a growing global interest in establishing links between the environmental and economic aspects of sustainability.

Along the same lines of thought and in support of the core concept of this thesis, a Swedish study from 2021 delved into the economic feasibility of retrofitting facades on heritage buildings. While the study's findings revealed a lack of economic advantage about this specific element, they nonetheless affirm the potential to prioritize a building's environmental aspect without compromising its visual aesthetics (Jerome et al., 2021). The study's methodology encompassed several approaches, including life cycle assessment, payback analysis, distribution of questionnaires and interviews with tenants, and the integration of empirical data from a recent energy renovation of a multi-residential pre-war building with wooden construction. These efforts culminated in developing an evaluation and decision-making model, which notably resonates with the objectives of the present thesis.

In 2022, a shift in focus within studies emerged, advocating for future research endeavors to formulate indicators and quantitative methodologies that complement the evolving sustainability paradigm. This evolution seeks to facilitate its practical application within real-world economic-political models while fostering discussions encompassing economic, philosophical, social, and anthropological dimensions pertinent to the imperative transformation toward a sustainable society.

A study conducted in Barcelona embarked on this trajectory by utilizing a comprehensive literature review to unravel the intricate connections between capitalism, sustainability, and the challenges posed by the Triple Bottom Line (TBL). The investigation delved into sustainability performance within diverse economic models and the challenges capitalism poses. Additionally, historical and philosophical reflections on the roles of society and economy were explored, leading to a synthesis of these findings to propose a novel sustainability approach. This approach considers societal and environmental considerations within the existing economic-political framework, striving for resilience and autonomy. A pivotal outcome of the study is acknowledging environmental and social sustainability as intrinsic aspects, irrespective of economic factors, unless robust quantification methods are established to effectively encompass all three pillars (Hereu-Morales and Valderrama, 2022). This underscores the pressing need to foster the development of a collective model that holistically integrates these dimensions.

Introduction

The assessment of an investment project's efficiency in the real economy is inherently tied to the evaluation of its environmental implications. A study conducted in 2023 delved into the realm of expert systems, examining their past applications and their effectiveness in enhancing both the environmental impact and investment aspects of projects. Notably, the study revealed a crucial limitation: the existing software tools available do not fully enable the complete automation of the environmental segment within a business plan. The study's findings underscored the necessity of developing a comprehensive model that addresses this gap. Such a model, as the research argues, could lead to expedited project material development, elevated planning quality, reduced error occurrences, lowered assessment costs, enhanced confidence among third-party participants regarding the environmental segment of the business plan, and an overall improvement in users' environmental literacy when utilizing the expert system (Bakumenko et al., 2023).

However, while the study underscores the significance of such a model, it does not provide a detailed unveiling of the system itself. Instead, it concludes with a call for future work focusing on presenting a concrete model meeting these criteria. Thus, this study serves as a foundational stepping stone toward the recognition and conceptualization of an expert system that can effectively automate the preparation of the environmental section within business plans, enhancing both project efficiency and environmental considerations.

On the other hand, environmental residential buildings have received some attention in recent economic feasibility research. Both homeowners and investors in Romania have exhibited skepticism towards the energy efficiency of residential constructions, primarily due to the higher initial investment costs and extended payback periods. However, the escalating energy prices have brought the imperative of energy reduction to the forefront. Through a comprehensive comparison between energy-efficient residential structures and conventional houses, this research undertakes an examination that encompasses variations in construction materials and labor expenses within Romania. Additionally, fluctuations in energy costs during the operational phase of the buildings are factored into the analysis (Karda et al., 2023).

The study's findings indicate that adopting energy-efficient residential buildings is a cost-effective solution, particularly in the medium term. This revelation presents compelling incentives for

investors and future homeowners to curtail their reliance on energy sources and, correspondingly, commit to long-term decarbonization efforts (Karda et al., 2023). It is worth noting, however, that while the study delves into construction methodologies and timeframes, it does not delve into architectural passive environmental strategies.

An essential study conducted in Canada has undertaken a comprehensive investigation into the Life-Cycle Cost Assessment (LCCA) of construction for single-family residential modular buildings. The outcome of this research is a meticulously structured framework, offering a step-by-step approach to benchmarking the life cycle economic sustainability performance of these specific building types. The study's inception was rooted in recognizing that life cycle economic performance, a pivotal facet of sustainability, remains inadequately explored within buildings constructed via off-site methods like modular construction. The proposed framework is designed to be a valuable tool for stakeholders across the construction spectrum, including decision-makers, developers, and contractors. By offering an analytical approach, this framework aids in making well-informed decisions regarding construction methods. Furthermore, its utility extends beyond initial construction choices; it can address areas that underperform over the life cycle of a modular building, even after the construction method has been determined (Kamali et al., 2022).

The methodology employed in this study stands out for its exceptional quality and applicability to ongoing research. It commences with the careful selection of suitable economic performance criteria, followed by the development of measurable economic performance indicators under each criterion. Subsequently, establishing performance level functions for each indicator paves the way for a multi-criteria decision analysis-based methodology tailor-made to suit performance benchmark scales. Incorporating the methodology showcased in this study into the current research can enhance the quality and depth of analysis, offering valuable insights into economic performance within the context of environmental and economic considerations.

Numerous research papers have adopted a similar methodology. For instance, a study conducted in Russia in 2022 formulated a comprehensive list of pivotal factors that could serve as the foundation for an impending system of environmental indicators to evaluate the efficiency of energy projects. The study's progression involved crafting an array of environmental indicators

that align with the industry's distinct characteristics. Following this, the most influential factors were identified, laying the groundwork for a concise yet comprehensive evaluation framework for appraising the efficiency of energy-focused investment projects (Karaeva et al., 2022).

Utilizing a priori ranking method in conjunction with an analysis of interrelations among these factors, the study proposed a range of indicators that could be quantified in either physical or monetary terms. Integrating such indicators substantially enhances the economic rationale behind assessing the viability of energy investment projects.

While the study focuses on the energy sector, its approach reinforces the current trend of seeking equilibrium between economic considerations and environmental impact across various investment projects. This resonance underscores the significance of this thesis within the broader context of balancing economy and environment in diverse investment endeavors.

In the Palestinian context, there was a lack of such research until the middle of 2022 when the Palestine Green Buildings Council published a study of the feasibility of environmental construction in Palestine. During the study, the most critical elements affecting the energy sector in the Palestinian construction behavior were highlighted, and the typical construction patterns were discussed along with their environmental impact within the region under political constraints (Council, 2022). The study hypothesized that the considerable risk and initial financial outlay may discourage many potential investors from entering these markets, the financial capacity of end consumers, developers, and contractors to absorb higher upfront costs, combined with their limited awareness of the numerous advantages and strategies associated with green building practices, often leads to suboptimal green building design and utilization. However, the study did not prove or disprove this hypothesis within the context as its focus was more oriented towards energy reduction and feasibility studies for retrofitting the existing buildings.

In conclusion, there is still an existing void within contemporary research seeking to identify the juncture at which economic factors intersect with environmental considerations within the framework of socio-cultural analysis specific to Hebron City.

1.4 Research Questions and Hypothesis

In the early design stages of office buildings, investors typically prioritize and optimize initial costs, often neglecting long-term financial considerations as they consider them imposed upon the users of the building. This is a short-sighted approach that can result in probable problems for future occupants. For instance, investing in less efficient wall construction might save money initially, but it could lead to higher energy expenses in the long run to achieve thermal comfort.

Accordingly, this study assumes that minor environmental adjustments in the preliminary design stage of office buildings may increase the initial construction cost by up to 10% but will reduce the total Life Cycle costs (LCC) of these buildings, including social costs (Reference 3.4).

This leads to the research question: Where can investors' economic vision meet their clients' and the building's users' environmental needs?

Consequently, the following sub-questions were raised.

- From an investment point of view (POV): How much increase in the construction initial phase cost (due to the building's environmental treatments) is considered economically acceptable in Palestine? (Economic factor)
- From the client's POV: Will clients in the study context accept the increase in real estate price in exchange for LCC and payback period? (Cultural factor)
- From users' POV: What are the most minor environmental treatments in office buildings for them to operate, benefit, and grow their economic firms? (Environmental, psychological, and social factors)

1.5 Objectives

Prior to defining the central objective of this thesis, the goal is to foster a harmonious equilibrium between real estate investors and office building users. The aim is to strike a balance between the economic demands and initial construction expenses of office buildings, concurrently addressing the environmental requirements and preferences of users within the Palestinian context. Aligned with this goal, the study proposes passive solutions during the initial design stage of office

buildings, optimizing environmental performance while prioritizing cost-effective measures. This approach is intended to enhance the overall performance of companies and employees within these buildings.

From this perspective, research objectives can be summarized as follows: To assess the viability of initial environmental design proposals to contribute to the development of more environmentally and economically viable office buildings in Palestine, which, in turn, can foster a healthier environment and support the well-being of building users and the broader community, by:

- Applying the preliminary design environmental improvements and compare the resulting increased initial costs with the original condition of chosen case studies for office buildings.
- Exploring investment behavior and investors' environmental awareness in the Palestinian context by proposing a new approach towards meeting their expectations.
- Achieving the building’s best investment practices without compromising environmental considerations.

1.6 Research Significance

This study explores the potential of applying economically viable early-stage environmental passive design strategies for office buildings in Palestine. Such solutions may increase initial construction costs but will follow a long-term cost reduction strategy, which indeed decreases the LCC of the real estate. In this study, the proposed environmental solutions shall provide maximum environmental performance measurements, as well as the enhancement of users' well-being, productivity, and amenities. For this study to attain these benefits, investors must be convinced through evidence of the importance of environmental adjustments to their office building’s construction and design strategies vs. their initial costs that can be loaded to the real estate’s price, which is a significant focus of this study. As well as spreading awareness amongst users of the payback periods and environmental initial costs efficiency.

1.7 Research Limits

The study focuses on Hebron City, a significant trade hub connecting the north of the West Bank with the south-central regions. Over the past two decades, the city has perceived a typical spread of office buildings. The research scope is confined to office buildings located in a Mediterranean climate and constructed with local building techniques, materials, and labor, considering their associated costs. The scope of this study is confined to office buildings constructed by investors for resale purposes, excluding those intended for personal use by individual firms. And is also confined to office buildings that were constructed and licensed during the early beginnings of the last decade with the common construction patterns of the given period.

The solutions proposed for the selected cases must consider various factors, including location, environmental considerations, initial and ongoing expenses related to office buildings, and cultural and societal limitations.

1.8 Research Limitations

The study faced the following limitations:

- Access to information: lack of cooperation from the needed entities and people in charge of information.
- Change in the market: material prices for calculations were obtained in the time of Gaza war, October 2023, and these prices were genuinely higher than the usual prices.

Despite these limitations, conducting a thorough study on the economic-environmental balance of office buildings in Palestine can yield valuable insights and recommendations to foster sustainable and economically viable real estate practices.

1.9 Research Structure

This thesis is divided into four main sections; each includes related chapters and subtitles, as clarified in the table below:

Table 1.1 Thesis Structure

Section	Chapters	Sub Titles
Conceptual Frame	Chapter 1: Introduction	Preface
		Research Problem
		Research Gap
		Research Questions and Hypothesis
		Research Objectives
		Research Significance
		Research Limits
		Research Limitations
		Research Structure
Theoretical Studies	Chapter 2: Environmental Considerations vs Investment Requirements	Preliminary Design Phase Environmental Considerations
		Environmental Performance Indicators in Office Buildings
		Buildings Materials in Palestine
		Economic Side of the Environmental Basic Needs
	Chapter 3: Investment Aspects of Office Buildings in Palestine	Financial Concepts
		Energy Costs Savings
		Economic Aspect of Employee Satisfaction
		Incentives and Tax Credits
		Cultural Aspect of Real Estate Investment in Palestine
Practical Work	Chapter 4: Research Methodology	Research Type and Data Collection Method
		Fieldwork
		Researcher's Confirmation
		Results Discussion Method
	Chapter 5: Results and Discussion	Fieldwork Results
		Researcher's Confirmation
		Results Triangulation
Final Approach	Chapter 7: Conclusion and Recommendations	Optimized Cost Efficient Environmental Preliminary Design Guidelines for Office Buildings in Palestine
		Life Cycle Assessment Highlights for Environmental Office Buildings
		Recommendations
		Future Extension
References		

Chapter 2

Environmental Considerations Versus Investment Requirements

2.1 Preface

The global approach to evaluating the sustainability of real estate projects entails a comprehensive assessment across the Environmental, Social, and Governance (ESG) pillars (Alessandrini et al., 2022). Despite the merits of this approach, it's important to note its limitation in possibly overlooking the economic dimension during the evaluation process. Nevertheless, Switzerland and several other European countries adhere to this approach, and funding institutions deem it sufficient to guide their project financing decisions. In the Palestinian context though, this approach has been partially applied, but there are political and sociological constraints that slowed down its full application.

In terms of environmental considerations, environmental issues have garnered significant attention within the real estate market. However, practical application remains theoretical in many regions worldwide, Palestine, for example. Although studies have demonstrated enhanced corporate performance in environmentally conscious office buildings (Devine et al., 2021), investors often perceive these benefits as not aligning with their interests. Consequently, they tend to overlook environmental factors in favor of reducing the initial construction costs that might incur.

Feige et al. conducted a study in 2013 to establish a link between the environmental performance of real estate properties and their corresponding rental prices in the market. The study's findings revealed that environmental buildings command higher values in the market when compared to non-environmental counterparts (Feige et al., 2013). This research underscores the potential economic advantages tied to environmental considerations, which could potentially shift investor perspectives and industry practices in the future.

The growing focus on sustainability is compelling the construction industry to prioritize the construction of more environmentally conscious buildings. In this context, numerous indicators for sustainable development have been put forth. The global adoption of sustainability rating systems and their frameworks is regarded as indicative measures for assessing the sustainability

of construction projects. These rating systems encompass a spectrum of approaches, ranging from systems that assess energy consumption to those that conduct life cycle analyses and comprehensive evaluations of overall quality (Berardi, 2012). Energy consumption is the most important consideration in such rating systems and they might not guarantee the best humane design or Quality of Life (QoL) considerations (Bousbia Laiche et al., 2023).

Real estate investment assessment process conducts the PESTLE methodology, the letters stand for Political, Economic, Social, Technological, Environmental, and Legal (Kircher, 2022). This approach is employed to assess the environmental performance of office buildings while taking into account the other aforementioned preferences, which are integral to the evaluation process. This holistic consideration is particularly pertinent in Palestine, where the Israeli occupation holds sway over all natural resources and the energy supply within the country. Friedman considered corporate sustainability and companies' ability to increase their profits a part of their social responsibility (Friedman, 2007). Thus, each of the above factors is correlated to all other factors during the assessment procedure.

This chapter delves deeper into the environmental factors pertinent to office buildings, presenting the standards related to basic environmental requirements. This is crucial for assessing the feasibility of implementing environmental features in office buildings in Palestine. Additionally, the availability of environmental building materials in the Palestinian market and their corresponding costs are presented.

2.2 Environmental Considerations in Office Buildings

The design of office buildings encompasses factors such as building shape, dimensions, and layout (Alonge et al., 2023). It is important to recognize that aligning office designs with the well-being and health requirements of employees is not only a legal imperative (Amriyati, 2022), but also contributes significantly to overall employee performance and satisfaction (Ilter et al., 2022). Furthermore, such alignment can impact employees' perception of their general Quality of Life (QoL) (Bousbia Laiche et al., 2023).

A non-well-designed office environment distracts employees into coping with their surroundings rather than focusing on their work responsibilities (Ilter et al., 2022). Users of office buildings support the priority of office layout, personal space, and indoor air quality to their overall satisfaction and well-being. Human well-being has recently been connected with the built environment as people tend to spend 80-90% of their time indoors (Bulfone et al., 2021). Many green buildings rating schemes have emerged to assess and support users well-being inside the built environment by considering Indoor Environmental Quality (IEQ) standards like LEED (Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method), but research has proven that green buildings codes alone are not enough to achieve employees well-being in office buildings (Bousbia Laiche et al., 2023). Numerous environmental standards must be taken into account during the preliminary design phase of office buildings. While these environmental basic needs may not always be explicitly outlined in green building rating schemes, they remain essential for ensuring the well-being of employees within the office spaces.

The well-being of employees within office buildings is a comprehensive concept that encompasses various aspects, including employee comfort, overall satisfaction with the office environment, and health. This also involves reducing the impact of pollutants and mitigating poor indoor air quality, all aimed at preventing Sick Building Syndrome (SBS) symptoms among its occupants (Ha et al., 2023a). The objective of green buildings is to reduce environmental risks to the broader society across various phases of their life cycle. The phases include the construction phase (or deconstruction) and during the design and buildings operations (Council, 2022). Green buildings must ensure a high level of indoor environmental quality, which encompasses temperature, ventilation, and lightening. This is imperative, considering that approximately 3.8 million premature deaths occur due to exposure to polluted air, largely stemming from the combustion of fossil fuels. Additionally, volatile organic compounds can lead to symptoms like nausea, headaches, and respiratory problems. To safeguard indoor environmental quality, it is crucial to implement measures that prevent contaminated outdoor air from infiltrating green buildings. Prioritizing thermal comfort and energy-efficient lighting solutions is also essential.

Environmental Considerations Versus Investment Requirements

Although environmental design considerations in office buildings can effectively reduce energy consumption, they may not always align with employees' well-being and individual preferences (Altomonte et al., 2017). For instance, providing employees with early morning sunlight exposure through a high Window-to-Wall Ratio (WWR) can enhance their happiness and psychological satisfaction. However, this design choice can lead to issues such as excessive glare during other hours of the day and increased thermal retention within the office space which affects work tasks quality and the time consumed for finishing them. Therefore, the design of office buildings should strive to strike a balance between managing energy loads and ensuring the physical and psychological well-being of employees. Office buildings designing today must not be designed only around the satisfaction of the employee, but also around the delightfulness and embracing the spatial experience employees have during their working hours through environmental considerations further than energy loads and CO2 emissions, and this spatial experience can be achieved through combination of equal attention to the three main elements of preliminary design; people, planet, and profits (Altomonte et al., 2020).

A triple bottom line (TBL) analysis for green office buildings most desired attributes by users and investors done in 2014 summarized the foremost attributes, which primarily benefit individuals and employees in office buildings, followed by cost savings for the investors, these attributes are: access to natural light, access to public transportation, indoor air quality, thermal comfort, efficient HVAC systems, cost-effective lighting solutions, and lease structures that incentivize environmentally conscious investment behavior (Robinson et al., 2014). Considering these attributes in the preliminary design stage will make office buildings a working environment (Alonge et al., 2023).

The next section of this chapter discusses the effect of the most considerable basic environmental factors in office buildings design in the Palestinian context on employee’s productivity and overall performance, while outlining the available codes and design standards for each environmental factor.

2.3 Environmental Performance Indicators in Office Buildings

Extracted form the Green Buildings Index (2022c), standards concerning the indoor environmental quality (IEQ) of non-residential buildings were set to outline the importance of air quality, thermal comfort, lightening and visual and acoustic comfort on employee's performance. Many studies have examined the last mentioned environmental index and proved that indoor environmental quality is highly affected by factors like natural ventilation, exposure to sunrays, and external and internal wall composition of the building, which have a direct impact on employee's health, well-being, and performance (Dimitroulopoulou et al., 2023, Khan et al., 2023, Cheung et al., 2020).

The influences and factors of IEQ were underscored as the most significant crucial factors for employees' workplace evaluation, enabling them to meet their task performance requirements effectively. The number of windows available in the office, for example, was highlighted as the second important factor by employees (after office enclosure). The number of windows allows both ventilation and natural lightening within the workspace (Alonge et al., 2023). While another study examining the Palestinian museum employees environmental satisfaction found that employees prioritize access to garden, energy efficient applications, and thermal comfort throughout the year within the building (Council, 2022).

Palestine Green Building Council highlighted the necessary criteria for good IEQ in 2022, these criteria included construction behavior and the available most common building material in the region associated with their environmental impact. Thermal comfort and minimum Indoor Air Quality (IAQ) as basic environmental needs are partially applied in Palestinian buildings, while daylight needs are met. Other indoor environmental quality standards along with other LEED variable basis are either not applied or not fully applied in large projects within the context of investigation which is three municipal regions.

Basic environmental needs include the IEQ standards of thermal, air, visual, and aquatics comfort. Nonetheless, the discussed subtitles in this section have standards and recommendations extracted from the international standards from ASHRAE55 in companion with Geen Buildings Guideline – the State of Palestine. The standards discussed under this title are:

1. Daylight and visual performance considerations.
2. Exposure to sunrays.
3. Indoor air quality and natural ventilation.
4. Thermal comfort.

1. Daylight and Visual Performance Considerations

Adequate lighting in a work environment is derived from both natural and artificial sources. Emphasizing the primary importance of natural lighting through building's openings for energy saving and other purposes, employees concern with utilizing both natural and electric lighting to suit their individual preferences (García-Fernández and Omar, 2023). Employees perception of illuminance differ during the day, by dividing the day into three periods; morning, noon, and afternoon, the balance between prioritizing daylight over artificial light differs accordingly (Jamala B et al., 2023). Employees prefer natural daylight over artificial lightening due to the glare that comes on screens from the last (Tekce et al., 2020). Other factors that might affect employee's perception of illuminance refer to personal differences like gender, age, hours spent at work, desk location relative to the window, etc. designing glass openings in office buildings should not be based upon only the physical parameters like materials, colors, thermal and acoustic features, airtightness, but also consider human experience; visual comfort, visual connection with the outsides, and these factors effect on the productivity and performance of the employees (Muraj et al., 2023).

Research findings have varied regarding the significance of natural daylight for employees in comparison to their overall satisfaction with the daylight conditions within their workspaces. Employees highlighted the importance of natural daylight and visual connection with the outsides to their health, satisfaction, work environment evaluation, QoL, and productivity, even when they are not satisfied with office illuminance (Tekce et al., 2020). Maximizing natural daylight use can reduse energy consumptions in office buildings leading to a less CO2 emmisions that can score environmental and economic profits for individuals and society, besides social, physical, health, and psychological benefits (Liu et al., 2023). Due to the lack of energy and energy supply political constraints, it is crucial to apply energy saving methods in the Palestinian context through the visual performance of buildings. Energy consumptions associated with lightening and

illuminations in house-hold sector alone have been measured to exceed 8% in Palestine, and the number for non-residential buildings is expected to be higher (Council, 2022).

Iluminance distrubution amongst the office is recommended to be between 300 and 500 lux for most tasks on the workplane (Altomonte, 2023). There is no specific design strategy to obtain this value, as building designs differ. Factors that affect illuminance in buildings are but not limited to: building location and orientation, glass ratio and glass type, and façade orientation. An effective natural lighting strategy manages the intensity of illumination within the office and distributes the light in a manner that enhances the overall environmental quality. The extensive integration of daylighting, along with the adoption of energy-efficient lighting technologies like LEDs and lighting controls (passive and active strategies), can be regarded as essential components of sustainable preliminary architectural practices (García-Fernández and Omar, 2023).

The design of office building facades has been conceptualized with the aim of decreasing, improving, reusing, or generating natural daylight by optimizing the window-to-wall and window-to-floor ratios (WWR and WFR) with the glass used accordin. When illuminance is considered as an independent factor, all other design techniques, both passive and active, become interdependent in their efforts to meet the illuminance standards.

Applications to achieve the environmental iluminance standars within office buildings in Palestine must guarantee an iluminance value not less than 250 lux on desk level for public buildings and when achieved within 75% of the space, it scores 2 points according to The Green Buildings Guidelines in Palestine (Association, 2013). Other lightening strategies incclude using light sensors in spaces like corridors, meetings and coference rooms, using automated or manual glare reduction techniques, besides ilumination detectors for constant iluminance check.

As for visual connection with the outsides in Palestine, it is recommended for the public buildings to have 75% of their internal spaces with direct visual connection with the outsides, and that open offices have glass partitions that allow direct visual access with the outsides (Association, 2013). This can be achieved by placing work desks in a maximum space of 2.28 m away from transparent parts of the exterior walls.

2. Exposure to Sunrays

Increased sun exposure hours indicated increased mental health among building occupants.the explanation of this mental health improvement goes back to vitamin D levels increment natually when exposed to the sun. vitamin D difficiency is associated with depretion. Sunlight is also responsible for regulating cortisol in human body, and decreasing cortisol levels improves mood and decreases stress. Low sunrays exposure is responsible for lower physical activity and thus, productivity (Wang et al., 2023, Soydan et al., 2012). Some countries' building codes require sun exposure standards and won't permit buildings unless sun exposure standards are met (Jiang et al., 2023). Residential real estate clients in china are willing to pay a premuim of 14% for south facing appartments relative to north facing appartments. Direct sun exposure results higher work productivity and better job satisfaction (Zhong et al., 2022, Lu, 2018). Buildings design, orientation, spacing and urban distribution affect hours of sunlight exposure, while interior spaces width affect its distrubution inside the building (Zhou, 2020).

Sunlight exposure is closely linked to both daylight availability and visual connections with the outdoor environment. While there is a commonality with the window-to-wall ratio (WWR) and window-to-floor ratio (WFR) factors, there are still distinctions to consider. Daylight and visual connections can be established in north-oriented facades, where sunrays do not directly reach offices located on the northern side of the buildings. Palestine Green Building Council implicitly discussed sunrays exposure as a basic environmental need. Exposure to sunrays wasn't solely mentioned as an independent factor in green buildings rating systems in Palestine. Daylight and quality views along with thermal comfort, energy consumption reduction and IEQ, mould prevention and renewable energy sources are all achieved by utilizing sunrays exposure. The aim to reduce buildings' heating and cooling loads was discussed in the Green Buildings Guidelines for Palestine in the form of passive solar systems. The guidelines recommended the longest façade to face the south orientation with a minimum WFR of 20% to allow most sunrays exposure inside interio spaces during winters and the use of external shading devices would decrease the glare and heat caused in summers. Solar chimneys, tromb walls, and solarium are all recommended passive solar tecniques in Palestine. Building Integrated Photovoltaic Cells BIPV are an active strategy to utilize sunrays in buildings.

3. Indoor Air Quality and Natural Ventilation

Indoor Environmental quality (IEQ) embodied in thermal, visual, acoustic, and indoor air quality (IAQ) charachteristics of the buillt environment directly affects the productivity of employees. Office buildings occupants productivity rate dropped by 10% when 70% of them expressed dissatisfaction with IAQ (Deng et al., 2023). Poor IAQ and poor ventilation causes sick building syndrome (SBS) amongst building's occupants which symptoms appear in the form of fatigue, azthma, irritation, nauzea, headache, and dizziness (Igwe et al., 2023, Vasile et al., 2023). All these mentioned symptomps have direct imopact on imployees productivity, abcense rate, and sick leaves frequency, affecting the performance and workplans implementation in these office building's companies. Research has demonstrated that workplace health initiatives can help reduce sick leave absenteeism by 27% and health-care costs for companies by 26% (WHO, 2017). Indoor air polution and smell caused by poor ventilation is considered a main stressor in the working environment for employees, causing them percieved health symptoms, diseases, discomfort, complaints, immune system traits and other phsychological symptomps (Bluyssen, 2019). To insure better air ventilation amid office buildings occupants, there are two indoor air exchange methods; natural through infiltration caused by closing elements such as doors and windows, and mechanical through air exchange systems or mixed systems (Vasile et al., 2023).

Models on how to improve internal air circulation and natural ventilation have been investigated in recent research. Smart ventilation as a concept of air quality modeling is used to improve IAQ while reducing energy loads and involving renewable energy systems all in the same model during the preliminary design stage of a building (Vasile et al., 2023). Another approach discussed night ventilation technique for office buildings and connected natural ventilation with thermal comfort and energy consumption in office buildings (Amaripadath et al., 2023, Altomonte et al., 2017). Night natural ventilation as a passive technique for energy saving has been used in many office buildings around the world and proved its efficiency to reduce cooling loads and internal office temperatures (Naili et al., 2023).

The ventilation effectiveness and IAQ were observed to be impacted by a range of factors and indicators, including temperature and humidity levels, the proportion of open windows and doors, outdoor wind speed, and the airflow rate (Harčárová and Vilcekova, 2022). Worldwide, 30% of

the buildings suffer from IAQ problems (Thongsumrit et al., 2023). To address indoor air quality concerns, minor passive enhancements can be made during the design of office buildings; increased cross ventilation and improved air distribution and air flow within the building through windows. Adding greenery helps purify the air in spaces where the air flow is week. Maintaining interior thermal comfort through regulating temperature and humidity levels within the range of 40% to 70% will prevent breeding of biological contaminants. Providing public smoking areas to avoid tobacco hazards inside the offices (Igwe et al., 2023).

Indoor environmental quality considerations concerning IAQ applied within the Palestinian region are limited. Minimum IAQ performance standards are partially applied, while environmental tobacco smoke control, enhanced IAQ strategies, the use of low-emitting materials, construction IAQ management plan, and IAQ assessment are still not applied. Central Heating, Ventilation, and Air Conditioning (HVAC) are only applied in big projects and by high-end users due to high installation costs and less efficiency on the long run which oriented customers into the use of split air conditioning units that are rarely cleaned in offices, which affects the overall IAQ (Council, 2022).

Green Buildings Guideline in Palestine states the importance of achieving the minimum IAQ by assuring all spaces are sufficiently ventilated either naturally or mechanically, with ventilation rate exceeding the minimum standard by 15% to insure a good IEQ for building occupants. Building plans must provide a clear distribution of natural ventilation openings and when mixed mode is used, a study for Computational Fluid Dynamics (CFD) must be proposed using simulation programs and allows a clear spotting of air intake and discharge points with the spaces between them placed according to ASHRAE standards.

4. Thermal Comfort

The comfort of employees in the workplace is closely linked to IAQ and humidity levels. Higher temperatures often result in lower humidity, leading to drier air, which can be uncomfortable for employees. On the other hand, lower temperatures tend to bring higher humidity levels, which can foster the growth of biological contaminants and diminish air quality by introducing pollutants. The optimum temperature inside workplace is between 22 and 24 C (Onabanjo et al., 2023).

Productivity and performance inside the work environment are highly affected by thermal comfort of the employees. Office buildings thermal performance are achieved through natural ventilation, HVAC systems, or mixed mode that employs both natural and mechanical thermal control. The mean indoor temperature in naturally ventilated office buildings is highly responsive to outdoor temperature, and employees have to achieve thermal comfort through responding activities like adjusting clothing, opening or closing windows and doors, and using fans. The correlation between the comfort temperature and indoor air temperature is more pronounced in the naturally ventilated building than in HVAC dependent buildings, which suggests that occupants in the naturally ventilated building exhibit greater adaptability to the indoor climate (Lamsal et al., 2023).

Thermal comfort is directly connected with IAQ as managing building ventilation through HVAC systems alone is not enough. Some HVAC systems recycle air in between the offices of the building creating a major health problem among workers. Thus, maintaining natural ventilation for thermal comfort is vital for the health and well-being of employees (Khadka et al., 2022). The international rating systems connected thermal comfort with air change effectiveness during evaluation (Bousbia Laiche et al., 2023). It is important to know the optimum temperature set points within office buildings to approach the nearest comfort temperature even with individual preferences. This can be known in a stage as early as the preliminary design stage of buildings through simulations and thermal transfer properties and calculations for the used materials, to achieve the best energy consumption model along with employee's satisfaction. Individual preferences in thermal comfort are due to many factors, one of these factors is gender. Females tend to have higher sensitivity to temperatures than males. The sense of relative humidity is also individual. Relative humidity is affected by the indoor temperatures and also responsible for the human sensation of them (Onabanjo et al., 2023). The indicators associated with thermal comfort through thermal modeling calculations encompass Predicted Mean Vote (PMV) and Predicted Percentage of Dissatisfied (PPD), in addition to the energy consumption indicator (Harčárová and Vilcekova, 2022). ASHRAE 55 standards suggest a scale from 1-7 equivalent to a scale ranging from -3 to +3 in ISO 7730 standards to measure the PMV for thermal comfort around a specific building's occupants. 1 (equal to -3) suggests a very cold sensation of indoor temperatures, while 7 (equal to +3) suggests a very hot indication. Green Buildings Guideline in Palestine requires a PPD percentage of maximum 10% with a maximum indoor temperature of 26 C, and when the

PPD exceeds 30% the indoor temperatures are considered unacceptable – this is when indoor temperatures are 29 C during 98% and 90% of yearlong for mechanically and naturally ventilated buildings respectively (Association, 2013).

The main goal of achieving the optimum indoor temperatures is to maintain thermal comfort among building users. Hence, overall satisfaction and more productivity. Considering individuals thermal preferences requires thermal zoning within office buildings for cooling and heating modeling calculations. The Palestinian Green Buildings Guidelines require thermal zones with separate thermostat that do not exceed the area of 35 sqm near external walls, and 70 sqm inside the building. Mechanically ventilated public buildings must contain separate control units inside each thermal zone, and the use of an occupancy sensor increases the assessment by one point. However, mixed mood ventilated public buildings should be 50-75% naturally ventilated. Yearlong thermal simulations must be run to create a report of the thermal effectiveness of the project, attached with a table defining project's thermal zones, their function, area, air temperature, and calculated heating and cooling loads for each or thermal discomfort hours total count in the case of mechanical systems absence. In the case of naturally ventilated buildings, a report of natural ventilation months, openings dimensions and control methods, elevations and plans displaying the openings and thermal zones table with average indoor temperatures are required.

The ultimate goal for passively achieving thermally comfortable indoors is to reduce the cooling and heating loads, thus, energy consumptions during the life cycle of the building. In spite of their higher initial costs, thermal insulation, efficient glazing, the elimination of thermal bridges, and an efficient HVAC system distribution are effective passive means to reduce energy consumptions associated with thermal comfort (Kaya and Caglayan, 2023). Thermal insulations reduce thermal conductivity within wall layers, and decrease heat loss rate. Using thermal insulations in walls and roofs can reduce cooling loads up to 40% and guarantee annual energy savings up to 66.4% with an approximate return on investment of 116,344 USD when applying proper wall and ceiling insulation and optimizing its type and thickness (Lisa and Zuraihan, 2014, Kaya and Caglayan, 2023). There exist numerous approaches for reducing the electricity demand in Palestine. A crucial finding from Green Buildings Council research in 2022 indicates that a substantial number of buildings lack thermal insulation, resulting in a notable escalation of energy consumption and

associated heating and cooling expenses. At present, the Palestinian Energy & Natural Resources Authority (PENRA) is actively engaged in raising awareness among developers and engineers regarding the imperative use of thermal insulation. They firmly believe that this practice will play a pivotal role in curbing the overall energy consumption for cooling and heating in buildings. One primary challenge in incorporating thermal insulation into buildings stems from a shortage of both practical and theoretical knowledge among engineers and contractors. This shortage extends to calculating the necessary amount of insulation and applying the most effective thickness.

There are three types of thermal insulation: Mineral Fiber, Cellular Plastic, and Plant/Animal Derived. While both mineral fiber and cellular plastic insulation materials are available in the West Bank and Gaza Strip, the most commonly utilized material is cellular plastic insulation, particularly polyurethane spray foam (Council, 2022). Highest thermal transmittance (U-value) for green buildings external walls in Palestine must not exceed 0.5 $W/m^2.K$ (Association, 2013).

Another exterior wall element that plays a vital role in maintaining an internal thermal set point is openings. Windows consist of two elements, glass and window frame, and both intervene in heat loss or gain into the building. Window frames, even when they form only a little percentage of building's components, may cause air infiltration or be the reason for air tightness which slightly changes internal air temperature. The main window frame material used in Palestine is aluminum frames. Since glass is imported to Palestine, almost every type of glass can be available, the market share of each depends on price and feasibility. Available types include single glazed, double glazed, triple glazed, low emissivity glass, untampered and tampered glass, as well as thermally insulated glass. Most investors opt for window glass with a thickness of 4-6-4 (glass thickness - air gap - glass thickness), while houseowners prefer thicker glass, typically 6-12-6. As for commercial buildings, low standard double glazing is used (thick, tempered, and with air gap). Curtain walls employ higher grades with e-glass. However, highest thermal transmittance (U-value) for green buildings external openings in Palestine must not exceed 2.46 $W/m^2.K$ (Association, 2013).

2.4 Building Materials in Palestine

Palestinian contemporary buildings represent a significant departure from traditional architecture, with a notable disregard for environmental responsiveness and the preservation of architectural identity (Germanà and Alatawneh, 2016). On the contrary of old Palestinian buildings, the contemporary ones lack basic environmental preliminary design principles that are rarely considered in the new architecture. The random environmental architectural jump has gained interest amongst researchers and architects in the last decade in trial to understand the main factors and influences behind this negative transition. Building's architectural design and building envelope both contribute to its environmental performance (Itma and Wasim, 2023). Thermal transmittance (U-value) of modern uninsulated buildings in Palestine reached 3.75 $W/m^2.K$ compared with traditional buildings wall layers U-value which is 1.81 $W/m^2.K$ according to the Palestinian Building Code (PBC, 2015). Palestinian traditional buildings wall layers (outer to inner) consist of: 0.20 m stone, 0.60 m mud, and 0.20 m stone. Uninsulated modern buildings in Palestine wall layers (outer to inner) consist of: 0.05 m stone, 0.20 concrete, 0.10 concrete block, and 0.02 plaster (Nasereddin and Dweik, 2021). In an effort to reduce building materials environmental effects, new materials are emerging. These materials are categorized as green building materials, characterized by their reduced carbon emissions achieved through the use of alternative raw materials, such as recycled content, or by modifying production techniques. Current building materials that are used in the Palestinian construction sector are cement, pre-cast blocks (made of gypsum and cement), glass, paints, aluminum, wood, metal, and insulation materials constitute the primary building materials. Each material follows a distinct production process and import strategies, resulting in varying environmental impacts.

Green building materials are available in the Palestinian market. Aluminum is regarded as green building solution due to its properties; aluminum is lightweight, robust, elastic; reflective, safe, durable, corrosion resistant, and long lasting, and is 100% recyclable. Gypsum is also more environmentally friendly than concrete, and lightweight concrete-gypsum blocks can be used to reduce the impact of cement and concrete. Gypsum is thermally effective and recyclable. Steel is highly recyclable and there have been worldwide methods to reduce its environmental impact during manufacturing. Glass is used in every building, its environmental contribution includes UV

rays' reflection and when thermally insulated, can reduce heat loss and gain. Available green glass in Palestine includes solar control glass, low emissivity glass, and thermally insulated glass.

2.5 Economic Side Versus the Environmental Basic Needs

Commercial buildings are responsible for 80-85% of electricity demand in Palestine. Environmentally inconsiderate office buildings in Palestine are not only high energy consuming, but are also responsible for negative health effects and decreased well-being of their occupants. Health costs spent by individuals and government in Palestine are estimated to tragically duplicate by 2050. The amount of money spent on health was 395$ per person and is expected to be 742$ per person in 2050. The statistical number evaluates direct money spent on health, but there are other uncalculated associated costs. The consequences of a rise in long-term diseases will affect various stakeholders. Individuals will experience prolonged health issues and economic obstructions due to medical costs and the loss of work opportunities during treatment. Healthcare service providers will face heightened demand for long-term disease treatment. Additionally, governmental bodies and budgets will need to allocate resources to support both service providers and individuals in their treatment and care needs (Council, 2022). However, green buildings basic features offer a great opportunity to avoid associated health and well-being issues amongst occupants. Long-term health problems and their costs can be decreased or eliminated when indoor environmental quality (IEQ) standards are applied. Maintaining good indoor air quality (IAQ), thermal comfort, sufficient daylight and enough exposure to sun can be of great benefit on the long run.

Financial parameters were calculated to observe the feasibility of insulation applications on existing public buildings and to identify the optimum insulation application (Kaya and Caglayan, 2023). Optimum insulation thickness was found to be between 0.4 to 9 cm in Palestine (Alsurakji et al., 2021). However, no calculation is used by contractors in Palestine, but rather a general rule of thumb. For example, spray foam thermal insulation application in Palestine, of 1.25 kg of foam for 1 m^2, at a cost of USD 7 per m^2. Nevertheless, thermal insulation offers advantages that extend beyond the reduction of heating and cooling expenses in commercial spaces. It also enhances thermal comfort and mitigates the risk of asthma. Improving IAQ and enhancing the air quality within offices significantly enhances occupants' comfort. This can be achieved through simple

measures like using air filters, smoke fans, houseplants, low or no volatile organic compounds (VOC) paints and products, ensuring proper air circulation. Moreover, maximizing natural light has unmeasured health benefits and lowers health associated costs. The main window frame material used in Palestine is aluminum frames, thermal aluminum break frames are very efficient concerning the thermal performance of buildings, but are not commonly used in the region due to their high initial costs. There is another imported efficient type that is still 30% more expensive than the ordinary aluminum frame and is limited to 2m window span. As for glazing component, contactors still use thin double-glazed in commercial buildings. The primary driver for opting for thinner double-glazed glass is the substantial cost differential. Thicker tempered glass, like the 4 6 4 (glass, air cavity, glass) variety, is available at approximately USD 35 per square meter, whereas thicker glass and low-e glass come at a higher cost of USD 74 per square meter and beyond.

Extracted from Green Buildings Council feasibility study (Council, 2022), the following table shows green building materials associated with their relative costs in the Palestinian real estate market.

Table 2.1 Green Building Materials in Palestine and Their Cost (Council, 2022)

Building material	Cost ($/m^2)	Availability in Palestine
Gypsum blocks	19	✓
Double glazed glass (4 6 4)	35	✓
Double glazed glass (6 12 6)	74	✓
Thermally treated double glazed glass	88	✓
E- glass	82-88	✓
Decorative water-based paint	15% more expensive than oil-based paint	✓
Thermal insulation polyurethane	7	✓

2.6 Conclusion

To promote the well-being and productivity of employees, it is essential to incorporate environmental considerations in the design of office buildings. Those buildings that prioritize these environmental factors from the outset typically have a reduced environmental footprint and provide greater satisfaction and overall quality of life for occupants. Key environmental aspects that designers should address include enhancing indoor environmental quality, encompassing

indoor air quality (IAQ), thermal comfort, daylight, visual connections to the outdoors, and exposure to sunlight, which are now regarded as fundamental rights for employees. These environmental considerations extend their impact beyond the health and well-being of employees, influencing the economic aspects and lifecycle analysis of environmentally conscious buildings throughout all phases: design, construction, operation, and eventual demolition.

Chapter 3

Real Estate Investment Sector in Palestine

3.1 Preface

This chapter encompasses two intertwined aspects: real estate economic considerations and socio-cultural influential factors. Regarding real estate financial considerations, constructing office buildings entails more than just a physical endeavor for investors. In today's economic landscape, investors must thoroughly assess their properties' Life-Cycle Cost (LCC). This necessitates a comprehensive understanding of construction costs, ongoing operational expenses, and maintenance outlays. Such insights are pivotal for effectively marketing their projects and facilitating their eventual sale. Furthermore, investors must understand the anticipated return on investment and undertake cost-benefit analyses for office buildings. These endeavors are crucial in enhancing numerical metrics for subsequent investments. Financial evaluations enable investors to pinpoint augmented resale or rental values linked to their projects, which can be conveyed to buyers to underscore the enhanced property worth in the real estate market.

However, this numerical data exploration extends beyond mere financial calculations. It serves as the foundation for gauging the environmental contributions of preliminary designs for forthcoming investment projects. Such evaluations uncover the impact of these additions on energy cost savings, occupancy expenses, and the potential to secure incentives and tax credits from local municipalities and relevant governmental bodies. This holistic approach bridges the divide between financial calculations and environmental enhancements, forming a comprehensive framework for evaluating investment projects.

Corporate sustainability encompasses integrating environmental, economic, and social considerations within companies (Gutterman, 2022). This relatively recent concept aligns with the Triple Bottom Line (TBL) approach, mirroring the broader sustainability principles. Focusing on Key Performance Indicators (KPIs) becomes crucial to delving into their practical application within operational businesses. These KPIs encapsulate human performance measurement within the business realm, significantly influencing a company's operations. The consistent assessment of this human factor inevitably drives enhancements, ultimately leading to heightened human satisfaction. This, in turn, yields greater returns and improved overall economic performance.

Numerous studies have underscored the connection between the environmental performance of office buildings and the efficacy and productivity of their occupants (Ling et al., 2023). This correlation emphasizes how a conducive and sustainable work environment contributes to enhanced functionality and employee performance, reinforcing the larger corporate sustainability framework.

3.2 Financial Concepts

Analyzing investments financially requires knowing the associated concepts for calculating the feasibility of the investment. There are several financial concepts related to real estate feasibility. This section discusses the most basic concepts and the associated formulas of the metrics needed for numerical calculations.

3.2.1 Time Value of Money (TVM)

This concept relates to the change in money's value over time; money now is worth more than the same amount in the future (Mudheher and Nobanee, 2022). Investors keep this concept in mind before any investment they make. There are many approaches for calculating TVM; all consider the application of stock valuation and bond valuation. Stock valuation is the process of determining the primary value of a stock, or in other words, the fair value of a company’s share. Experts employ several metrics in deciding whether the stock value is overvalued, undervalued, or fairly valued (Psychoyios, 2023). Several stock valuation metrics are: The dividend discount model (DDM) is a model that values the stock based on the present value of its expected future bonuses. Discounted cash flow (DCF) values the stock by estimating the present value of its future cash flows. The price-to-earnings ratio (P/E) is a model that compares an investment price to its earnings per share (EPS); a high P/E ratio indicates the investment is overvalued, while a lower ratio indicates undervaluation. Comparable company analysis (CCA) involves comparing one investment with a similar investment in the industry (Vishwanath, 2009). Investors apply different metrics depending on their investment and the sociological context. Bond valuation determines the theoretical par value of a present bond with anticipation of its future value (cash flow) and the number of years this bond reaches its maturity date (par value) (Psychoyios, 2023).

However, individual investors in Palestine apply a general rule of thumb: they might not be aware of using financial metrics in their real estate valuation. Investors compare their investments to similar investments in the industry, applying the CCA metric when pricing their investments. While also considering the revenue (earnings) to their investment value (price). Other metrics are only applied by public buildings feasibility studies for fund seeking from outer funding entities or banks (Council, 2022).

3.2.2 Return on Investment (ROI)

Return on investment (ROI) is a simple metric to determine the profitability of an investment. ROI comprises two main elements: the investment and the returns (Kumar and Pandey, 2022). At its simplest, ROI can be calculated using the following equation:

$$ROI = \frac{total\ benefits\ -\ total\ costs}{total\ costs}$$

ROI calculation depends directly on profits. A profit is the subtraction of all costs from revenue (Jacobs, 2002).

3.2.3 Life Cycle Cost Analysis (LCCA) and Payback Period

Life Cycle Cost Analysis (LCCA) is a tool used to evaluate and appraise the initial and operating costs associated with diverse investments. In the real estate sector, investors use this tool to roughly estimate the costs associated with the investment (Pasqualino et al., 2008). In simplifying the concept of LCCA, the sum of initial investment, operating, maintenance, and demolition costs is calculated. Investors may take the risk of higher initial costs when anticipating a profitable Return on Investment (ROI) over time. The period required for the investment to be recouped is called the payback period (Jerome et al., 2021).

When calculating LCCA-associated costs, some factors must be considered for better accuracy. The time value of money, discount rates, inflation, and environmental and social costs are considered depending on the objective of the assessment (Reference 3.4). However, most of these factors are excluded from payback period calculations (Karda et al., 2023). The payback period

for office building investments in Palestine encompasses both the investment payback duration for investors and the payback period for clients acquiring properties. For investors, the payback period reflects how fast they sell their investments and recover their capital, allowing for reinvestment. A shorter payback period indicates a higher Time Value of Money (TVM). Conversely, for clients, the payback period is assessed through factors such as energy savings and improvements in employee productivity (operating and maintenance costs).

3.2.4 Occupancy Rates, Risk Mitigation, and Enhanced Rental and Resale Values

Real estate construction involves a series of sequential steps, starting from market analysis, selecting a location, initial design ideation, tailoring designs to meet the target segment's needs, proceeding with the construction phase, and ultimately managing ongoing operations and development. This comprehensive process in the real estate sector resembles the stages of product development. Real estate is market-oriented, considering building occupants are the core of this product throughout all its development stages. This requires ongoing market research and analysis to understand better the needs and preferences of the real estate customers segment (Christensen et al., 2016). Investors in the real estate market build for financial profit; thus, higher occupancy rates indicate a successful investment. Green-certified buildings have achieved a premium of up to 26% in selling. Office buildings that consider the passive application of basic environmental needs have higher occupancy rates in the real estate market (Robinson et al., 2016). Well-oriented office buildings that allow sufficient daylight and good ventilation are appreciated by tenants and clients (Namayanja and Mubiru, 2023), and customers' preferences can impact real estate pricing (Robinson et al., 2016). Marketing environmental real estate products should rely on highlighting the features that distinguish them from other buildings.

However, environmental real estate customers do not choose all environmental features when calculating the addition to their initial costs. For investors to achieve the highest occupancy rates for their environmental office buildings, customers' preferences must be considered during the preliminary design stage. Still, the customer’s Willingness to Pay (WTP) might differ from the actual willingness to pay, which increases risk mitigation in sustainable real estate development amongst investors. Risk mitigation involves a dual process, where investors who decline to invest in green features also face the risk of reducing their real estate occupancy rates. Clients exhibit

environmental preferences for which they are willing to pay, and the absence of these features may result in a decline in property desirability, even with marginal differences in price. Environmental office building investors demand premiums for increased initial investment costs, raising occupancy rate risks. Investors worldwide do a quick risk analysis to identify their risks analyze, assess, and surveil the risks to control them (Koul and Ahuja, 2017). Reducing the risks associated with occupancy rates involves gaining insight into clients' environmental preferences for office buildings. This way, investors can avoid investing in environmental features that customers are unwilling to pay a premium for, mitigating potential financial setbacks.

In some countries, clients expressed their WTP an average premium of 9.3% for indoor air quality (IAQ), improving features, and access to natural daylight. While clients expected other green features to exist in the property, they were unwilling to pay a premium. Some other features clients are willing to pay a premium include parking lots and easy access to public transportation near the building. However, premium rates remained unchanged after stating the expected future savings (Robinson et al., 2016). Though these premiums and green building preferences differ regionally, a continuous market study and customer segment analysis are required to increase the environmental real estate occupancy rate and decrease risk mitigation among investors.

3.3 Energy Costs Savings

Buildings designed with environmental considerations utilizing passive techniques achieve lower energy consumption by optimizing daylight, leveraging solar gain, and implementing effective thermal insulation. Passive methods contribute to energy efficiency by reducing lighting requirements, managing thermal comfort (heating and cooling), and ensuring good indoor air quality (IAQ). Additionally, active techniques, such as photovoltaic panels (PVCs) and HVAC systems, further contribute to energy savings by minimizing overall building loads (Hushlamoun, 2020, Benli and Gürtürk, 2021, Karda et al., 2023). By replacing single-glazed windows with double-glazed windows, modifying the window-to-wall ratio, applying the optimum thickness of thermal insulation, and applying energy-efficient light fixtures, the operational energy can be reduced by roughly 35% (Ahsan et al., 2019). In Palestine, those adjustments in the form of retrofitting helped reduce total energy consumptions from a residential base case in different cities by up to 80%, with considerations of 1kW price of 0.68 NIS, this reduction saved more than 68.54

NIS per square meter per year (Monna et al., 2021). 35% of these savings were achieved through lightning enhancements, 70% through heating loads reduction strategies, 87% through cooling loads reduction strategies, and 95% through domestic hot water. Nevertheless, preliminary design passive environmental considerations can be more cost-efficient due to the ability to control building orientation, insulation location within the wall and its optimum thickness, cross ventilation, and other techniques (Council, 2022).

3.4 Economic Aspect of Employee Satisfaction

The costs linked to employee dissatisfaction are considered social costs and can be categorized as either private or external. Private costs refer to the direct losses incurred by employees due to their dissatisfaction, encompassing both financial and intangible setbacks. Financial losses may arise from decreased productivity and increased absenteeism, leading to a reduction in income. On the other hand, external social costs extend beyond the individual and impact society and the environment. Employee dissatisfaction may have repercussions not only for the employer and fellow employees but also for the broader societal context, including the company's clients and beyond (Pettinger, 2024).

The economic aspect of employee satisfaction in the built office environment encompasses the financial implications of creating a workspace that enhances employees' contentment and well-being. Considering employees satisfaction and productivity is one important aspect of the social costs that result from office buildings. This involves considering factors such as increased productivity, reduced absenteeism, improved concentration, and overall job satisfaction, which can lead to tangible economic benefits for businesses (Altomonte et al., 2017). Investments in a positive office environment can enhance employee performance and morale, ultimately contributing to the organization's economic success. Thus, employee satisfaction with the built environment financial benefit lies in the improved profit resulting from increased workers' productivity, estimated at $100,000 for every 100 workers per year (Hushlamoun, 2020).

Beyond the performance and absenteeism of employees, the profitability of companies is influenced by the retention rate of employees. When employees remain with the organization for an extended period, there is a reduction in turnover, recruitment, and training costs. Organizations

prioritizing their employees' well-being and psychological satisfaction through an improved work environment tend to attract highly talented individuals, reducing recruitment expenses (Mathisen et al., 2022).

3.5 Incentives and Tax Credits

Incentives and tax reductions for environmental buildings aim to encourage sustainable construction practices by offering financial advantages and tax reductions to investors and clients who adhere to environmentally conscious building strategies. These incentives are designed to promote the adoption of green building techniques and technologies, fostering a more sustainable and energy-efficient built environment. By providing financial benefits, governments and authorities seek to motivate stakeholders in the construction industry to prioritize environmentally responsible practices and contribute to overall sustainability goals (Prasetyawan et al., 2023). Governmental entities provide a means for the municipalities to implement rigid regulatory incentives, necessitating mandatory participation from construction stakeholders or voluntary incentives, allowing stakeholders to choose their involvement. Research indicates that voluntarily operated incentives are particularly effective, often outperforming rigid regulatory approaches in promoting green building practices. The various forms of rewards and compensation illustrate the government's role in facilitating the voluntary adoption of green building construction in the sector.

These incentives come from financial and non-financial motivations (Rana et al., 2021). Incentives and tax-direct financial reductions increased the number of certified green buildings in Malaysia from 1 to 137 in four years. As for non-financial incentives, permitting a higher floor-to-area density was the most effective in Singapore; the government guaranteed 2% higher floor density for investors that met high environmental standards (Council, 2022) Incentives may also be indirect, such as reducing the taxes associated with importing environmentally friendly building materials. Until 2022, there were no incentives to ease the import process and costs for these materials in Palestine, according to the Green Buildings Council. Forms of direct and indirect incentives include:

Table 3.1 Forms of Direct and Indirect Incentives for Environmental Buildings Application (Saka et al., 2021)

Incentive Type	Form	Beneficiaries	Success
Rebates	The government gets many green sustainability or energy-efficient features and distributes them to beneficiaries within its authority at reduced prices. The government drops fees or offers refunds to beneficiaries for practical purchases that follow specified sustainability standards.	Investors + clients	The City of Charlottesville offers a green roof building permit fee reduction, providing a 50% discount on the building permit fee for the construction of green roofs in commercial, residential, and non-residential buildings within the city.
Special loans	Involves loans to beneficiaries for green-building improvements. The government uses advanced contracting means to incentivize green building practices—for instance, loans at reduced interest rates.	Investors + clients	Malaysia: loans for young clients of green building projects. Occupied Palestine: loans failed and resulted in a decreased desire to pay for green projects
Direct grants	A direct amount of money is available for renewable energy features. It pays off for high initial costs.	Investors + clients	Australia: non-residential building innovation fund Europe: 50% of cities offer direct grants for green roof installation Toronto: Grant up to 10$ Cdn/m^2 for green roof installation
Technical assistance	Supporting the green project's actual construction by providing staff.	Investors + clients	Not available
Eco-labeling	Generating valued premiums upon the green building environmental functionality and features to increase the market branding of investors and owners and their WTP.	Investors + clients	New Zealand uses eco-labeling
Density bonus	Expanded construction total area on the land, higher floors, reduction on landscaping requirements, and higher floor/area ratio (FAR).	Investors + clients + users + government	Singapore: 2% extra FAR Hong Kong: Additional gross floor area
Government awards	Rewards and compensations, prestige for beneficiaries for enhanced reputation.	Investors + researchers	Florida: annual green building award. USA + Hong Kong: awards for green building research.
Expedited permitting	Licensing green building design from its proposal and construction can start before the approval. Allowing faster development and earnings.	Investors	Australia: Green Door program for accelerating planning decisions for sustainable building proposals.

Demonstration projects	Provide experts for green building construction during all its phases or provide easy access to green materials. And creating green building prototypes for demonstration	Investors + government + labor and technicians	China: Heat pumps were installed in some buildings for demonstration purposes. Australia: Lochiel Park Sustainability Center to demonstrate efficient use of energy and water

Government incentives are crucial in promoting environmentally conscious construction practices among investors and their clients. These incentives build investor confidence in environmental investments and facilitate effective client marketing. Governments can implement various incentives for entire green buildings or specific components to incentivize and steer investments toward environmentally friendly constructions. This approach encourages clients to invest in eco-friendly properties, contributing to the community's overall well-being (Saka et al., 2021).

3.6 Cultural Aspect of Real Estate Investment in Palestine

This section introduces two primary cultural factors influencing environmental buildings: societal beliefs and awareness regarding environmental construction and associated costs. Additionally, the section addresses barriers associated with the implementation of environmental buildings.

3.6.1 Investors Beliefs Towards Environmental Buildings

The socio-economic evaluation of real estate investment behavior is predominantly qualitative. This evaluation entails a multifaceted assessment process encompassing the review of social policies, client and employee management, support mechanisms, occupant health and well-being, promotion of on-site safety, community impact, and community management (Alessandrini et al., 2022). Conversely, another assessment criterion involves specific factors to gauge investor behavior within the Palestinian real estate market. This encompasses prevalent construction strategies in Hebron City, material usage trends, labor dynamics, property marketing, and other elements influencing the city's real estate investment sector.

Real estate products require WTP from investors as well. Examining the environmental features investors are willing to pay for creates a more vital communication ground with their clients

(Kumah et al., 2022). Their beliefs regarding various aspects significantly influence investors' willingness to pay for green building features. Six primary factors affect investors' willingness to pay: economic, financial, political, technological and training, knowledge, and time-related barriers. Economic barriers are tied to investors' perceptions of the high costs of green buildings, concerns about limited demand in the market, and the restricted supply of expensive green materials. Financial barriers encompass the lack of financial support, high investment risks, and a scarcity of incentives. Political factors involve the absence of policies and regulations, a lack of building codes and regulations, and inadequate law enforcement. A lack of data and information on green buildings, a shortage of expertise and experienced labor, and insufficient technology impact technological factors. Investors also consider the knowledge (cultural) factor as a lack of public awareness and expertise. Finally, investors consider green building construction time-consuming (Ha et al., 2023b, Kumah et al., 2022, Prasetyawan et al., 2023). The previous barriers follow the PESTLE analysis, which considers factors impacting a particular decision (Kircher, 2022).

However, when these factors were deliberated in Palestine, it was affirmed by the Green Building Council (Council, 2022) that green building materials were available on demand in the Palestinian market. Additionally, a feasibility study for environmentally retrofitting a green building was proposed and implemented using green building materials. Financially, various funding entities have supported the implementation of green public buildings in Palestine; however, there is a lack of governmental incentives. Regarding political barriers, no policies or regulations are supporting environmental real estate. However, the political obstacles in Palestine go beyond that. Palestine has been under Israeli occupation for decades, and the land divisions and lack of available lands for building-oriented investors behavior into using every available meter of their land. The occupation also put restrictions on green resources and the application of environmental strategies. Nevertheless, Palestine has a green building code and regulations derived from international standards prepared by the Engineering Association in 2013 (Association, 2013). Referring to the proposed study by the Green Building Council (pages 50-52), many green building attributes require external experts for assessment and implementation, leading to increased costs.

Table 3.2 List of Barriers Affecting the Implication of Environmental Buildings (Ha et al., 2023b)

Factor	Barrier	Global Analysis	Palestine
Economic	High costs of green buildings	✓	✓
	Lack of market demand	✓	NA
	High green material price	✓	✓
	Limited supply of green materials	✓	×
Financial	Lack of financial support	✓	×
	High risk of investment	✓	NA
	Lack of incentives	✓	NA
Political	Lack of policies and regulations	✓	✓
	Lack of building codes and regulations	✓	×
	Lack of enforcement of law	✓	NA
	Occupation	invalid	✓
Technology and Training	Lack of database and information on green buildings	✓	✓
	Lack of expertise	✓	✓
	Lack of experienced labor	✓	✓
	Lack of technology	✓	NA
	Lack of professional personnel	✓	NA
Knowledge	Lack of public awareness	✓	NA
	Lack of knowledge of green buildings	✓	NA
	Lack of expert knowledge	✓	✓
Time	Time consumption is the barrier.	✓	NA

There remains an insufficient understanding of specific barriers hindering investors from engaging in environmental real estate in Palestine. As indicated in table 3.2 above, factors such as lack of market demand, high investment risk, absence of technology and professional personnel, inadequate public awareness, limited knowledge of green buildings, and time element remain unclear. Therefore, ongoing updates on the market are essential to comprehend the evolving dynamics of real estate implementation in Palestine.

3.6.2 Cultural Awareness About Initial Costs and Payback Periods

A significant cultural facet in the region involves comprehending the community's capacity to understand and embrace the equilibrium between initial costs and the potential acceptance of increased costs in favor of long-term operational cost reduction. Elevating awareness of terminology such as payback periods and Life Cycle Costing Analysis (LCCA) among investors and property owners poses a challenge in the Palestinian real estate investment market. However, this endeavor holds profound importance, particularly in constructing environmentally conscious office buildings, given that the investors and users of these buildings often diverge. The investment expenditures associated with green buildings were 6.5% higher in Europe and 20-25% higher in Jordan. Similarly, the additional investment cost in Indonesia amounted to 7.85% (Prasetyawan et al., 2023). However, there are no calculated expenditures regarding environmentally conscious

buildings in Palestine. If reasonable, figuring such a percentage could be critical in convincing investors of the affordability of environmental buildings and the relative LCCA.

Table 3.3 Initial Cost Increase for Environmental Buildings (Prasetyawan et al., 2023)

Country	Europe	Jordan	Indonesia	Palestine
Environmental investment expenditures	6.5%	20-25%	7.85%	NA

3.7 Conclusion

In conclusion, this chapter explored the intricate relationship between real estate economic considerations and socio-cultural influential factors. It theoretically underscored the multifaceted nature of constructing office buildings globally in the contemporary economic sector and the available data concerning Palestine, emphasizing the importance of Life-Cycle Cost (LCC) assessments for investors. These assessments, encompassing construction costs, operational expenses, and maintenance outlays, are essential for effective project marketing and eventual sales. The chapter extended beyond financial calculations to explore the environmental impacts of preliminary designs, highlighting the potential for energy cost savings and incentives from local authorities.

Furthermore, embracing the concept of corporate sustainability aligns with the Triple Bottom Line (TBL) approach. Key Performance Indicators (KPIs) are crucial tools for practical application within operational businesses, particularly in measuring human performance. The consistent evaluation of this human factor drives enhancements, leading to increased human satisfaction, higher returns, and improved economic performance. The correlation between the environmental performance of office buildings and occupant efficacy and productivity reinforces the significance of creating conducive and sustainable work environments within the broader corporate sustainability framework. Overall, this chapter provided a comprehensive framework for evaluating investment projects beyond financial metrics to encompass more general environmental and human factors.

Chapter 4

Methodology

4.1 Preface

The research methodology followed a structured sequence of steps to organize the entire framework effectively. It was structured into three primary sections: fieldwork phase 1, fieldwork phase 2, and researcher's validation. Each section comprised key stages meticulously followed in a well-organized process, contributing to the comprehensive structure of the final research. The first phase of fieldwork encompassed discussions on research type, data collection methods, the selection of the study context, and a detailed description of the study area. Phase 1 served as the foundation for phase 2. Relying on the information gathered in phase 1, phase 2 delved into outlining the implementation of each step using the PESTLE method (Political, Economic, Social, Technological, Legal, and Environmental), which justified the entire process encompassing networking, interviews, case study selection, and questionnaire distribution. The methodology concluded with the researcher's validation, achieved through comparative simulations, optimization techniques, and mathematical calculations. This validation aimed to either endorse or refute the feasibility of applying optimized preliminary design standards in the study context for future work. The fieldwork outcomes and the researcher's validation steps were subsequently proposed and discussed using the Lean Six Sigma method (Francescatto et al., 2022), as elaborated in this chapter's conclusion and recommendations' section. (Reference 4.2.1)

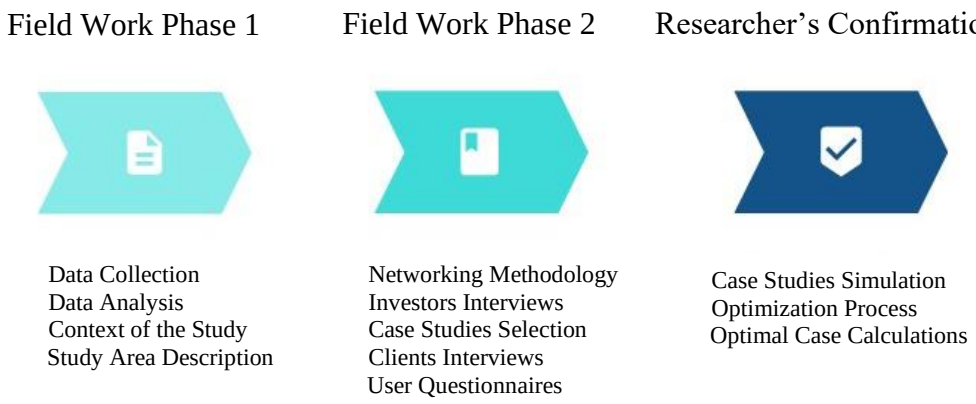


Figure 4.1 Methodology Framework

Aiming to answer the main and sub research questions, methodology structure was followed as briefly explained in table 4.1 below. The table discusses the contribution of each fieldwork output to the research until reaching the conclusion and recommendations of the research.

Table 4.1 Methodology Structure Implementation

Research Question	Fieldwork	Output	Contribution to Research
Where can investors' economic vision meet their clients' and the building's users' environmental needs?	Data collection	Stakeholders' definition	Knowing the names and entities associated with office real estate
	Networking	Stakeholders contact lists	Having contacts for stakeholders for interviews
	Interviews	Stakeholders point of view	Knowing the economic, technical and social considerations of stakeholders
	Cases selection	Offices	Used for simulations and questionnaires
	Users' questionnaires	Employees' perspective	Comparing what employees want to what investors want
	Simulations	Models for examined cases before and after edits	Needed preliminary designs for making the building environmental
	Calculations	Premium cost for environmental office buildings + payback period	Research question answered
Conclusion and Recommendations Extraction			
The premium cost is the acceptable by investors		The premium cost is higher than what investors would accept	
Extracting from interviews: the barriers behind abandoning the application of environmental office buildings (influential factors extraction)		Abandonment for applying environmental office buildings is justified by economic aspects	

4.2 Research Type and Data Collection Method

Through comparison, the study selected and justified the most suitable methods based on their availability and relevance to the local context, providing the practical work necessary to achieve results. The main aim was to answer the research questions and either prove or refute the proposed hypothesis of the research.

Practical work included office building surveys, case study selection, current case evaluation, validation, and simulation. Afterward, preliminary environmental design techniques for the same case were suggested, simulated, and cost-efficient investigated. Finally, the proposed results were subject to sociocultural evaluation to understand their applicability in Palestine. All the results obtained from the practical work were framed into a set of influential factors that affect the environmental office buildings investment implementation in Palestine, these influential factors

were designed for shaping the future of environmental buildings investment by influencing the decisions of key stakeholders and decision-makers.

Qualitative and quantitative approaches were used to collect and analyze this thesis's data. The quantitative method was used to measure the environmental performance of the case studies and then the proposed techniques, and also to quantify the cost of current investment behavior in Palestine and the increase in the initial costs when applying the suggested best environmental practice. The qualitative method was used to thoroughly understand the socio-cultural investment behavior in the Palestinian region. Subsequently, the equilibrium proposal was optimized, selected, and backed by justifications by combining all the results from the quantitative methodology under consideration of the qualitative framework results.

To create artificial models for the selected case studies, Design Builder software version 6.1 was used; this software was also used in the simulation process to understand the environmental performance before and after adjustments. Other information about the studied cases were collected through interviews, questionnaires, survey sheets, electricity bill data, and observation.

4.2.1 Data Analysis Method

The research methodology employed a comprehensive approach to gather and analyze data, ensuring a thorough investigation of environmental considerations in office buildings within the Palestinian market. Practical work involved the meticulous organization of field data, whether acquired through on-site observations and simulations, into extensive Excel sheets. These sheets were designed to systematically compare the existing investment behavior in the Palestinian market with the optimal investment practices, focusing on environmental data and their associated cost-related figures. This step was crucial for establishing a clear understanding of the current state of environmental investments in office buildings.

To complement the practical data, interviews were conducted with all stakeholders that affect the real estate investment process before and after implementation, then subsequently analyzed using Delve software. This qualitative aspect aimed to capture insights and perspectives from various stakeholders in the real estate sector, providing a nuanced understanding of the challenges and

opportunities related to environmental considerations. Delve software facilitated a structured analysis of the interview data, ensuring a thematic extraction of patterns and themes which were considered the influential factors for investment behavior in the final chapter.

In assessing the long-term feasibility of proposed edits and considering external factors, the study employed the Lean Six Sigma methodology. This approach extended the analysis beyond economic considerations, incorporating socio-cultural insights that influence investment behaviors. Lean Six Sigma method leverages the best problem-solving methods to help businesses achieve their missions while satisfying customers. This process encompasses a sequence of steps that involve defining the influential factors that cause the problem or directly affect results implementation positively or negatively, and then measuring their impact. Measuring the influential factors impact means quantifying the effect of each on the process. The analysis step comes afterwards, where each influential factor is isolated, analyzed, and associated with the responsible stakeholder or team player. The final steps of Lean Six Sigma process are to smoothly improve and control business operations, to insure better performance and less defects in the future. This process is also known as the DMAIC process, define, measure, analyze, improve, and control (Tengtarto et al., 2023).

By applying Lean Six Sigma on PESTLE factors, the research sought to identify and understand the broader impacts of political, economic, social, technological, legal, and environmental aspects on the investment decision. This holistic analysis allowed for a more comprehensive evaluation of the results, enabling the formulation of recommendations that considered the dynamic interplay of various factors.

In summary, the research methodology integrated practical data analysis, qualitative insights from interviews, and a systematic examination of long-term feasibility using Lean Six Sigma and PESTLE analysis. This multifaceted approach aimed to provide a robust foundation for understanding the current state of environmental investments in Palestinian office buildings, extracting valuable insights, and formulating informed recommendations for future practices.

4.2.2 Context of the study selection criteria

The selection of the study context in Palestine was underpinned by several criteria. The research context aligned with the researcher's accessibility, providing direct and practical engagement with the field. The geographical proximity facilitated on-site data collection, enabling firsthand observations and interactions with key stakeholders involved in the real estate sector in Palestine. This proximity was essential for fostering deep understanding of the local dynamics, challenges, and opportunities associated with environmental investments in office buildings. Furthermore, the choice of Palestine, specifically Hebron City, as the study context was driven by the availability of data and information facilitated through governmental entities and municipalities. The researcher was able to leverage existing partnerships or collaborations with these entities, ensuring access to comprehensive datasets, regulatory frameworks, and pertinent documentation. This access is critical for conducting a thorough investigation into the current state of environmental investments, understanding existing policies, and identifying potential areas for improvement.

The unique socio-cultural and political context of Hebron City added a distinctive dimension to the research. Examining environmental office buildings in this context allowed for an exploration of how local factors, and cultural influences shape investment behavior. Understanding these nuances is vital for developing targeted and context-specific recommendations that align with the socio-cultural fabric of Palestine.

By focusing on a region with its own set of challenges and opportunities, the research became a valuable addition to the broader conversation on balancing economic considerations with environmental sustainability in diverse contexts.

4.3 Field Work Methodology and Implementation Process

All sections under this title follow the PESTEL analysis methodology (Political, Economic, Sociological, Technological, Legal, and Environmental), and each section aims to cover one or more points of the analysis (Kircher, 2022).

4.3.1 Networking Methodology

Networking methodology was used to identify possible contacts necessary for problem confirmation, data gathering, and case study selection. The networking process was distributed over five subsequential steps, as in figure 4.2.

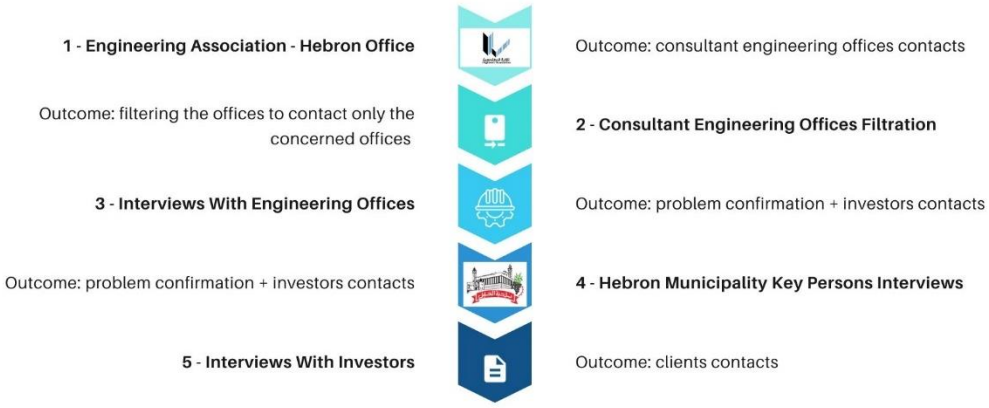


Figure 4.2 Networking Steps

1. Engineering Association – Hebron Office

A visit was conducted to Engineering Association in order to collect all the consultant engineering offices' data in Hebron. Collected data included office names, locations, and contact numbers. This step served as the first step in the networking process as the Engineering Association has the list of consultant engineering offices that are allowed to license larger building areas.

2. Consultant Engineering Offices Filtration Criteria

Criteria was established to identify the offices that license and design office buildings. Criteria include:

- Licensed office buildings during the last ten years (2013 – 2023)
- Licensed two or more office buildings in the mentioned period

These criteria were put to filter the engineering offices that have enough expertise with the ongoing investment behavior and patterns in the context.

3. Interviews with Engineering Offices

Once the engineering offices meeting the earlier criteria have been pinpointed, the next phase involved contacting a random sample from this group. This contact aimed to arrange in-person interviews with the office's chief engineers; all interviews were voice-recorded. These interviews confirmed the research problem and assured the gap between investors economic needs and user's environmental preferences. The interviews also helped establishing initial connections with potential investors for subsequent stages. The interview process concluded when investors' names began to duplicate. Interviews with engineering offices were semi-structured interviews with the following questions:

- How informed are you about the basic needs for buildings to be environmental and their impact on users?

This question is intended to gain insight into the role of engineering offices in disseminating essential environmental awareness to potential investors. It also seeks to identify whether any existing investment-related issues in office buildings can be attributed to engineers or investors. (Technological aspect of PESTEL analysis)

- How far are the current Palestinian office's real estate patterns from the basic environmental needs?
    - Please explain the current wall layers and thermal insulation.
    - Please explain current ventilation standards (natural/ HVAC).
    - Please explain current daylight considerations.
    - Please explain current sunray building exposure.

This question aims to gain a deeper understanding of the actual circumstances of office buildings within the study's context. It is employed to validate or refute investors' responses in subsequent stages. (Sociological and environmental aspects of PESTEL analysis)

- Kindly provide the names of investors involved in real estate investments related to office buildings with whom you are familiar, have had dealings, or have been designing their projects.

This question is for investors' networking aims. (Economic aspect of PESTEL analysis)

4. Hebron Municipality Key Persons Interviews

Face-to-face, voice-recorded interviews with key persons at Hebron Municipality were needed to validate the results of the interviews conducted with the engineering offices. The purpose of these interviews is twofold: firstly, to corroborate the findings from the prior step and verify the contacts with potential investors. Secondly, these interviews highlight the municipality's role in the environmental building's licensing process.

Interviews with Hebron Municipality key persons were semi-structured interviews with the following questions to cover the Political and legal aspects of PESTEL analysis:

- Kindly explain the current construction patterns in Hebron and the government's role in addressing the environmental needs of office buildings during the licensing stage.

This question is to investigate the current situation of office real estate in Hebron and better understand the political and legal role in the process.

- How do you read investors' current tendency for basic environmental needs in their buildings?

This question aims to confirm the previous data collected from engineering offices about Hebron's real estate investment behavior.

5. Interviews With Investors – Networking Section

The contacted investors for clients' networking went through the triangulation filtration method as the Engineering Association, Hebron Municipality concerned departments, and engineering offices confirmed their names. Nominated investors went through specific filtration criteria through a small direct interview to assure relevancy and achieve the shortlisted contacts for connection. Phone questions were:

- Do you own office buildings in Hebron? (to confirm relevancy)
- Was any of these buildings licensed after 2013?

Contacted investors were the investors who approved their willingness to cooperate with the researcher, give the needed information and contacts, and conduct building visits when required. Each shortlisted investor for the in-person interview was then requested to furnish a list of clients who had purchased office spaces through their real estate as part of the networking process.

4.3.2 Investors Interviews

Semi-structured interviews were conducted with investors. The interviews were in-person sessions, and mobile voice recording was utilized to document the discussions. Thematic analysis using Delve software was then used to create themes relative to the research questions and propose the collected data from the interviews.

Table 4.2 Investors Interview Questions and Their Objectives

Question Number	Interview Main Question	Sub-Questions | Notes	Question Objective
1	How informed are you about the basic needs for buildings to be environmental and their impact on users?	Please note that environmental buildings' primary considerations include internal environment air quality through good ventilation standards, interior thermal comfort that can be achieved via good thermal insulation, natural daylight, and exposure to sun rays.	To investigate the investor's awareness of the building's basic environmental needs. To proceed with the interview questions and obtain accurate relative answers.
2	How far are your current real estate investment patterns from the basic environmental needs?	Please explain the current wall layers and thermal insulation.	To know the current construction status in Hebron. To understand which basic environmental needs investors consider the most when constructing and which they neglect. To confirm or refute engineering offices' answers
		Please explain current ventilation standards (natural/ HVAC).	
		Please explain current daylight considerations.	
		Please explain the current sunray exposure.	
3	How much will the initial construction costs of the building be to make it environmentally acceptable for your investment?	How will your answer be affected knowing that environmental buildings guarantee enhanced resale or rental values and higher return on investment?	To validate the outcome from the initial cost calculations process and their applicability.
		How will your answer be affected knowing these initial costs are delivered to your clients?	
		How will your answer be affected by municipality and governmental incentives and tax credits?	
4	how much increase on the investment payback period is considered acceptable for you?		To validate the outcome from the payback period calculations process and their applicability.

4.3.3 Buildings and Offices Selection Process

This process encompassed the essential steps for selecting buildings and offices samples needed for hypothesis examination.

1. Office Buildings Survey

A satellite survey was conducted to locate the related buildings in the wanted investigation category. The selected satellite survey limit was based on the data gathered from investor interviews. This survey was done with the help of the GIS department in Hebron Municipality to allocate all the buildings licensed under the commercial-administrative category with the maximum height of floors in the selected study zone.

To limit the number of buildings, categorization based on their licensing year was made with the Buildings Department's help in Hebron Municipality. Only licensed buildings after 2010 were picked; after The Second Intifada ended in 2005, the construction patterns started taking new approaches and behaviors.

Building selection followed specific criteria:

- Located in the selected zone, the study is limited to.
- Licensed under the commercial-administrative or office building category.
- Licensed after 2010.
- Available investor for interviewing.
- Operating years 5-10 years.

2. Cases Deep Investigation

This step aims to investigate all the shortlisted buildings inside the selected buildings after applying the previous filtration, remove undesired buildings from the survey, and narrow down the number of cases to the essential minimum. The elimination process was through building' visits and followed specific criteria:

- Available Drawings.
- Occupancy rate exceeds 60%.
- Common construction patterns in the study area.

With the buildings chosen and architectural plans acquired, the next step involved the identification of specific offices within these buildings for in-depth examination and establishing connections with clients and users. Site visits to the selected buildings were conducted to assess all available office spaces systematically. A comprehensive building survey sheet was utilized for this purpose, featuring essential information for the final selection of office case studies. This information encompassed:

- Floor, operating office number, each office function/ job
- Offices orientation

3. Cases' Selection

This phase is essential to specify the selected offices of the studied buildings. This step intersected with investor interviews and buildings survey visits. Each investor was asked to provide clients' contacts, and the field survey specified the ones located on different floors (first, middle, and highest floors) and four different orientations on each floor.

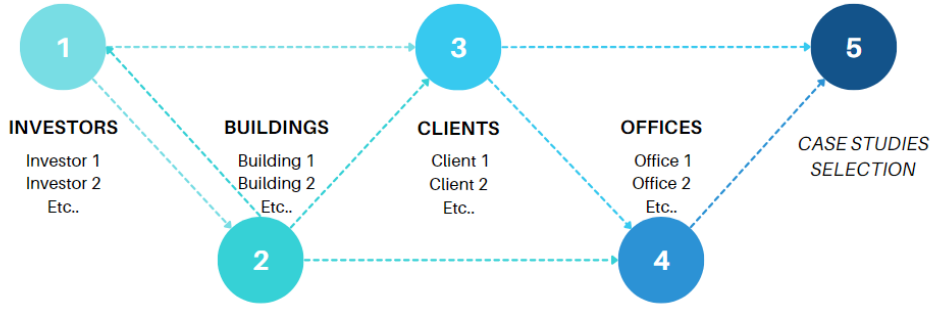


Figure 4.3 Intersection of Case Studies Selection

Several office owners were then contacted and interviewed, and based on their response's cooperation, availability, and specific criteria; the final examined offices were selected. The whole process for case study selection is clarified in the figure.

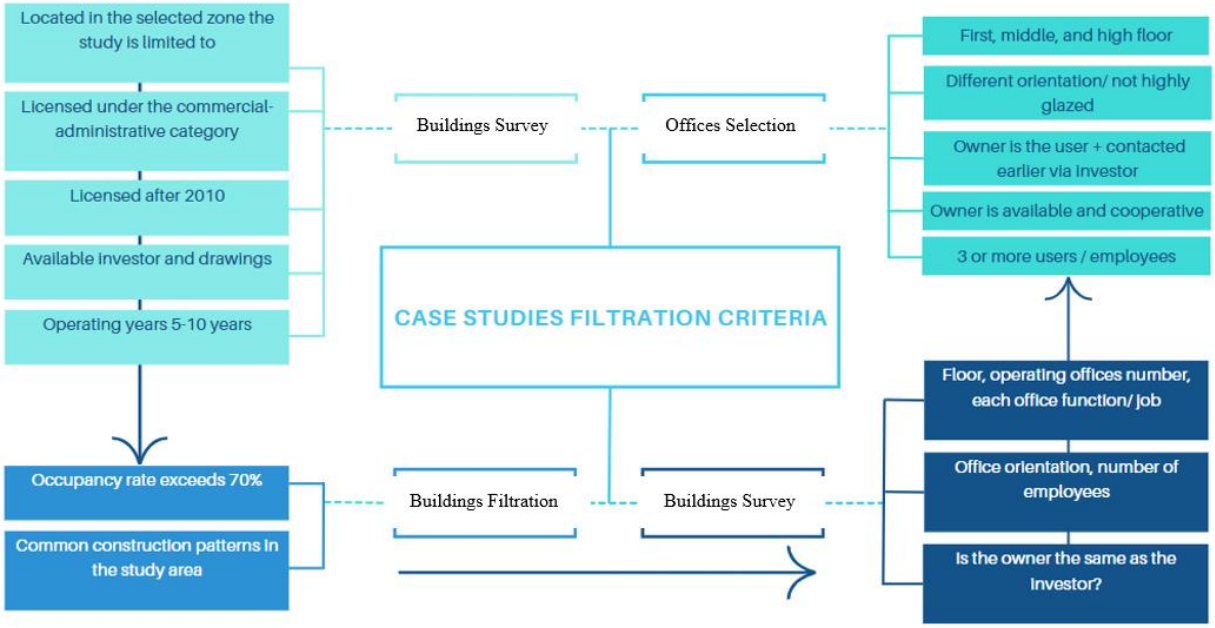


Figure 4.4 Case Studies Filtration Process

4.3.4 Clients Interviews

The process of selecting clients was closely linked to the chosen case studies. Interviews were conducted with the owner of each case, as well as individuals recommended by investors for their willingness to cooperate and availability. Semi-structured interviews with clients took place in-person, and mobile voice recording was employed to capture the discussions. The obtained recordings were thematically analyzed using Delve Software.

Table 4.3 Clients Interview Questions and Their Objectives

Question Number	Interview Main Question	Sub-Questions | Notes	Question Objective
1	How informed are you about the basic needs for buildings to be environmental and their impact on users?	Please note that environmental buildings' primary considerations include internal environment air quality through good ventilation standards, interior thermal comfort that can be achieved via good thermal insulation, natural daylight, and exposure to sun rays.	To investigate the clients' awareness of the building's basic environmental needs. To proceed with the interview questions and obtain accurate relative answers.
2	How far are your current real estate properties from the basic environmental needs	Please explain what basic environmental needs you consider when owning a new real estate property.	To confirm the investors' answers To understand which basic environmental needs clients consider the most when purchasing offices and which they neglect.
		Please explain current ventilation techniques (natural/ HVAC).	
		Please explain the current daylight satisfaction.	
		Please explain the current sunray exposure in your property.	
3	How much higher is the initial real estate price acceptable for you?	How will your answer be affected knowing that environmental buildings guarantee less energy consumption and enhanced rental prices?	To validate the outcome from the real estate price calculations process
		If you are not an office user, how will your answer be affected if these initial costs were delivered to property users (energy bills)?	
		How will your answer be affected knowing that environmental buildings guarantee higher employee productivity rates, higher retention rates, lower absenteeism rates, better talent attraction and recruitment, and better employee satisfaction?	
4	How much increase on the real estate price payback period is considered acceptable for you?		To validate the outcome from the payback period calculations process and their applicability.

4.3.5 Users Questionnaires

Questionnaires were conducted to the users of the selected case studies to assess several benchmarks related to office users. Key metrics included the employees' awareness of their environmental needs, satisfaction, the impact of each environmental consideration on their performance when examined in isolation, and the current work environment situation within the study context to have an estimation of the social costs associated with poor indoor environmental

quality in the workplace. The questionnaire was structured into five sections, each intended to address a specific aspect.

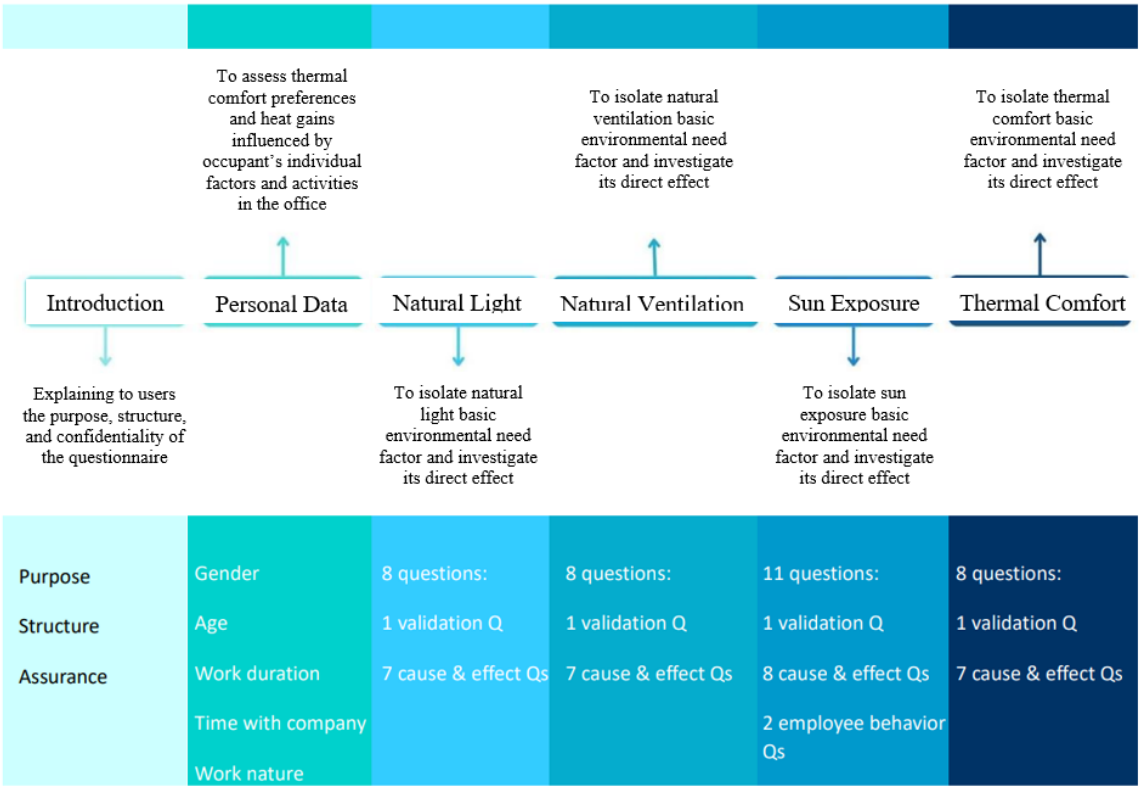


Figure 4.5 Questionnaire Structure

Collecting general personal data was essential to identify variations in thermal comfort preferences within a given case, primarily stemming from individual factors such as age, gender, and health, while also aiding in the assessment of heat gains generated by occupants during their occupancy, influenced by their activities and the devices they utilize. The last four sections of the questionnaire isolated the effect of each basic environmental need on employee satisfaction, overall performance, work productivity, retention rate, general mental and physical health, and workplace evaluation.

The variation between male and female responding employees was proposed earlier in 2022 by The Palestinian Central Bureau of Statistics (PCBS). The "rate of female participation in the labor force was 18.6% compared to 70.7% for males" (PCBS, 2022). The responses were analyzed using Excel sheets regarding employee satisfaction, employee financial and environmental preferences,

and performance in the work environment. After proposing the analysis regarding each case study, another general analysis for employees in Hebron was held. The general analysis helped create a pattern of the working environment in Hebron City.

Table 4.4 Questionnaire Section 1 Questions

Section 1 | General Personal Data					
Question		**Answer Options**			
Q1	Gender	Male		Female	
Q2	Age	22-30	31-40	41-50	51 and more
Q3	Work duration	Eight or less	9	10	Ten and more
Q4	Employment duration in the company	0-1 years	1-3 years	3-5 years	More than five years
Q5	Work nature	Filled by employee			
*Q: Question					

Question 1: Gender. Research indicates that females typically prefer slightly higher temperatures, about one °C, due to their lower skin temperature and greater physiological sensitivity to cooler environments. At the same time, males tend to be more sensitive to warmer conditions. Gender is used to identify answer variations in the questionnaire as thermal individual differences and establish the baseline model's metabolic rate (Chang and Kajackaite, 2019).

Question 2: Age, age can also play a role in identifying thermal individual differences, as research indicates that older individuals tend to be more sensitive and experience less comfort in colder conditions compared to younger people (Schweiker et al., 2018, Wang et al., 2018).

Question 3: Work duration; this question serves as input for the base model, which computes the heat gains generated during the workday and various other parameters, including the operation of lighting and HVAC systems. Previous studies indicated that people feel indoor air temperatures differently during the day (Vellei et al., 2021).

Question 4: Work duration in the company, gaining insight into an employee's length of service, offers valuable historical context, enabling more understanding if their feedback is objective (Schluer et al., 2023).

Question 5: Work nature: This question helps create the base model by filling in data related to the characteristics of the employees' tasks and workplace to ascertain their metabolic rate and identify the equipment utilized, such as computers, printers, and more.

Section 2 involves direct questions about natural daylight in the examined office from an employee's perspective to help investigate the awareness of their natural daylight needs amongst office building users. Moreover, natural daylight section questions also help understand the importance of daylight for employees as an isolated basic environmental need in buildings, to provide a thorough review of energy consumption patterns in offices concerning lightening comfort and also study the effect of natural daylight on the company's social costs regarding productivity and retention rates. Each question was designed to serve the specific purpose of impact and cause. The effect in all questions in this section is fixed, natural daylight. The effect varies upon each question as follows:

Table 4.5 Questionnaire Section 2 Questions

Section 2 | Natural Light						
Question		**Answer Options**				
Q1	Natural daylight in the office is good and enough	Strongly agree	agree	neutral	disagree	Strongly disagree
Q2	I depend on natural light more than artificial lightening	Strongly agree	agree	neutral	disagree	Strongly disagree
Q3	I can work in an office without daylight	Strongly agree	agree	neutral	disagree	Strongly disagree
Q4	Daylight absence from the office affects my work productivity	Strongly agree	agree	neutral	disagree	Strongly disagree
Q5	Daylight absence from the office is a reason I am considering searching for another workplace	Strongly agree	agree	neutral	disagree	Strongly disagree
Q6	I would change my workplace to another with natural light, even with a salary	Strongly agree	agree	neutral	disagree	Strongly disagree
Q7	Daylight absence from the office affects my general mental and physical health	Strongly agree	agree	neutral	disagree	Strongly disagree
Q8	Daylight absence from the office directly affects my general workplace evaluation	Strongly agree	agree	neutral	disagree	Strongly disagree
*Q: Question						

Question 1,2: Natural daylight in the office is good enough; I depend on natural light more than artificial light. These questions directly offer the occupants' perception and evaluation of natural daylight levels and their requirements for artificial lighting. Question 2 validates question 1.

Question 3: I can work in an office without daylight. Understanding how comfortable employees are with working in a windowless office space is crucial for assessing overall workplace satisfaction.

Question 4: Daylight absence from the office affects my work productivity. This question can help assess whether employees are concerned about potential impacts on their productivity and mood when working in spaces with limited daylight.

Question 5: Daylight absence from the office is why I am considering searching for another workplace. High turnover due to factors like the absence of daylight can result in increased recruitment and training costs (social costs) (Taborosi et al., 2023). This question helps read social costs that are directly related to natural daylight.

Question 6: I would change my workplace to another with natural light even with less salary. This question provides insights into what factors are most important to employees. It justifies initial costs to offer naturally lit work environments in return for social costs and competitive advantage in talent acquisition.

Question 7: Daylight absence from the office affects my general mental and physical health. Employee health is closely tied to productivity and performance, as psychological and physical health causes higher absence rates (Banjade et al., 2023). This question studies the direct effect of natural daylight on employee’s general health.

Question 8: Daylight absence from the office directly affects my general workplace evaluation. This question provides insights into how important natural light is for employees' satisfaction with their work environment.

The next section of the questionnaire is concerned with studying natural ventilation and indoor air quality. It employs questions to understand employee’s awareness of their work environment and indoor air quality preferences. Section 3 also examines natural ventilation, the importance of basic environmental needs for employees as an isolated factor, and its effect on the company’s total energy consumption behavior and social costs. Each question was designed to serve the specific purpose of impact and cause. The impact in all questions in this section is fixed, natural ventilation. The effect varies upon each question as follows:

Table 4.6 Questionnaire Section 3 Questions

Section 3 | Natural Ventilation						
Question		Answer Options				
Q1	Natural ventilation in the office is good and enough	Strongly agree	agree	neutral	disagree	Strongly disagree
Q2	I depend on natural ventilation more than mechanical ventilation	Strongly agree	agree	neutral	disagree	Strongly disagree
Q3	I can work in an office without natural ventilation	Strongly agree	agree	neutral	disagree	Strongly disagree
Q4	Natural ventilation absence from the office affects my work productivity	Strongly agree	agree	neutral	disagree	Strongly disagree
Q5	Natural ventilation absence from the office is a reason I am considering searching for another workplace	Strongly agree	agree	neutral	disagree	Strongly disagree
Q6	I would change my workplace to another with natural ventilation even with a salary	Strongly agree	agree	neutral	disagree	Strongly disagree
Q7	Natural ventilation absence from the office affects my general mental and physical health	Strongly agree	agree	neutral	disagree	Strongly disagree
Q8	Natural ventilation absence from the office directly affects my general workplace evaluation	Strongly agree	agree	neutral	disagree	Strongly disagree
*Q: Question						

Question 1, 2: Natural ventilation in the office is good enough; I depend more on natural ventilation than mechanical ventilation. These questions directly offer the occupants' perception and evaluation of natural ventilation levels and their requirements for other ventilation techniques. Question 2 validates question 1.

Question 3: I can work in an office without natural ventilation. Understanding how comfortable employees are with working in an office space that doesn’t provide natural ventilation and regular indoor air change is crucial for assessing overall workplace satisfaction.

Question 4: Natural ventilation absence from the office affects my work productivity. This question can help assess whether employees are concerned about potential impacts on their productivity and mood when working in spaces without changing indoor air.

Question 5: The absence of natural ventilation from the office is why I am considering searching for another workplace. This question helps read the economic and social expenses companies pay that are directly related to natural ventilation.

Question 6: I would change my workplace to another with natural ventilation, even with a lower salary. This question offers a glimpse into whether natural ventilation is a critical factor that holds the most significant importance for employees.

Question 7: Natural ventilation absence from the office affects my mental and physical health. This question studies the direct effect of natural ventilation and indoor air quality on employees' general health and, thus, the company's social costs.

Question 8: Natural ventilation absence from the office directly affects my general workplace evaluation. This question provides insights into how crucial natural ventilation is for employees' satisfaction with their work environment.

Similar to the preceding sections, Section four explores the impact of exposure to sunlight, a basic environmental requirement, as a significant factor influencing employee work performance and the evaluation of their work environment, as outlined below:

Table 4.7 Questionnaire Section 4 Questions

Section 4 | Sunrays Exposure						
Question		Answer Options				
Q1	Sun exposure in the office is good and enough	Strongly agree	agree	neutral	disagree	Strongly disagree
Q2	I need sun rays daily in the office	Strongly agree	agree	neutral	disagree	Strongly disagree
Q3	I can work in an office without sun exposure	Strongly agree	agree	neutral	disagree	Strongly disagree
Q4	One or more office walls suffer from humidity issues	Strongly agree	agree	neutral	disagree	Strongly disagree
Q5	Sun exposure absence from the office affects my work productivity	Strongly agree	agree	neutral	disagree	Strongly disagree
Q6	Sun exposure absence from the office is a reason I consider searching for another workplace	Strongly agree	agree	neutral	disagree	Strongly disagree
Q7	I would change my workplace to another with sun exposure, even with a salary	Strongly agree	agree	neutral	disagree	Strongly disagree
Q8	Sun exposure absence from the office affects my general mental and physical health	Strongly agree	agree	neutral	disagree	Strongly disagree
Q9	Sun exposure absence from the office directly affects my general workplace evaluation	Strongly agree	agree	neutral	disagree	Strongly disagree
Q10	I visit my coworker's sun-exposed offices to feel comfortable during work hours	Strongly agree	agree	neutral	disagree	Strongly disagree
Q11	I go out of the building to gain sun exposure	Strongly agree	agree	neutral	disagree	Strongly disagree
*Q: Question						

Question 1: Sun exposure in the office is good and enough. This question directly offers the occupants' perception and evaluation of sunray levels in the office.

Questions 2 and 3: I need sun rays daily in the office; I can work in an office without sun exposure. These questions help assess whether employees perceive daily sun rays as essential for their well-being and job performance.

Question 4: One or more office walls suffer from humidity issues. This question validates question 1 by assuring whether the office is sufficiently exposed to sun rays or not since lack of sunray exposure causes humidity, which might cause mold that directly affects employees' general health, as reported by the World Health Organization (WHO) (Afshari et al., 2009)

Question 5: Sun exposure absence from the office affects my work productivity. This question can help assess whether employees are concerned about potential impacts on their productivity and mood when working in spaces without exposure to the sun.

Question 6: Sun exposure absence from the office is why I am considering searching for another workplace. This question helps read companies' economic and social expenses for sun exposure.

Question 7: I would change my workplace to another with sun exposure, even with a lower salary. This question offers a glimpse into whether sun exposure is a critical factor that holds the most significant importance for employees.

Question 8: Sun exposure absence from the office affects my mental and physical health. This question studies the direct effect of sun exposure on employee's general health and, thus, the company's social costs.

Question 9: Sun exposure absence from the office directly affects my general workplace evaluation. This question provides insights into how vital sun exposure is for employees' satisfaction with their work environment.

Questions 10 and 11: I visit my coworker's sun-exposed offices to feel comfortable during work hours; I go out of the building to gain sun exposure. These two questions validate question 5 as they indicate whether the lack of sun exposure in the office causes employees to leave their desks and thus have fewer working hours and less productivity.

As in the previous sections of the questionnaire, section 5 investigates the effect of thermal comfort in the office on different aspects regarding companies' economic and social costs as follows:

Table 4.8 Questionnaire Section 5 Questions

Section 5 | Thermal Comfort						
Question		Answer Options				
Q1	I feel comfortable with the office's thermal conditions	Strongly agree	agree	neutral	disagree	Strongly disagree
Q2	I depend on HVAC to achieve thermal comfort in the office	Strongly agree	agree	neutral	disagree	Strongly disagree
Q3	I can work in an office that is not thermally comfortable	Strongly agree	agree	neutral	disagree	Strongly disagree
Q4	Lack of thermal comfort in the office affects my work productivity	Strongly agree	agree	neutral	disagree	Strongly disagree
Q5	Lack of thermal comfort in the office is a reason I consider searching for another workplace	Strongly agree	agree	neutral	disagree	Strongly disagree
Q6	I would change my workplace to a more thermally comfortable office even with less salary	Strongly agree	agree	neutral	disagree	Strongly disagree
Q7	Lack of thermal comfort in the office affects my general mental and physical health	Strongly agree	agree	neutral	disagree	Strongly disagree
Q8	Lack of thermal comfort in the office directly affects my general workplace evaluation	Strongly agree	agree	neutral	disagree	Strongly disagree
*Q: Question						

Question 1, 2: I feel comfortable with the office's thermal conditions; I depend on HVAC to achieve thermal comfort. These questions directly provide an understanding of the occupants' perception and evaluation of indoor thermal comfort levels and their requirements for other techniques to attain suitable indoor temperatures. Question 2 validates question 1.

Question 3: I can work in a thermally uncomfortable office. It aims to understand how satisfied employees are working in an office space that isn't thermally comfortable, which is crucial for assessing overall workplace satisfaction.

Question 4: Lack of thermal comfort in the office affects my work productivity. This question can help assess whether employees are concerned about potential impacts on their productivity and mood when working in spaces with unsatisfying thermal conditions.

Question 5: The lack of thermal comfort in the office is why I am considering searching for another workplace. This question helps read companies' economic and social expenses for thermal comfort.

Question 6: I would change my workplace to a more thermally comfortable office, even with a lower salary. This question offers a glimpse into whether thermal comfort is a key factor that holds the most significant importance for employees.

Question 7: The lack of thermal comfort in the office affects my mental and physical health. This question studies the direct effect of thermal comfort on employee's general health and, thus, the company's social costs.

Question 8: Lack of thermal comfort in the office directly affects my general workplace evaluation. This question provides insights into how crucial thermal comfort is for employees' satisfaction with their work environment.

4.4 Researcher's Confirmation

This step intends at building the case studies' models to simulate the actual situation of the internal environment in the offices and simulate the effect of every preliminary design edit. The utilization of Design Builder software version 6.1 for simulating the internal environment in the offices was essential in constructing the models for the case studies. The software was selected for researcher's familiarity and its capabilities in providing a robust and reliable platform for environmental simulation, ensuring a thorough examination of the internal environment factors within the offices.

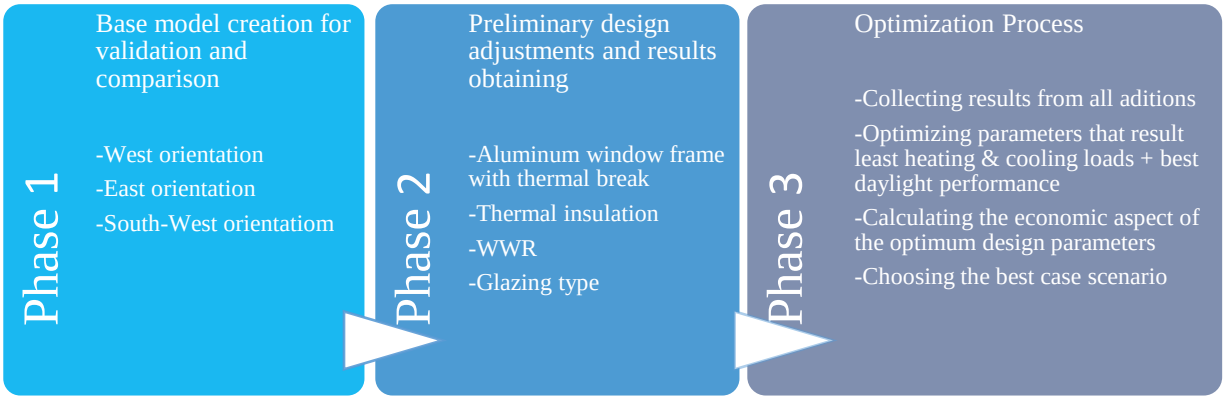


Figure 4.6 The Three Phases of Researcher's Confirmation Process

Phase 1 involved utilizing data collected through observational research and completed datasheets to validate the built models for each office. The primary objective was to acquire environmental readings for comparison with questionnaire results and environmental standards outlined in Chapter 2. Validation occurred through electricity bills, comparing the average annual energy cost per square meter with simulated base case results.

In Phase 2, the validated base model was used to create another model with energy loads aimed at achieving optimal internal environmental standards. The theoretical standards from Chapter 2 guided the process, and preliminary design parameters were added to observe changes in heating and cooling loads and daylight factors necessary to meet the desired standards.

Phase 3 encompassed a computerized parametric process using Design Builder software version 6.1. Excel sheets were used to post the results for each design edit, selecting scenarios to minimize heating and cooling loads while comparing them with optimal daylight factor distribution. Computerized optimization using Design Builder software version 6.1 followed these steps. Economic optimization followed to determine the preliminary design that was both environmentally and economically optimal.

- Base Model Creation and Preliminary Design Edits

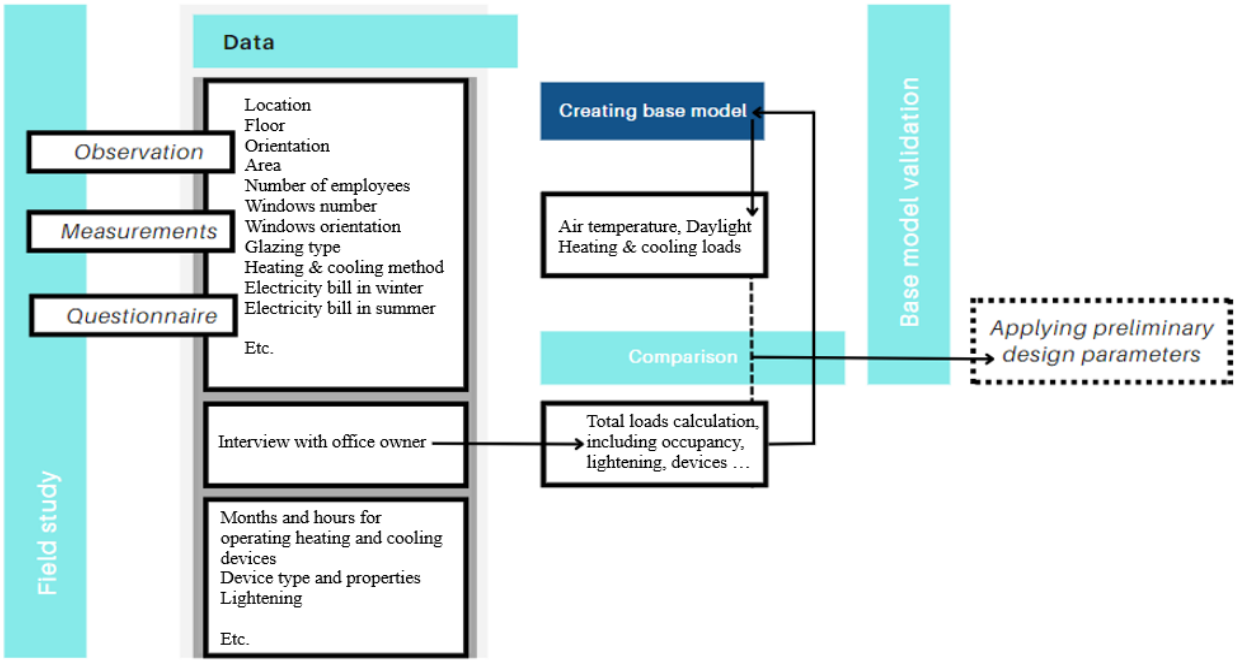


Figure 4.7 Base Model Creation and Validation Process

This step started with creating the base model for the chosen buildings with all the environmental considerations, the weather data file used was the available 2002 weather data file for Jerusalem Airport. Attached in the appendices is the data used to create each base model. The step is then followed by preliminary design edits and obtaining their environmental improvements data.

Selected edits to the base models were implemented as preliminary designs to attain the best-case scenario for basic environmental needs, including thermal comfort, and daylight. The standards for office buildings were previously outlined in Chapter 2. To meet these standards, locally available solutions in the Palestinian market, particularly the most commonly employed ones, were applied. Results obtaining from this phase encompassed two consequent steps. The first step was to obtain each edit's effect on the interior environmental quality (IEQ), air temperatures, daylight, and heating and cooling loads. The second step was to measure these results by sequential application of the edits and applying parametric analysis to obtain all probable scenarios. All results were posted and analyzed using Excel sheets to measure the annual effect by suitable units and percentages.

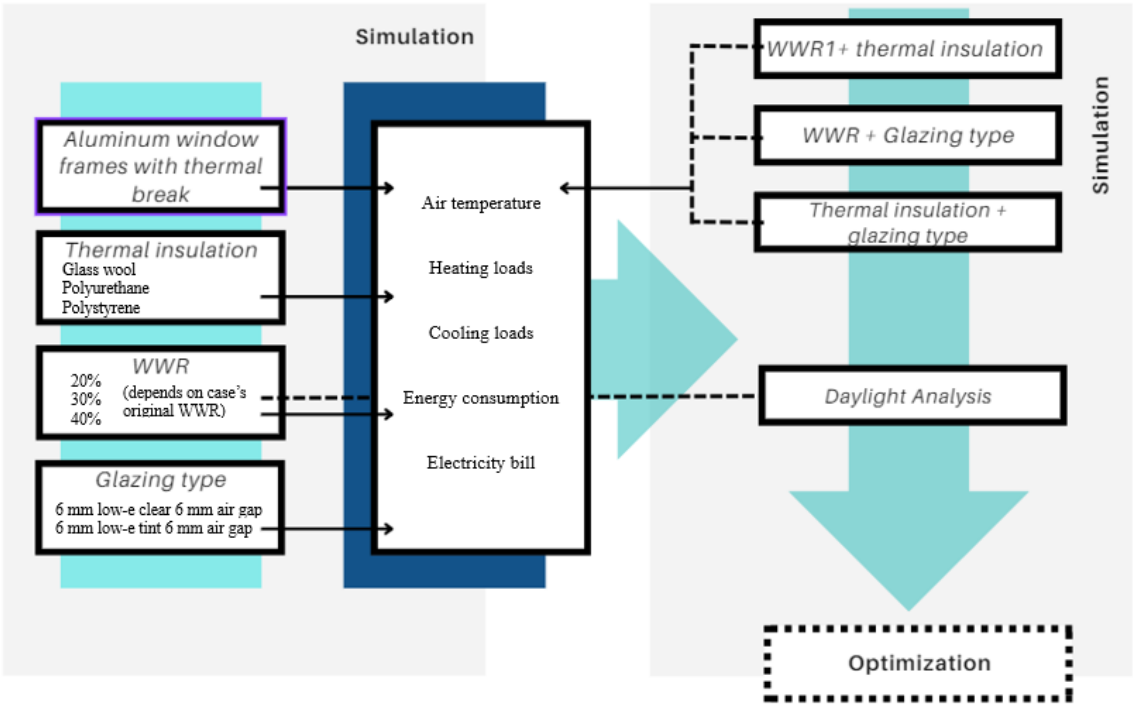


Figure 4.8 Preliminary Design Edits and Simulation

- Optimization Process – Environmental and Economic Optimization

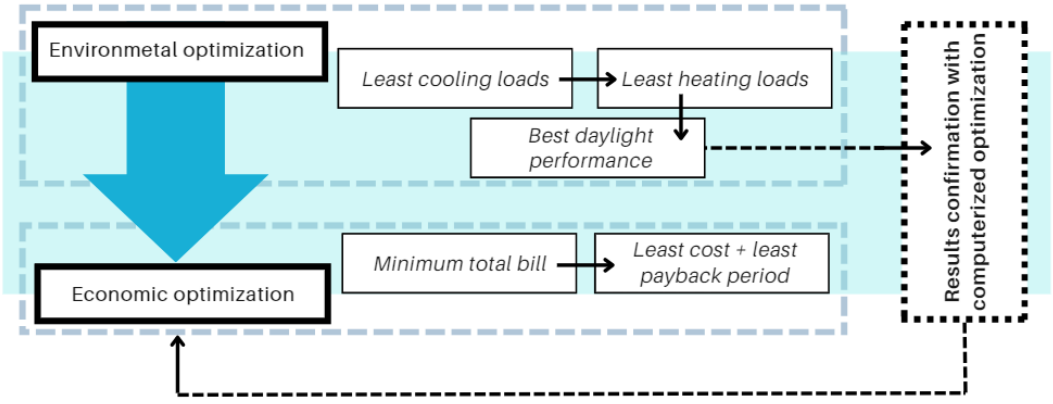


Figure 4.9 Optimization Process

This phase involved a triangular optimization method. It commenced with computerized parametric analysis of environmental parameters solely. The next step involved optimizing these outcomes through computerized simulations, prioritizing those leading to minimal cooling loads, followed by minimizing heating loads, and ultimately comparing them with the optimal daylight analysis for the selected scenarios. The results underwent economic analysis to derive figures related to total costs and payback period. The preferred preliminary design parameters were those yielding the lowest total annual electricity bills through reductions in heating and cooling loads, along with lighting loads. The parameters with the shortest payback period were then recommended in the final results as the researcher's suggested model for office buildings, along with their associated costs.

4.5 Conclusion and recommendations Discussion Method

Real estate, being a business, necessitates the application of business analysis tools for optimal outcomes across its various stages. The Lean Six Sigma methodology proves invaluable in business by extracting recommendations from any given situation and presenting them to the relevant departments for proactive problem management.

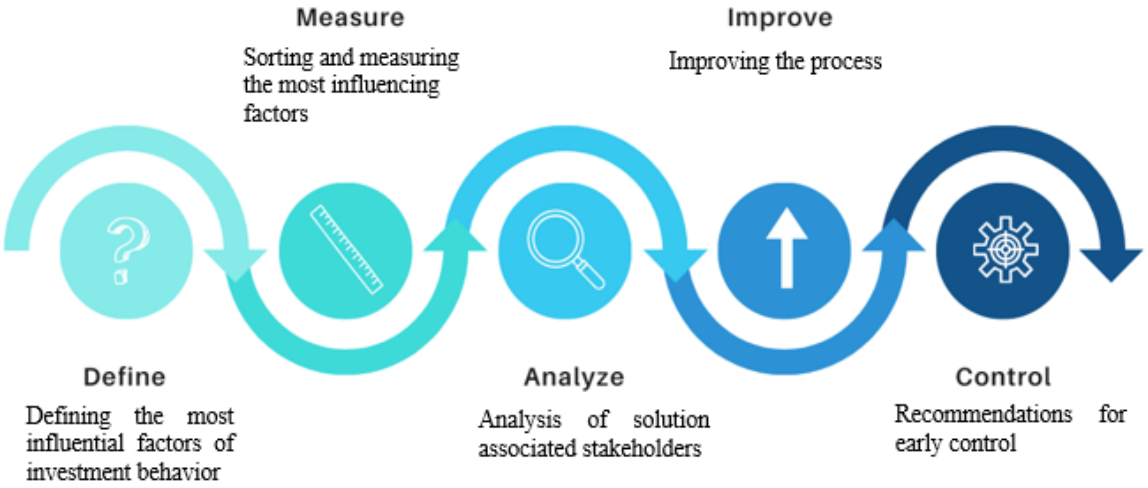


Figure 4.10 Lean Six Sigma (DMAIC) Process Implication

The key factors hindering the implementation of environmentally friendly office buildings in the Palestinian context were identified and defined as the primary influential factors shaping real estate investment behavior in the market. The insights were derived from the findings obtained through interviews and questionnaires, with the influencing factors being the ones that previously formed the labels and patterns in Delve software thematical analysis. The most influencing factors were sorted and measured, identified, and defined as the primary influential factors shaping real estate investment behavior in the Palestinian market. A solution-oriented mindset was embraced in the initial phase of comprehending the origin of the issue. The process of enhancement and the provision of a comprehensive set of recommendations for future control and error prevention in the environmental real estate sector in Palestine was crucially initiated by allocating each task to its respective stakeholder responsible for addressing it proactively. The improvement process involved the involvement of relevant stakeholders for each factor. Early control measures resulted in recommendations for future actions in the environmental real estate sector in Palestine.

Chapter 5

Results and Discussion

5.1 Fieldwork Results

The fieldwork process started with determining the study area and gathering textual weather data. After displaying the study area description, the networking and interview results are demonstrated. The selection process of the case studies is explained, and the questionnaires distributed to the case users' results are shown for employees in Palestine and then for each office's condition. Finally, the researcher's confirmation results are demonstrated with their triangulation with all the previous results.

5.1.1 Context of the Study

Due to the following essential factors, the study occurred in Palestine and was limited to Hebron. Hebron was accessible by the researcher, and most of the needed data is easy to collect due to the political constraints. Hebron City has a unique urban development fabric that distinguishes it from other Palestinian cities in terms of fast urban growth and commercial construction evolution, making it challenging to maintain proper development. As is the case in most of the Palestinian cities, Hebron suffers from environmental vulnerabilities because of the Israeli occupation; this is embodied in water scarcity, limited natural resources, and vulnerability to climate change impacts. The previous reasons justify the importance of studying, testing and developing the construction directions to achieve more sustainability in the area. Such studies are helpful in cost reduction, job creation, and improved quality of life for building users while also attracting collaboration from international supportive organizations and governments that fund sustainable urban development in Palestine.

5.1.2 Study Area Description

Hebron is the largest city in the West Bank, located to the south, and acts as a central trade hub between the northern and southern Palestinian regions (figure 5.1). Hebron City lies 943 m above sea level with a latitude of 31.532569° and a longitude of 35.099826° (Hushlamoun, 2020). Hebron city experiences a Mediterranean climate characterized by chilly, rainy winters and hot, arid summers. The peak of warmth occurs during July and August, with an average high

temperature of 29°C, and temperatures rarely go below 0°C in cold winters (figure 5.1). The yearly humidity averages around 61%, while the mean annual rainfall measures approximately 130mm.

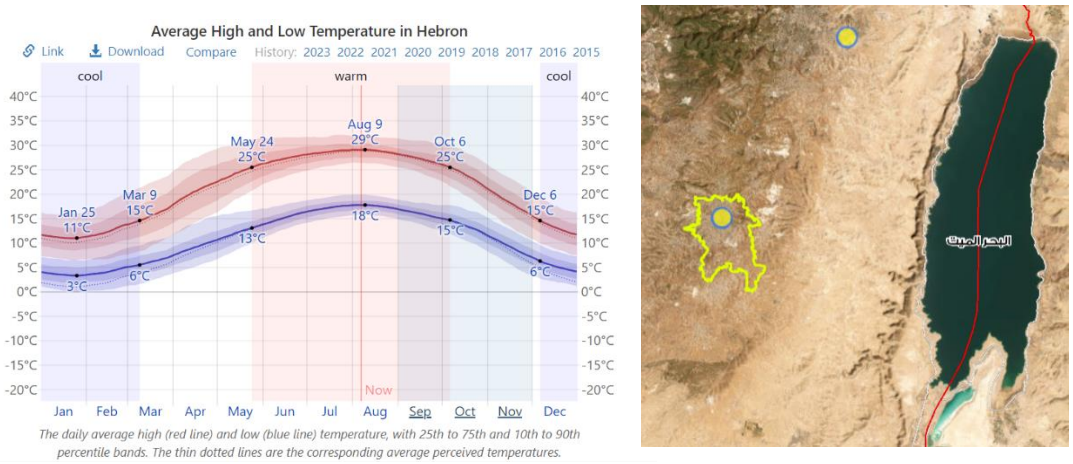


Figure 5.1 Average Temperature in Hebron, Hebron City Location to Dead Sea (Weatherspark, Mstkshf, 2023)

The average rainfall in Hebron in winter is highest in January, with an average rainfall of 37mm, and the month of the year with the least rainfall is July, and the number is 0mm (figure 5.2). Days in Hebron vary over one year; December 2023 has the shortest sunlight exposure, with ten hours and 6 minutes, while the longest day is in June, with 14 hours and 12 minutes of daylight (figure 5.2).

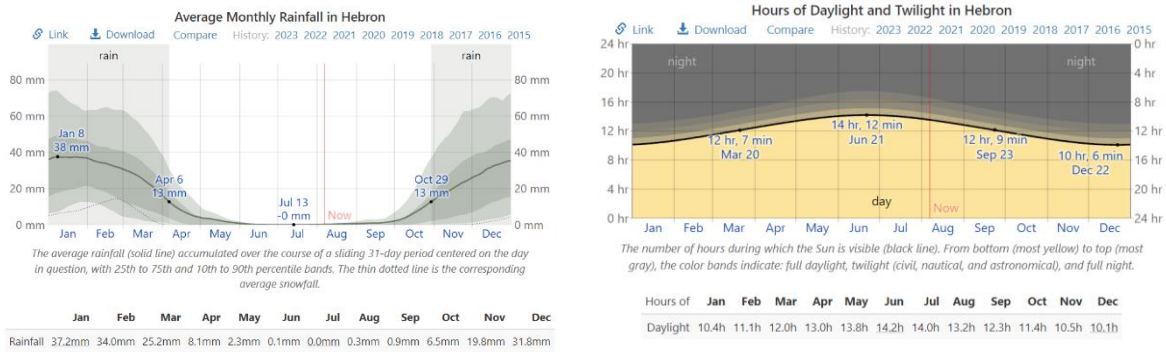


Figure 5.2 Average Monthly Rainfall, and Hours of Daylight and Twilight in Hebron (Weatherspark, 2023)

The average highest wind speed in Hebron is in July and reaches 12.9 kph, while the calmest wind is in December and reaches 10.3 kph. From August to November, the prevailing wind in Hebron predominantly comes from the northwest. Conversely, during the months from November to August, the dominant wind shifts originate from the west (figure 5.3).

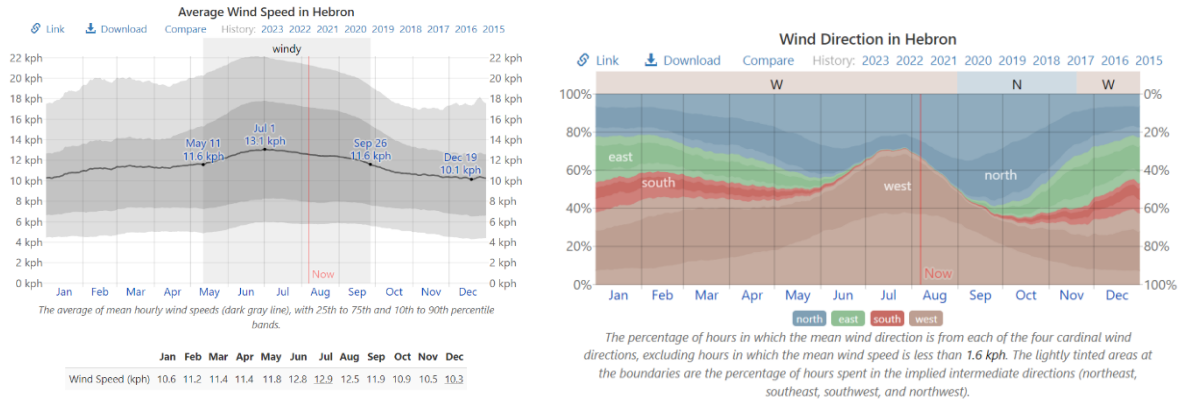


Figure 5.3 Average Wind Speed and Wind Direction in Hebron (Weatherspark, 2023)

The discussed weather data in this section helps determine the average weather conditions the study is limited to, which is the Mediterranean climatic conditions.

5.1.3 Networking Results

To answer the research questions, it was essential to have contact information for all stakeholders engaged in environmentally-conscious building construction across all stages. This encompasses various stakeholders outlined in the theoretical background, including governmental entities, engineering offices, investors, clients, and building users.

A visit was undertaken to the Hebron branch of the Engineering Association in pursuit of a comprehensive directory encompassing all consultant engineering offices located in Hebron. The list contained a total of 86 offices. An examination was then conducted to categorize those offices that had obtained licenses for office buildings within the past decade, which amounted to 44 offices. Notably, 27 offices were responsible for licensing two or more office buildings. Subsequently, communication was initiated with 14 of these offices via phone, resulting in productive and genuine cooperative interactions with 8.

From these 8 offices, valuable data was collected through interviews. The subsequent table shows the number of investors each office recommended. The names of these investors were then cross-referenced with those provided by key figures within Hebron Municipality, and all individuals were contacted for initial telephone interviews. Seven of these investors were found to possess office buildings that had been licensed after the year 2013. Subsequently, they were engaged in

in-person semi-structured interviews. The results derived from networking interviews with Engineering Association and engineering offices have been categorized as follows:

Table 5.1 Results of Networking with Engineering Association and Engineering Offices

Engineering Association	
Consultant Engineering Offices	86 offices
Licensed office buildings during the last ten years	44 offices
Licensed two or more office buildings in the period	27 offices
Contacted offices	14 offices
Responding offices (number of interviews)	8 offices
Engineering Offices	
Engineering Office	Provided number of Investors' Contacts
Engineering office 1	5
Engineering office 2	0
Engineering office 3	2
Engineering office 4	1
Engineering office 5	1
Engineering office 6	2
Engineering office 7	0
Engineering office 8	1
Total Investors Contacts	12 investors

Each investor was also requested to nominate a selection of their clients for further interviews and prospective candidates for case studies. The response rates for this process were contingent upon the interviewees being geographically located within the country, their availability for interviews, and their willingness to be part of the research.

Table 5.2 Results of Networking with Hebron Municipality and Investors

Hebron Municipality – 2 Interviews		
Confirmation of 12 investors contacts		
Contacted investors	12 investors	
Responding investors (mobile initial connection)	10 investors	
Owns office buildings in Hebron	10 investors	
Owns office building licensed after 2013 (number of interviews)	7 investors	
Investors		
Investor	Provided Number of Clients' Contacts	
	Building 1 Clients No.	Building 2 Clients No.
Investor 1	1	2
Investor 2	4	3
Investor 3	0	0
Investor 4	0	4
Investor 5	0	0
Investor 6	2	3
Investor 7	0	3
Total Client's Contacts	22 clients	
Responding Clients (number of interviews)	8 clients	

5.1.4 Interviews Results

All interviews were semi-structured; each participant sought a specific response while considering the provided context. Interviewees were requested to provide explicit responses in addition to their more open conversational ones. Interviews results were concluded from the recordings following PESTLE analysis:

Table 5.3 PESTLE Analysis Method

PESTLE	Political	Economic	Sociological	Technological	Legal	Environmental
Engineering Offices		•	•	•	•	•
Hebron Municipality	•	•	•		•	•
Investors	•	•	•		•	•
Clients		•	•			•
• : the PESTLE specific factor is related to this stakeholder						

1. Interviews With Engineering Offices

- During this phase, interviews were conducted with eight consulting engineering offices, all demonstrating an understanding of basic environmental requirements and their impact on both users and the environment. Only one engineer expressed skepticism about the significance of environmentally conscious buildings, emphasizing that mechanical lighting and ventilation systems alone were sufficient to meet user needs regardless of cost.

- “Until the past decade, many engineering offices had limited to no knowledge about basic environmental requirements. However, changes emerged with Hebron Municipality's parking requirements and the Engineering Association's crucial role in reviewing and approving engineering plans. Palestinian Civil Defense also played a transformative role by enforcing safety regulations related to setbacks and internal space requirements, which inadvertently contributed to environmental considerations”. This provides information about the existence of enforced laws for implementing environmental strategies in Palestine. The Palestinian Civil Defense did not directly consider environmental needs when the law was put. Still, it indirectly helped achieve better setbacks and create enhanced social interiors of office buildings through widened gathering points.

- “Newly graduated engineers possess limited knowledge about environmentally designed buildings, yet it is sufficient for creating designs that incorporate essential environmental requirements”. To a certain limit, this knowledge can be considered an elimination of the barrier of lacking professional personnel in the environmental construction industry.

- From a technological perspective, “the Palestinian construction market, particularly in Hebron, is fully capable of adopting new building technologies”, which considers environmental construction practices no longer a barrier for investors in the industry.

- “When assessing construction trends in Hebron, focusing on buildings licensed within the last 10-15 years, it is evident that the current real estate market is increasingly aligning with basic environmental requirements”.

- “Investors are generally averse to implementing high insulation standards in office buildings due to the associated cost increases, which could lead to higher real estate prices that some clients may be unwilling to accept. Insulation between offices, such as using two layers of 10 cm of brick with 3 cm of insulation between them, is only considered if neighboring offices’ owners mutually agree during the finishing stages”. Three engineers consider External insulation unfeasible, primarily because indoor and outdoor temperatures do not vary significantly, and “the cost of insulating an office building outweighs its lifetime HVAC expenses”. Although theoretically convincing, applied studies have proven external insulation to be 2.44% of the total investment costs for residential buildings (Abu Hanieh et al., 2022).

- “Investors now prioritize natural lighting and sunlight standards because they recognize that clients perceive such offices as "comfortable," even if they are unaware of the sources of this comfort. Some offices cannot have direct sunlight exposure due to their orientation, so engineers advise investors to position services and circulation areas facing this direction”. This point indicates knowledge about the importance of and methods to achieve two basic environmental needs: daylight and sun exposure.

- “In terms of ventilation, mechanical systems for air filtration and HVAC are sometimes preferred over opening windows, as the latter can result in excessive noise that negatively affects employee performance”.

- “Investors are more willing to invest in an "exceptional building design" and structural elements than in environmental considerations, which may go unnoticed by their clients. Nevertheless, a building with a distinctive entrance and high-quality services is widely recognized as having added-value”.

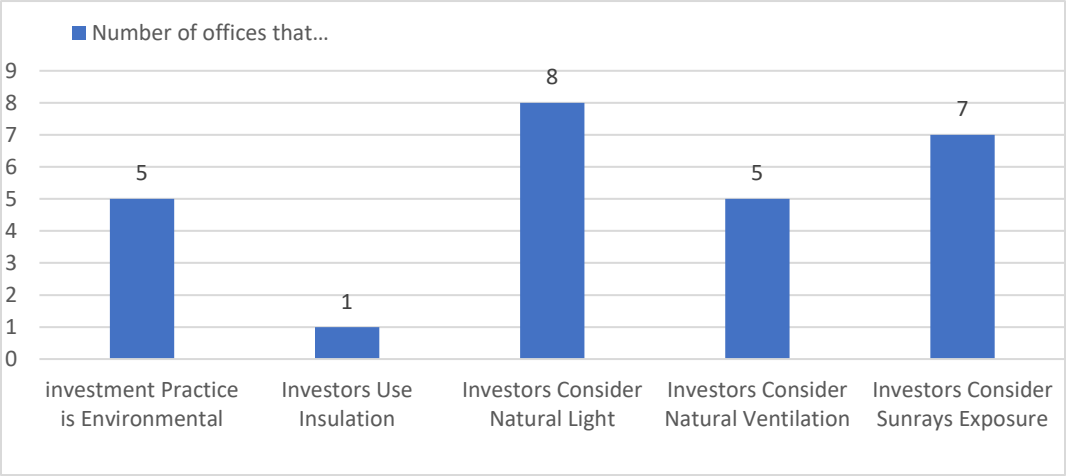


Figure 5.4 Interviews with Engineering Offices - The Answers

2. Interviews With Hebron Municipality Key Persons

- “At present, there are no regulations or legal mandates in place that compel Palestinians to incorporate environmental building standards into their architectural designs, nor are there any associated incentives”. Thus, this assures the existence of the “lack of law enforcement, and lack of incentives” political and financial barriers.

- “The implementation of the 2019 Palestinian Civil Defense laws, which mandated adherence to international standards in building construction, had a profound impact on the environmental construction industry in Palestine, especially in Hebron”. Which confirmed engineering offices point.

- “Certain public administrative buildings have adopted environmental building design standards, primarily due to financial constraints and stringent oversight by relevant authorities. Some of these public administrative structures have even been required to retrofit their initially non-environmentally oriented buildings”. Which assures the existence of external funds provided for public and governmental administrative buildings in the region.

- “Many privately-owned office buildings deviate from the originally proposed and licensed designs. Some investors obtain licenses for parking lots but later repurpose them as storage areas or underground shops after the building has been licensed”. This point indicates the existing investment behavior in Hebron City.

- “Investors are well-informed about the value of aesthetic architecture, environmentally friendly construction, safety requirements, and competitive services. However, various factors deter them from investing in such features. Some of these factors include investors' assumptions that clients are unwilling to pay extra for these features as well as the complex political situation in Hebron and the scarcity of available land, which motivates investors to maximize their land usage”. Which confirms three important barrier investors have, the lack of public awareness, the lack of knowledge of green buildings amongst clients, and the lack of market demand.

- “Only through implementing regulations and providing incentives can we encourage investors to incorporate basic environmental requirements into their projects”.

- “The implementation of regulations aimed at enhancing investment practices within the real estate sector would ultimately prove highly advantageous for the municipality, as it would lead to a reduction in total energy consumption when every building incorporates environmental considerations during the initial design phase”.

- “To foster awareness of environmentally conscious construction and design, it is imperative to conduct workshops that underscore the significance of these principles to the entire community, not just from an environmental perspective. These workshops should target

various audiences, including the engineering community for reinforcement, investors for raising awareness, and clients to demonstrate the overall benefits".

- "People predominantly communicate in the language of finances and economics. Convincing property owners to invest an additional 10% in property prices, for instance, requires articulating the economic advantages that such an investment offers to them. The same holds true for investors. If you seek to persuade them, it is essential to speak their language exclusively".

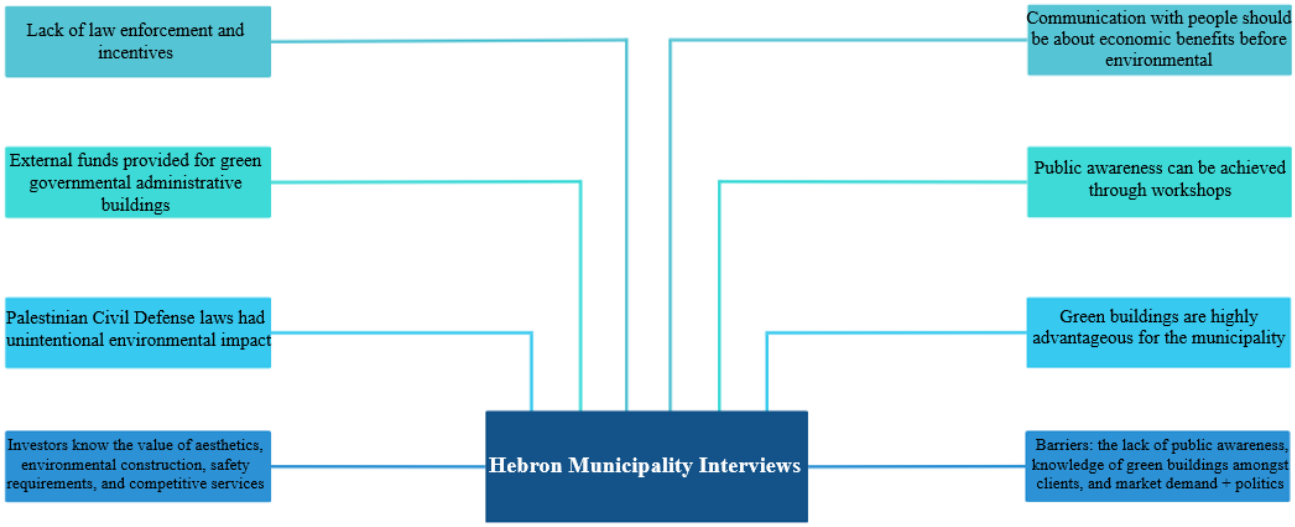


Figure 5.5 Interviews with Hebron Municipality Key Findings

3. Interviews With Investors

Aligning with this research objective in exploring investment behavior and investors' environmental awareness in the Palestinian context, semi-structured interviews were conducted with office building investors, and the main obtained answers for the questions (reference: 4.3.2 Investors Interviews) are as follows:

Table 5.4 Investors Short Answers

Investors									
			Investor 1	Investor 2	Investor 3	Investor 4	Investor 5	Investor 6	Investor 7
Q1	Informed	Y/N	N	Y	Y	Y	Y	Y	Y
	Needed Clarification	Y/N	Y	Y	N	N	N	N	N
Q2	Insulation	Y/N	N	N	Y	N	N	N	N
	Ventilation	Natural/ HVAC	Natural + HVAC	Natural	Natural + HVAC	Natural	Natural	Natural	Natural
	Daylight	Y/N	Y	Y	Y	Y	Y	Y	Y
	Sunrays	Y/N	Y	Y	Y	Y	Y	Y	Y
Q3	Ratio %		10-20	25	100	20-25	10-20	15-20	30
	Sub1 %		10-20	25	100	20-25	10-20	15-20	30
	Sub2 %		10-20	25	100	20-25	10-20	15-20	30
	Sub3 %		10-20	25	100	20-25	10-20	15-20	30
Q4	Payback Period (+years)		0	0	0	0	0	0	0
*Q: Question Y/N: Yes/ No Sub: Sub-Question									

- Question 1: How informed are you about the basic needs for buildings to be environmental and their impact on users?

Table 5.5 Question 1 – Number of Investors for Each Level of Environmental Knowledge

Well Informed	Extra Irrelevant Information	Wrong Information	No Prior Knowledge
5	4	1	1

- One out of seven investors had no prior knowledge about basic environmental requirements. This investor, along with another who possessed limited information on the topic, required further clarification before proceeding with additional questions.

- Five out of seven investors displayed a comprehensive understanding of basic environmental needs, obviating the need for further clarifications.

- One investor believed “a building with a spacious entrance, ample parking facilities, fast elevators, and non-slip flooring could be considered environmentally friendly”.

- Some investors considered a building in which all floors and office interiors were fully finished to be attractive to clients, an environmental building. “A fully finished building also minimizes inconveniences such as dust, paint odors, chemical emissions, and noise, thereby enhancing productivity”.

- Investors held varied opinions about the implications of the Palestinian Civil Defense laws enforced after 2019. Some saw these laws as a guarantee of constructing the most environmentally friendly office buildings in the area.

- As clarified in figure 5.6, investors' awareness of environmental building practices depended on three key factors. The first factor pertained to the engineering personnel with whom the investor collaborated and their ability to convey the importance and feasibility of environmental considerations. The second factor was the investor's exposure to countries that prioritized environmental architecture. A third significant factor was the investor's history of real estate investments and personal use of their older properties, providing valuable feedback over an extended period and fostering environmental awareness for future investments.

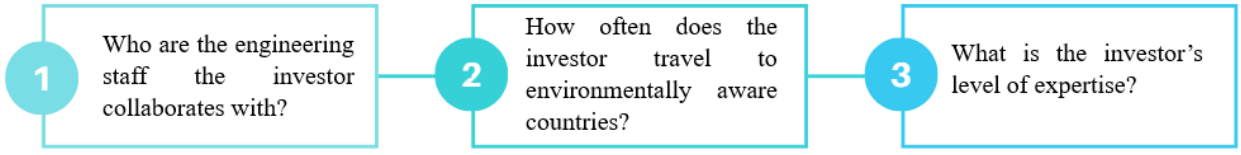


Figure 5.6 Question 1 - Factors Affecting Investors Awareness of Environmental Buildings

- “The design stage of real estate investments involves a collaborative process between the engineering staff and the investors”. Some investors offered guidance to the engineers regarding their environmental preferences. In contrast, in other cases, the investors were receptive to the engineering staff's recommendations, which influenced the investors' approach to environmental construction.

- This collaborative process highlighted that “recently graduated engineers exhibited better awareness of environmental architecture and its feasibility, while older engineers tended to

prioritize the allocation of investment capital towards constructing more robust buildings with increased steel and higher-quality concrete".

Figure 5.7 Question 1 – Relationship Between Investors and Engineering Offices

- Three investors emphasized the importance of enhancing environmental architectural practices in Hebron, as "clients and their customers were becoming increasingly discerning about the quality of the internal environment".

- Quoting one of the investors, "Investors are astute; we recognize that every additional feature we incorporate into our investments, whether aesthetic or environmental, yields return several times over. When engineers suggest new environmental features, we consider them for economic reasons rather than solely for the environment's sake."

  - Question 2: How far are your current real estate investment patterns from the basic environmental needs?

- Every investor affirmed that "when the investor is also one of the users of their real estate, there are more significant consideration for environmental preferences in the building".

- "Investors who prioritize their reputation and standing in the real estate industry are not willing to compromise construction quality for the sake of higher profits. It is typically new investors who have other business interests and are less concerned about long-term engagement in real estate development or investment who focus solely on maximizing profits, often at the expense of quality". This point confirms chapter 3 findings: investors who seek long-term engagement in the real estate industry consider their reputation for high quality and environmentally considerate buildings.

- Without exception, all investors acknowledged that, based on feedback from their clients and their observations of multiple investments, “the real estate sector in Hebron has witnessed significant improvement over the past decade. Almost all buildings now incorporate some degree of consideration for basic environmental needs”.

- Confirming the interviews with Hebron Municipality, one investor highlighted “client’s limited awareness of the distinction between design and the actual implementation of the design. Some clients purchase property during the planning stage without seeing the completed building, and many office buildings in Hebron do not precisely match their architectural drawings”.

Question two key extracted queries are shown in figure 5.8 below:

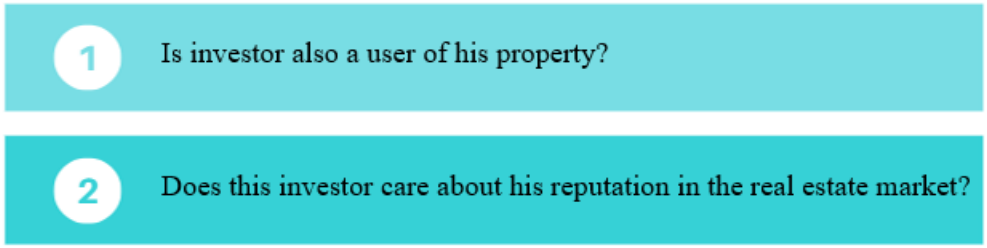


Figure 5.8 Question 2 – Key Extractions

➢ Question 2 | Sub-Question 1: Please explain the current wall layers and thermal insulation.

- Only one of the seven interviewed investors confirmed the application of thermal insulation to the administrative floors of their building, while all other investors did not employ thermal insulation.

- Six investors indicated that the responsibility for thermal insulation lies with the clients. “If clients wish to insulate their offices, they must purchase the property during the skeletal construction phase, before any interior finishing is applied. However, most clients choose not to apply insulation”.

Figure 5.9 Question 2 – Insulation Sub Question Summary

- One investor believed that "a 10 cm brick with its air cavity and a plaster layer provided sufficient thermal insulation".

- Another investor mentioned "using gypsum boards between the offices because they offer more space than brick, irrespective of thermal or sound insulation standards".

- The prevailing opinion among most investors echoed the sentiments expressed by engineering offices: "insulation is not considered cost-effective, as the expenses of applying insulation outweigh those of HVAC systems used to maintain internal thermal comfort, with the eventual cost passed on to the users".

➢ Question 2 | Sub-Question 2: Please explain current ventilation standards (natural/ HVAC).

- Natural ventilation was a primary concern for all investors in their real estate properties. However, only two investors partially incorporated mechanical ventilation into their real estate projects. Notably, one investor opted for the use of variable refrigerant flow (VRF) in their investment.

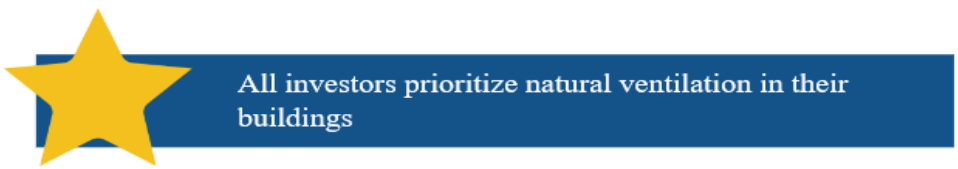


Figure 5.10 Question 2 – Natural Ventilation Sub Question Summary

- The significance of location with respect to natural ventilation application was underscored by one investor. Confirming the point highlighted by engineering offices, they pointed out that “if a building is situated on a main street, clients tend to avoid natural ventilation due to the potential noise interference, which could affect their concentration and productivity”.

- An investor highlighted a specific issue related to the size of office spaces in their building. “Lower-floor offices were designed with larger areas compared to the upper floors. Consequently, when internal partition walls were installed, many of these offices experienced poor natural ventilation. Addressing this challenge would require the installation of larger ducts or potentially the inclusion of courtyards. Still, such solutions would come at a considerable cost and result in reductions in the building's overall floor area”.

➢ Question 2 | Sub-Question 3: Please explain current daylight considerations.

- As stated by engineering offices, investors confirmed that “natural daylight is a common consideration when it comes to real estate properties, particularly in office function spaces, the main staircase, and essential services”.

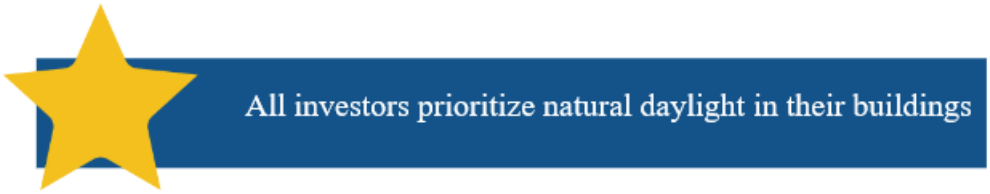


Figure 5.11 Question 2 – Natural Daylight Sub Question Summary

- It's worth noting that only one investor explicitly emphasized the existence of naturally well-lit parking floors in their real estate.

- All investors unanimously agreed that “the engineering offices nowadays never compromise the availability of natural daylight in the primary areas of the designed building”.

- One of the investors offered insight into the preferences of potential clients. “They may not explicitly articulate their environmental requirements, but these needs are still a significant

factor when evaluating properties. An office space lacking natural daylight is rarely sold, or if it is, the sale is often motivated by investment considerations rather than intended usage".

➢ Question 2 | Sub-Question 4: Please explain the current sunray exposure.

- All investors were in consensus regarding the fundamental necessity of sunlight exposure in the environmental real estate context.

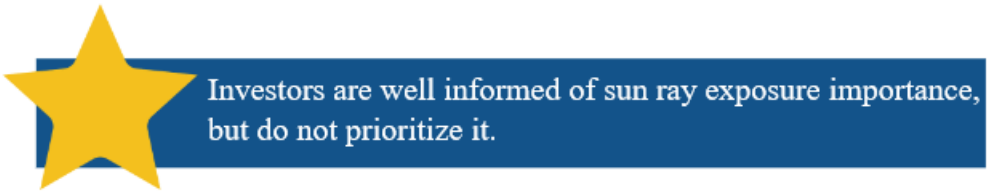


Figure 5.12 Question 2 – Sun Exposure Sub Question Summary

- One investor displayed a notable understanding of the importance of a building's sun exposure and its daily solar trajectory. They explained their strategic approach of minimizing the window-to-wall ratio (WWR) on the southern façade while placing a highly glazed façade on the northern side of the building to maximize the collection of heat, light, and visual connection with the outdoors.

- Another investor pointed out their "limitation in avoiding the placement of offices on the northern façade, which lacks direct exposure to sunlight". They justified this decision by mentioning that such office spaces are typically sold at a lower price.

Figure 5.13 below summarizes the priorities of the interviewed investors which will be compared with clients' and employees' priorities in the following sections.

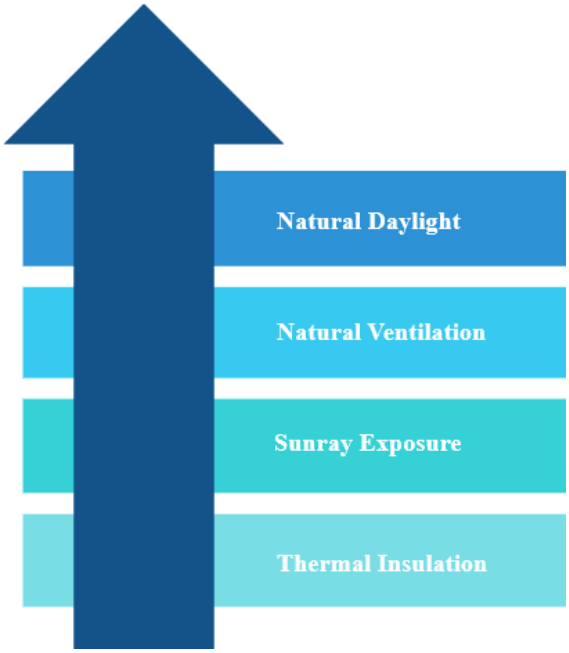


Figure 5.13 Question 2 Summary – Investors Environmental Needs Priorities

- Question 3: How much increase on the initial construction costs of the building to make it environmental is acceptable for your investment?

- In response to the third question, all investors expressed that the percentage of profit they anticipate depends on their real estate investment location. They stressed the pivotal role location plays in determining the profitability of their projects.

- Investors unanimously identified the main street of Ain Sarah, spanning from Ibn Rushd Circle to Ras Al Jourah, as “the most lucrative area for office real estate investments”. This preference is attributed to various factors, including proximity to public transportation, accessibility, and nearby services.

- Investors emphasized that “they aim to recoup their land and construction investments primarily through ground-level shops on the main street and possibly one floor above. Any floor beyond that is considered part of the profit”.

- For most investors, a reasonable increase in initial real estate investment costs to make it environmentally friendly ranged from 10% to 30%.

- All investors agreed on an increment in the property value in the real estate of more than 20% when environmental considerations are thoughtfully incorporated.

- All investors agreed on "the benefit of targeting a higher value niche market segment customers that are willing to pay more to get more when buildings are environmentally considerate".

- The majority of investors concurred that "every investment made in real estate can yield a two to fourfold return if well-considered". However, they acknowledged that "there is an upper limit to this investment, as excessively raising the selling price can deter potential clients due to affordability concerns".

- All investors actively market their environmentally considerate properties to clients, emphasizing their higher value, faster appreciation in the real estate market, and a higher rate of renting and selling.

- A notable difference in occupancy rates was mentioned by all investors when comparing environmentally conscious properties to those that lack such features. "Environmental considerations lead to faster occupancy and increased rental or selling rates".

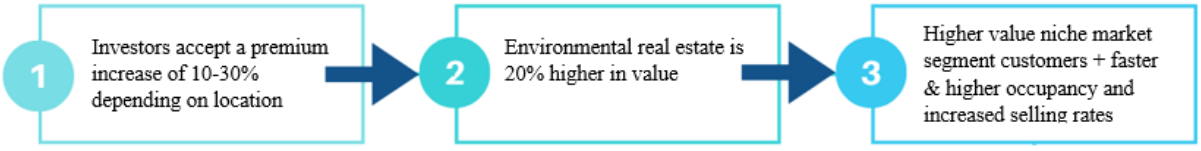


Figure 5.14 Question 3 Summary

- Investors recognized a higher risk when directing investment capital toward environmental design rather than focusing on services, as not all clients fully appreciate the value of these features. "Clients only pay for square meters. They want these meters to be well-designed and

full of services. Still, they will always pretend not to care in order not to pay more", stated one of the investors, "this makes such environmental real estate investments limited to more capable investors, not the fresh ones, as they will become upset if their first risk did not work."

- One investor expressed a willingness to pay double the price to achieve an environmentally designed building, recognizing that "a comfortable internal environment leads to long-lasting investments and an effective marketing strategy that appeals to customers". This investor clarified that initial costs were not a concern when starting the investment, as they aimed for a lasting and enduring investment. They did not find it necessary to create a feasibility study for the environmental impact of the building, as "the engineering staff was convincing about the economic viability of these features".

- An investor mentioned that "opting for environmentally designed buildings may entail sacrificing floor area for environmental features such as natural lighting, cross ventilation, and the placement of services on the northern facade, resulting in the loss of office space in those areas". However, they were willing to accept these losses, but to a less extent in the prime location of the main street of Ain Sarah.

- One investor stated that they are willing to lose only up to 20% from the total floor area to achieve environmental considerations.

- All investors agreed that they are willing to pass on the extra costs to clients, recognizing that this practice increases the property's selling price while remaining within the same mentioned acceptable extra percentage on initial costs.

- All investors expressed dissatisfaction with the lack of incentives from the municipality and the absence of differentiation between environmentally conscious investors and those who build without considering the environmental impact of their real estate.

  - Question 4: how much increase on the investment payback period is considered acceptable for you?

- The response to this question was consistent among all the interviewed investors:

> An environmentally conscious building sells considerably faster than one that neglects environmental essentials, resulting in a significantly shortened payback period. However, 3 years is an acceptable payback period.

Figure 5.15 Question 4 – Acceptable Payback Period Amongst Investors

- Additionally, all investors stressed that, “in general, the acceptable payback period for their real estate investments should not exceed three years”. This is essential for them to recover their entire capital swiftly, allowing them to reinvest it promptly to avoid any erosion in the value of their money due to the time factor (time value of money).

- One of the investors highlighted a fundamental principle in successful investing: “using one's capital rather than relying on collected money from people by partially selling real estate. This is precisely why investors aim to recoup their entire investment by selling the real estate property as quickly as possible, ensuring they can proceed to the next construction project without delay”.

It is worth noting, though, that none of the investors mentioned time limitations as a barrier, and none of them thought environmentally conscious buildings took longer to construct.

4. Interviews With Clients

For this research to answer the question concerning clients in the study context and their acceptance of the increase of real estate price in exchange with LCC and payback period, semi-structured interviews were conducted with office owners and the main obtained answers for the questions (reference: 4.3.4 Clients Interviews) are as in table 5.6:

Table 5.6 Clients Short Answers

Clients										
			Client 1	Client 2	Client 3	Client 4	Client 5	Client 6	Client 7	Client 8
Q1	Informed	Y/N	Y	Y	N	Y	Y	Y	Y	Y
	Needed Clarification	Y/N	Y	Y	Y	N	N	N	N	N
Q2	Insulation	Y/N	N	N	N	N	N	Y	N	N
	Ventilation	Natural	Natural	Natural	Natural	Natural	Natural	Natural	Natural	Natural
	Daylight	Y/N	Y	Y	Y	Y	Y	Y	Y	Y
	Sunrays	Y/N	Y	Y	Y	Y	Y	Y	Y	Y
Q3	Ratio %		10	100	10-20	10	0	20	40	20
	Sub1 %		10	100	10-20	10	0	20	40	20
	Sub2 %		10	100	10-20	10	0	20	40	20
	Sub3 %		10	100	10-20	10	0	20	40	20
Q4	Payback Period (+years)		7	-	2	-	0	10	2-3	-
*Q: Question Y/N: Yes/ No Sub: Sub-Question										

- Question 1: How informed are you about the basic needs for buildings to be environmental and their impact on users?

- About 90% of the interviewed clients are well aware of the basic environmental needs and require them when looking for a property to purchase. It is worth mentioning though, that one of the clients said “they were never aware of these environmental basic needs until after they started using the property they purchased”.

- Almost 40% of clients needed clarification about the basic environmental needs in buildings as some of them didn’t know about them, and the others thought environmental buildings were “only the ones with dynamic skins, living facades, and green walls”.

- The answers to this question emphasize the importance of spreading the awareness about the basic environmental needs, investors mentioned client’s request for these needs “without specifically naming these needs”. Nevertheless, there remains a gap between requesting these needs and being aware of their associated specifications and standards.

- Question 2: How far are your current real estate properties from the basic environmental needs

- Among the clients, only one affirmed the use of interior insulation in their office. They rationalized this decision by acknowledging that "spending a significant portion of their daytime, around 8 hours, in the office warranted such measures". In contrast, the remaining clients opted not to apply thermal insulation, citing "the limited time they spend in the office, approximately 8 hours daily".

- All clients emphasized the significance of natural daylight, natural ventilation, and exposure to sunlight in their workspace environments.

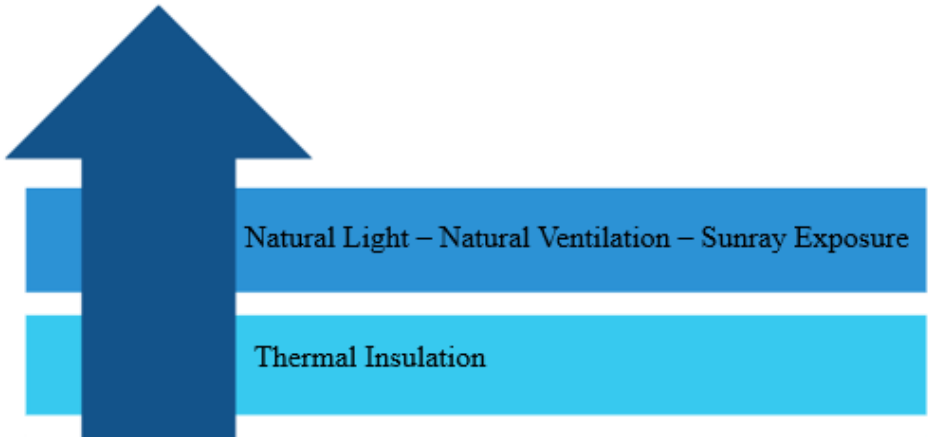


Figure 5.16 Question 2 Summary – Clients' Environmental Needs Priorities

- Question 3: How much higher is the initial real estate price acceptable for you?

- Among the eight clients surveyed, two were open to paying an additional amount of no more than 10% over the base real estate price for access to environmental features. Three clients were comfortable with an increase of up to 20%, while one was willing to go as high as 40%. Notably, one client demonstrated significant enthusiasm for environmentally conscious office spaces, expressing a willingness to pay double the standard price for an office that fulfills basic environmental requirements.

- Clients universally prioritized services, all indicating a willingness to pay an extra 50% on top of the initial office cost in exchange for improved services, especially in terms of parking facilities for themselves and their customers.

- One client believed that their company's current location already met the basic environmental needs and, as a result, was not inclined to allocate additional funds for a more sustainable location.

- These ratios remained consistent even after considering the decrease in social costs associated with environmental buildings and the reduction in energy consumption. This customer's behavior was previously highlighted in the theoretical background. Customers' willingness to pay a premium for environmental needs remained constant even after stating the expected future savings.

  - Question 4: How much increase on the real estate price payback period is considered acceptable for you?

- When it comes to the payback period, three clients emphasized that "they prioritize environmental advantages over economic gains and, therefore, consider the payback period to be of little significance".
- Certain clients specified an acceptable payback period falling within the range of two to three years, while others expressed their willingness to extend it to seven or even ten years.

5.1.5 Case Study Selection

The research was carried out within Hebron City, specifically focusing on Ain Sarah Street, stretching from Ras Al Jourah to Ibn Rushd Circle. This location was chosen because investors had identified a significant challenge in implementing environmental requirements within the building structures. The study involved a multi-step process that integrated insights from investor interviews, existing building surveys, collaboration with the Geographic Information System (GIS) Department, and engagement with the Licensing Department at Hebron Municipality.

1. Office Buildings Survey

Investors contributed information regarding their latest office buildings, totaling 14 structures, with 7 of these being granted licenses after 2013. These 7 recently licensed buildings, along with an additional 3 identified by the GIS department, were subjected to a rigorous selection process based on specific criteria. Ultimately, 5 buildings met all the specified criteria. These five selected buildings underwent further examination with the Buildings Department to ensure the availability of up-to-date as-built architectural drawings. The result from this survey was two office buildings in the context of the study and they were further investigated.

Table 5.7 Office Buildings Survey Results

Investors						
Investor		Provided Buildings				
		Building 1 Location		Building 2 Location		
Investor 1		Farsh Al Hawa		Ras Al Jourah		
Investor 2		Down Town		Down Town		
Investor 3		Manarah Circle		Ramallah		
Investor 4		Ibn Rushd		Ibn Rushd		
Investor 5		Salam St.		Haras St.		
Investor 6		Manarah Circle		Haras St.		
Investor 7		Haras St.		Ein Sarah St.		
Total Office Buildings		14 buildings				
Buildings That Meet the First Condition (Licensed After 2013)		7 buildings				
GIS Department and Licensing Department – Hebron Municipality						
Building		First Filtration				
		Location Criteria	License Type Criteria	License Year Criteria	Operating Year Criteria	Available Investor Criteria
Ras Al Jourah Building	(1)	✓	✓	✓	✓	✓
Down Town Building	(2)	×	×	✓	✓	✓
Ramallah Building	(3)	×	-	-	-	✓
Ibn Rushd Building	(4)	✓	✓	✓	✓	✓
Haras St. Building	(5)	✓	✓	×	×	✓
Haras St. Building	(6)	✓	✓	✓	✓	✓
Ein Sarah St. Building	(7)	✓	✓	✓	✓	✓
Ras Al Jourah Building	(8)	✓	✓	✓	×	×
Haras St. Building	(9)	✓	✓	✓	✓	✓
Ein Sarah St. Building	(10)	✓	✓	✓	×	×
Buildings Department– Hebron Municipality						
Building		Second Filtration				
		Available Drawings		Occupancy Rate Exceeds 60%		Common Construction Pattern
Building 1 (1)		×		✓		✓
Building 2 (4)		✓		×		✓
Building 3 (6)		✓		✓		✓
Building 4 (7)		✓		✓		✓
Building 5 (9)		✓		×		✓

2. Cases Deep Investigation and Case Studies Selection

The selected two office buildings were visited, and on each floor, a count of offices was performed, focusing on identifying those in operation to determine the accurate occupancy rate. Occupancy rates of 76% and 70% were recorded for buildings 1 and 2, respectively. The selection of office case studies was made using the final case selection criteria, considering the willingness and cooperation of office owners and the availability of employees. The selection and filtration process for the first case is elucidated in table 5.8 below.

It is crucial to emphasize the decision to exclude highly-glazed office buildings from the investigation, despite their prevalent use in the study's context. This exclusion was justified by the study's focus on investors who prioritize cost considerations over aesthetics or architectural design when evaluating office buildings. Investors who opt for a highly-glazed facade, emphasizing aesthetics, are those willing to invest more.

Table 5.8 Offices Selection Results from Building 1

Buildings Investigatory Survey – Building 1 (Haras St. Building)												
Floor	No. of Properties	Operating	Function									
1	2	0	-									
2	3	3	Lawyer (N)			Insurance (W)			Studio (SW)			
3	1	1	Salon + dresses couture (full floor)									
4	5	3	Lawyer (N)			Doctor (W)			Lawyer (SE)			
5	5	3	Accounting (N)			Couture (W)			Accounting (SW)			
6	7	6	Lawyer (N)	Interior (W)		Engineering (W)	Engineering (W)		Lawyer (SW)	Interior (SE)		
7	4	4	Interior (W)			Interior (W)			Owner's (SW)			
8	1	1	Gym (full floor)									
9	1	1	Restaurant (full floor)									
Filtration Criteria												
Floor	Office	Orientation	Not Highly-Glazed		Owner Is the User		Contacted via Investor		More than 3 Employees		Cooperative	
F2	Lawyer	N	✓		✓		×		×		×	
F2	Insurance	W	✓		✓		✓		✓		✓	
F2	Studio	SW	✓		✓		×		×		NA	
F5	Accounting	N	×		✓		×		✓		×	
F5	Couture	W	✓		✓		✓		×		✓	
F5	Accounting	SW	✓		✓		✓		✓		✓	
F7	Interior	W	✓		✓		×		×		×	
F7	Interior	W	✓		✓		×		×		✓	
F7	Owner's	SW	✓		✓		×		×		✓	
Total Office Case Studies					2							
No. of Employees		B1F2 Office			3		B1F5 Office				5	

The filtration process in the previous case resulted a selection of two offices, one on the second floor and the other on the fifth floor. The first case was west-oriented, with total number of three employees. the second case had the total of five employees. the number of employees in each of the offices indicates the number of distributed questionnaires.

The second building investigatory survey is illustrated in table 5.9 below. The table illustrates the results of the investigation after applying all filtration criteria. The resulting case is located on the second floor with orientation on three main elevations, east, south, and west. However, the case is big, and only one office inside this company was selected for further simulations and calculations, this office is west-oriented.

Table 5.9 Offices Selection Results from Building 2

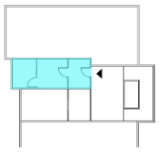
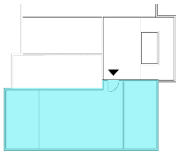
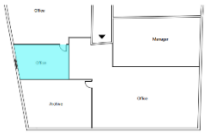
Buildings Investigatory Survey – Building 2 (Ein Sarah St. Building)							
Floor	No. of Properties	Operating	Function				
1	2	2	Insurance Company (E,S,W)		Ladies Salon (NE)		
2	5	4	Nutrition (W)	Accounting (E,S,W)	Storage (E)	Lawyer (NE)	
3	4	4	Lawyer (S)	Lawyer (NW)	PlayStation (E)	Academic (E,S)	
4	Unoccupied						
5	6	2	Dentist (E)		Engineering (E)		
6	4	4	Ladies Salon (SW)	Engineering (E)	Lawyer (E)	Physiotherapy (NE)	
7	4	1	Engineering (E)				
8	1	1	Restaurant				

Filtration Criteria							
Floor	Office	Orientation	Not Highly-Glazed	Owner Is the User	Contacted via Investor	More than 3 Employees	Cooperative
F2	Nutrition	W	✓	✓	×	×	×
F2	Accounting	E, S, W	✓	✓	✓	✓	✓
F2	Storage	E	×	✓	×	×	NA
F2	Lawyer	NE	✓	✓	×	✓	×
F6	Ladies Salon	SW	✓	✓	×	✓	×
F6	Engineering	E	×	✓	✓	✓	✓
F6	Lawyer	E	×	✓	×	×	×
F6	Physiotherapy	NE	✓	×	×	✓	✓
F7	Engineering	E	×	✓	✓	✓	✓
Total Office Case Studies				1			
No. of Employees		B2F2 Office			10		

3. Cases Description

In this section, the selected case studies' current situation is described regarding the building, office floor, orientation, area, number of employees, office nature, number of windows and their location, orientation, and dimensions, the glazing used, office ventilation, office heating, office cooling, lightening, and sunray exposure. All this information was gathered using a measurement and information datasheet separately filled for each office. Cases full plans are attached in the appendices.

Table 5.10 Selected Case Studies Description

	Case1 B1F2	Case2 B1F5	Case3 B2F2
Building Name	Haras St. Building	Haras St. Building	Ein Sarah St. Building
Company Name	Abd-Baset Insurance	Froukh Accounting	Maswadeh Accounting
Floor	2nd	5th	2nd
plan			
Office Orientation	West	South West	West
Office Area	26 m^2	64.5 m^2	28.5 m^2
Office Type	Closed	Open	Closed
Employees	3	5	3
Windows Number	1	6	1
Windows Location	Exterior	Exterior	Exterior
Windows Orientation	West	East +South + West	West
Glazing Area m^2	4.4	9	1.30
Glazing Type	Double 4-6-4 mm	Double 4-6-4 mm	Double 4-6-4 mm
Ventilation	Natural	Natural	Natural
Heating Method	Air Conditioning	Air Conditioning	Air Conditioning
Cooling Method	Air Conditioning	Air Conditioning	Air Conditioning
Lightening	Natural + artificial	Natural + artificial	Natural + artificial
Sunray Exposure	Sufficient	Sufficient	Fine
12-month Average Electricity Bill (NIS)	280	500	(432.8 m^2): 2600

- Building 1 – Haras St. Building: this building is located at Haras main street, it consists of nine floors, ground floor has shops on the main street with mezzanine and the offices are located in the higher floors. The offices that met the criteria were two offices. The first office is located to the west in the second floor, the second is located to the south west in the fifth floor.

- Building 2 – Ein Sarah St. Building: this building is located on the main street of Ein Sarah. Following the local commercial building pattern for administrative buildings in Hebron, the ground level has shops on the main street, and the offices are located in the upper floors. The selected office that met the criteria is located on three facades of the second floor, it is a large accounting company, and one office inside this company was selected for further investigation, and is located to the west. Case studies' collected data is displayed in the following table:

5.1.6 Users Questionnaires

In each building, two chosen offices were questioned, with a total of 22 respondents. Male respondents were 16, and female respondents were 6. This variation was proposed earlier in 2022 by The Palestinian Central Bureau of Statistics (PCBS). The "rate of female participation in the labor force was 18.6% compared to 70.7% for males" (PCBS, 2022).

The responses were analyzed using Excel sheets regarding employee satisfaction, employee financial and environmental preferences, and performance in the work environment. After proposing the analysis regarding each case study, another general analysis for employees in Hebron is proposed later in this section. The general analysis helped create a pattern of the working environment in Hebron City. By knowing the basic environmental need employees view the most important, investors can ask for incentives from the governmental entities to achieve this need in their buildings.

1. Case Study 1: Abd-Baset Insurance:

- In this office, only one surveyed employee expressed satisfaction with all environmental performance indicators. This individual indicated a willingness to consider leaving the

workplace for an office with improved lighting, ventilation, and sun exposure, but not necessarily for better thermal conditions. Another employee expressed satisfaction exclusively with the thermal performance and would consider leaving for better thermal conditions without a change in salary.

- All employees emphasized the importance of sun exposure and thermal comfort. The office operates daily from 8:00 am to 4:00 pm, and is located to the west, which might be an indication why employees do not catch sunrays during their working hours and thus expressed their need for it.

- While all employees stated they could work in an office without natural ventilation, one employee stood out by expressing an inability to work without daylight, sun exposure, or thermal comfort. The majority of employees acknowledged that the lack of basic environmental needs significantly influenced their workplace evaluations.

- Even when employees said they do not rely on daylight as a primary source of light in their workplace, all of them stated the absence of daylight affected their productivity, and most of them confirmed it affected their physical and psychological health. The same applies to natural ventilation and thermal comfort, all employees confirmed that the absence of natural ventilations or thermal comfortability affected their productivity, physical, and psychological health. However, employees did not consider the absence of sunrays an important factor affecting their productivity, but they all would go outside of the building to catch sunrays.

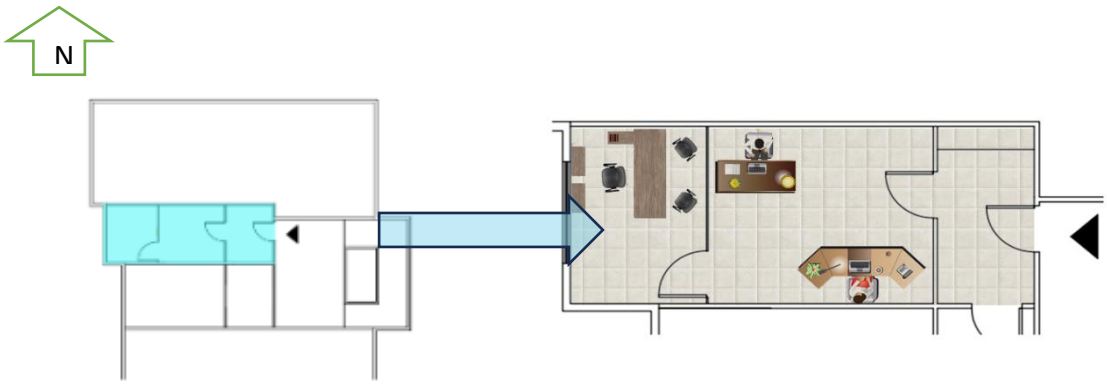


Figure 5.17 Case 1 Plan

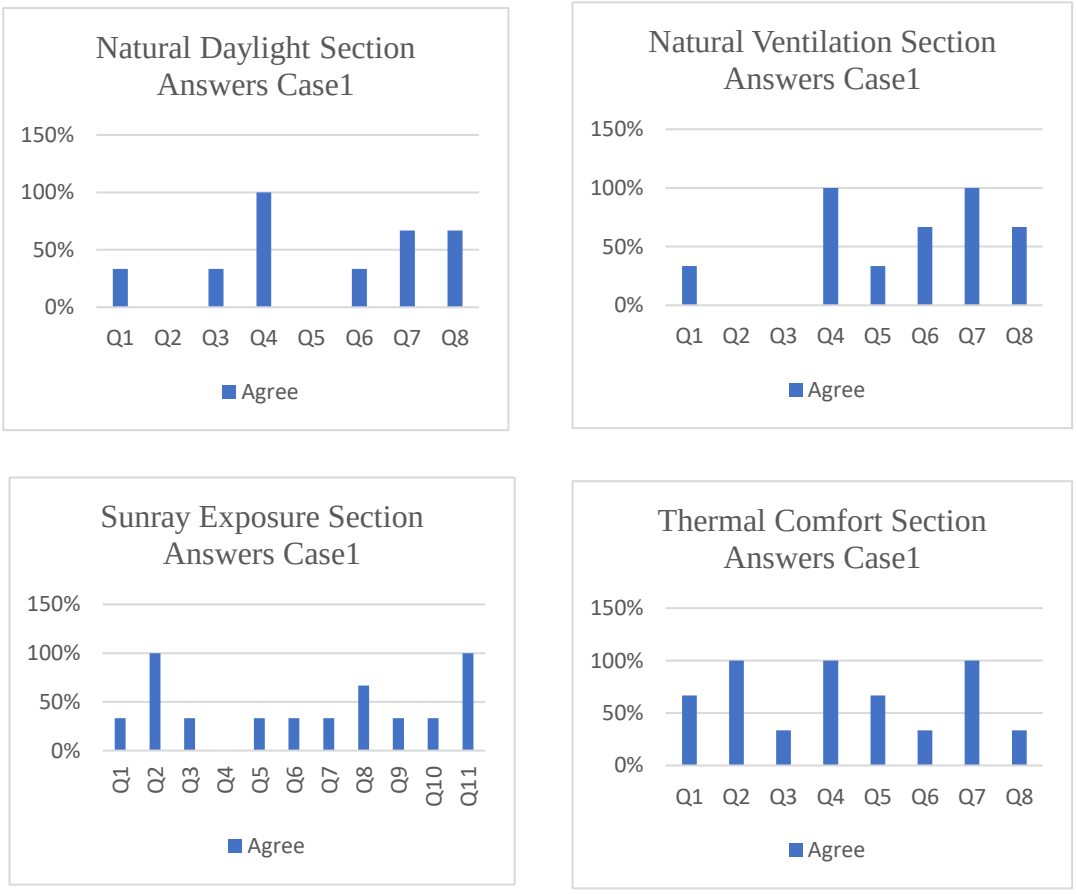


Figure 5.18 Case 1 Questionnaire Results

2. Case Study 2: Froukh Accounting:

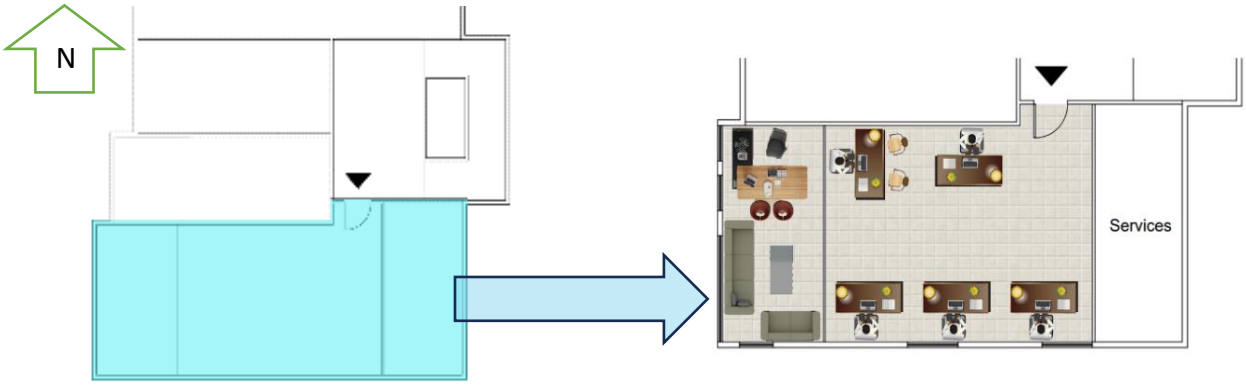


Figure 5.19 Case 2 Plan

- All employees in this office are satisfied with the natural daylight, ventilation, sunray exposure, and thermal performance of the office. The office has six windows that are externally located to the south and west of the building.

- Most of the employees said they would leave their job for the sake of better environmental performance even for a less pay.

- All employees expressed their reliance on natural daylight, natural ventilation and sunrays, but they all use mechanical methods to adjust the thermal conditions of the office. Most of the employees confirmed their ability to work in an environmentally unsatisfying workplace. However, lacking these environmental needs affected their workplace evaluation.

- Most employees confirmed a negative effect of the absence of good environmental conditions on their productivity, and physical and psychological health. All of them stated a bad effect of the poor ventilation on their health.

- Most employees stated leaving the desk or the building to catch sunrays even when they were satisfied with the amount of sunray entering the office.

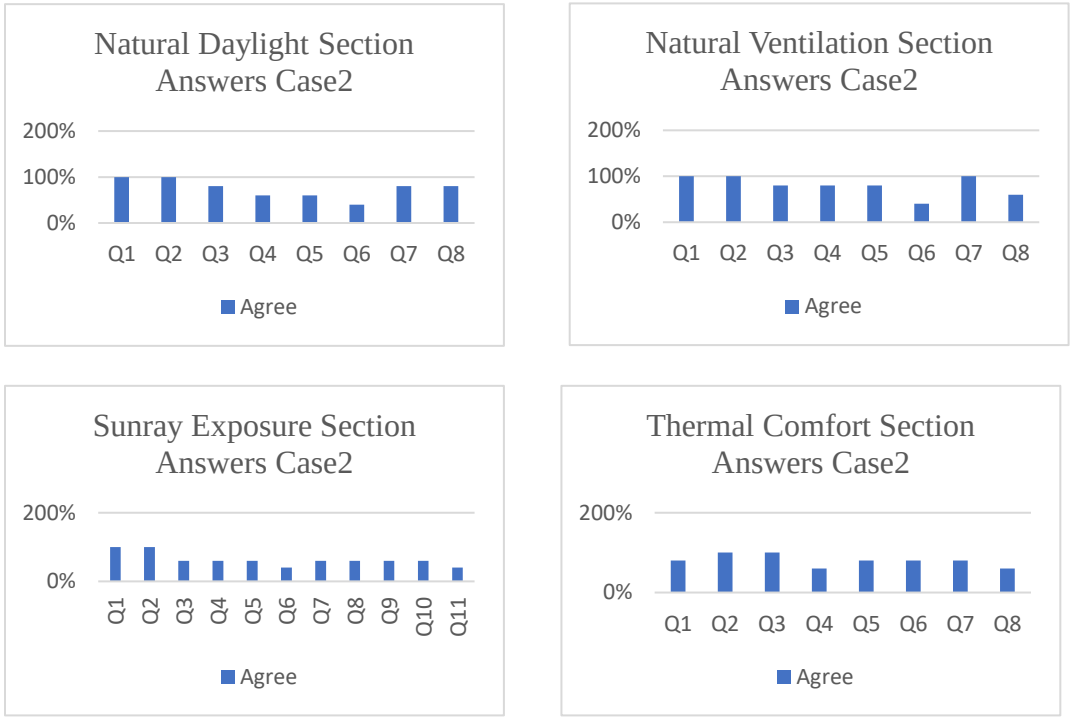


Figure 5.20 Case 2 Questionnaire Results

3. Case Study 3: Maswadeh Accounting:

- All employees expressed their satisfaction with the environmental performance of this office, except for the thermal performance which was only satisfactory to one employee.

- All employees would change the workplace for a better daylight, and sun exposure but only one would change it for a less salary. Two for natural ventilation even with less pay and two for better thermal comfort, one for less pay.

- Most of the employees confirmed relying on artificial lightening more than the natural daylight even when it was considered satisfying to them. Most of them relied on natural ventilation, sunrays, and the natural thermal performance of the office.

- All employees stated their inability to work in bad natural lightening conditions, one in bad ventilated office, and bad thermal performance. Most of the employees confirmed less evaluation for their workplace in the absence of good environmental conditions.

- Every employee acknowledged that the absence of natural daylight and sunrays in the workplace had a detrimental impact on their productivity and both physical and psychological health. Most employees also believed that the absence of proper ventilation negatively affected them, and thermal discomfort had adverse effects on their health.

- Additionally, all employees expressed a tendency to leave their desks to seek more sun exposure in other offices or outside the building.

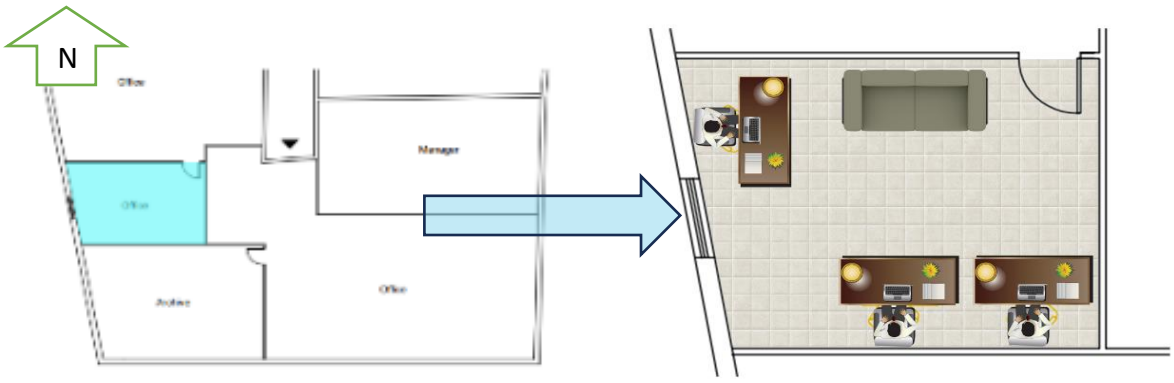


Figure 5.21 Case 3 Plan

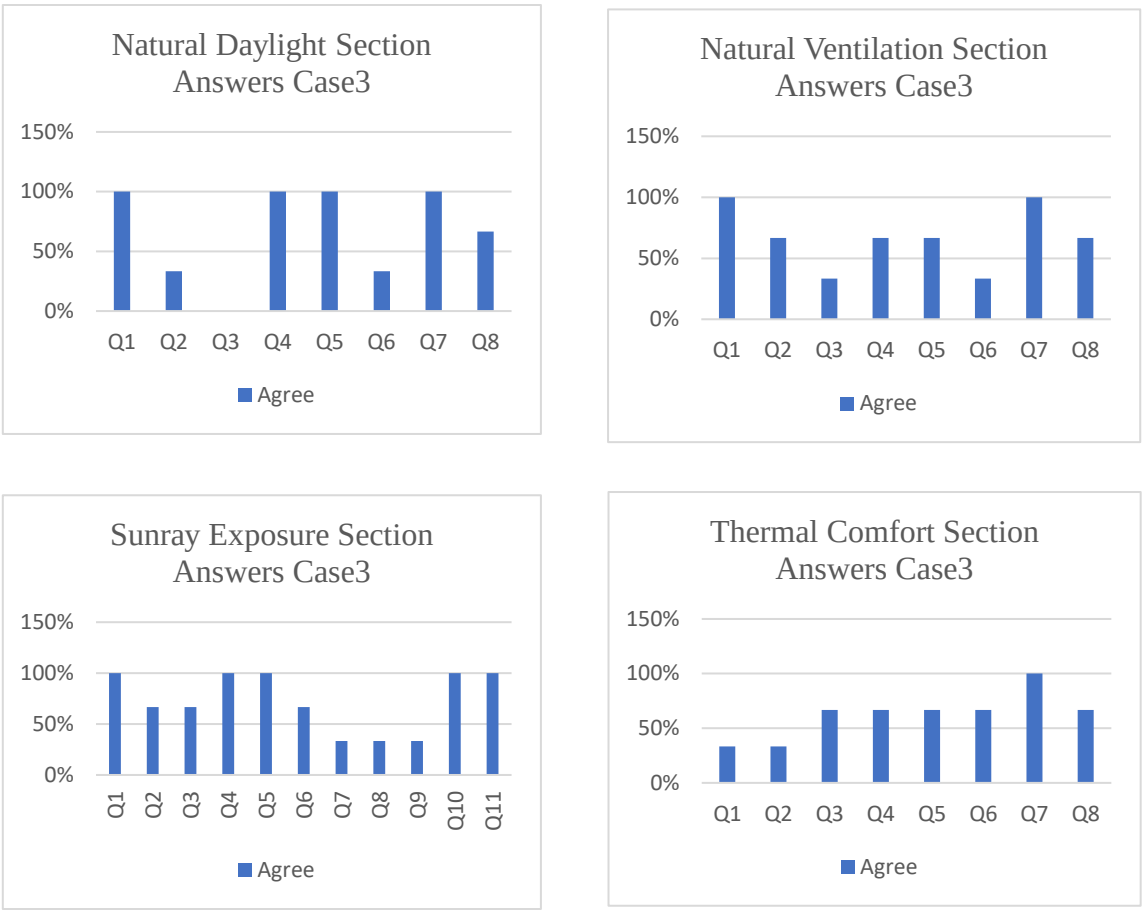


Figure 5.22 Case 3 Questionnaire Answers

4. Employee Satisfaction

The results from question one indicate higher satisfaction rates with each environmental basic need among males than females. While males are highly satisfied with sunray exposure, it is the least environmental basic need females are satisfied with.

- The chosen case studies are located east, west, or south of the buildings, which justifies the high satisfaction rate with sunray exposure.
- Daylight and natural ventilation satisfaction is due to the existence of windows in all of the cases.
- Male employees were least satisfied with the thermal conditions of the offices.

Table 5.11 Questionnaire Results, Employee Satisfaction

		Natural daylight	Natural ventilation	Sunray exposure	Thermal comfort
Male	Satisfied	87%	87%	94%	81%
	Unsatisfied	13%	13%	6%	19%
Female	Satisfied	33%	33%	17%	33%
	Unsatisfied	67%	67%	83%	67%

5. Employee Preferences

Employee preferences analysis was categorized into financial preferences and basic environmental needs preferences. The financial preferences helped indicate the expected retention rates associated with each environmental performance factor and whether employees would change their jobs for a better working environment for less income. The results in this section were surprising; males had higher expected retention rates associated with environmental needs than females. Females would only leave a workplace for a thermally more comfortable one, and only one female expressed willingness to search for a better-ventilated workplace, but never for lower pay. When missing, natural ventilation and thermal comfort are reasons why employees leave a workplace in Hebron even for less income.

Table 5.12 Questionnaire Results, Employee Financial Preferences

		Natural daylight	Natural ventilation	Sunray exposure	Thermal comfort
Male	Job search	44%	63%	50%	63%
	Less income	31%	44%	44%	56%
Female	Job search	0%	17%	0%	50%
	Less income	0%	0%	0%	50%

Employee basic environmental needs preferences analysis indicated employee’s preferred environmental needs for a comfortable workplace. Preferred basic environmental needs differ from employee satisfaction with these needs in the office. While 14 male employees expressed satisfaction with daylight performance at the workplace, only 10 stated that they rely on natural daylight more than artificial lighting during work hours. 13 male employees stated they are satisfied with the thermal performance of their workplace, but 13 said they mechanically adjust their office thermal status using air conditioning and other methods. As for females' answers

confirmed changing the office thermal environment using air conditioning or heaters. The absence of daylight was the main reason employees rated their workplace less. Female employees' basic environmental needs were expressed higher than males', except for thermal comfort.

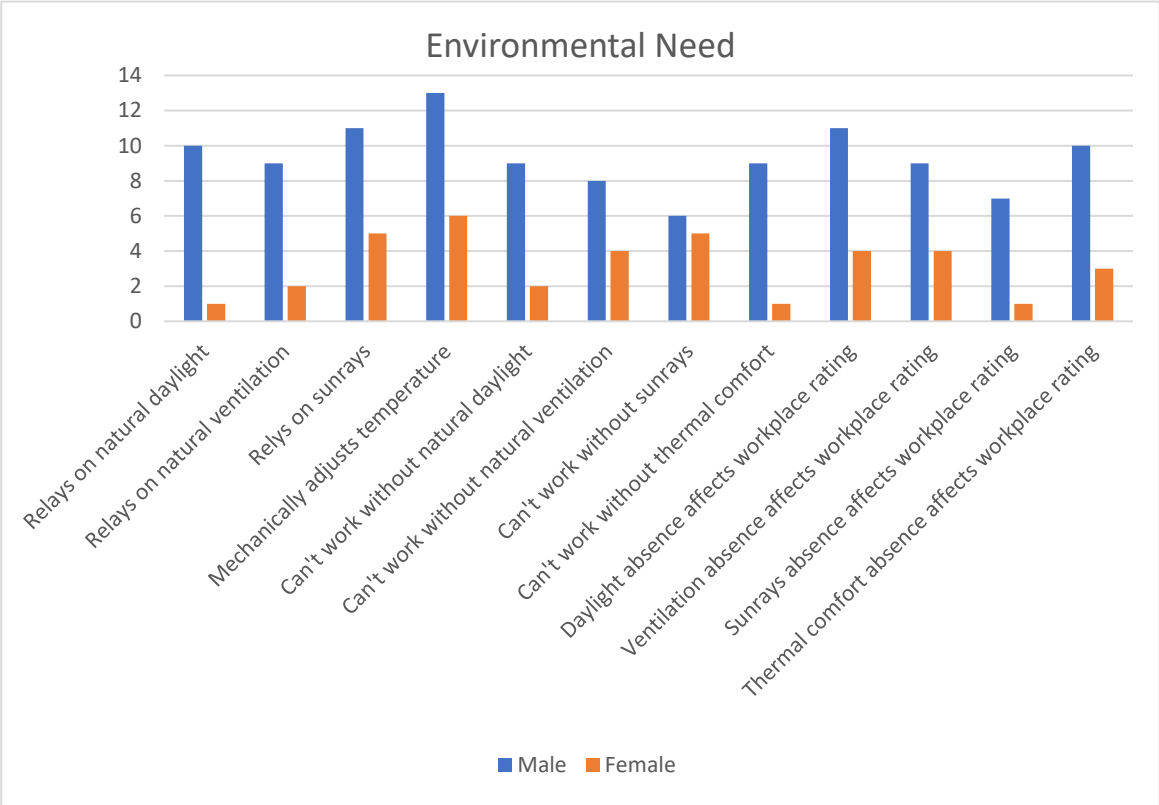


Figure 5.23 Questionnaire Results, Environmental needs

Regardless investors and client's preferences, employees expressed their crucial need for thermal comfort and daylight. Which indicates the importance of thermal insulation.

6. Employee Behavior (Performance and Productivity)

This section analyzes the relationship between environmental comfort at the workplace and employee productivity and well-being. Male and female employee's productivity rates are affected mainly by natural daylight. More than half of employees said they left their desks at another colleague's desk or went outside the building to seek more sunray exposure, which means less

time on desks. Employee's well-being mainly was affected by thermal comfort and indoor air quality IAQ.

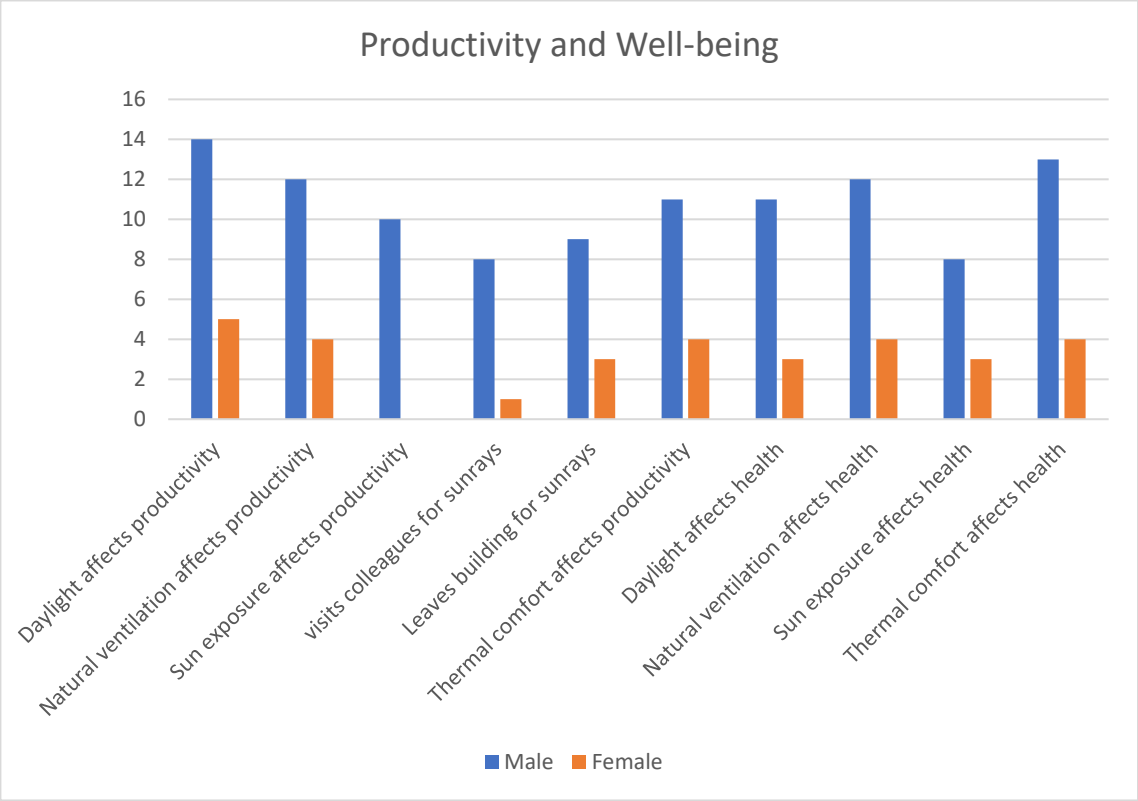


Figure 5.24 Questionnaire Results, Productivity and Well-being

5.2 Researcher's Confirmation

This section aims at finding the confirmation of all the interviews and questionnaire through last step investigation that connects all the collected data about the offices, current building typology in Hebron City, and the optimum preliminary environmental office design solutions associated with their relative cost calculations and payback periods. This step is done by computational simulation to investigate the current offices environmental performance and the optimum environmental performance. Calculations are then made to find the premium increase on initial costs.

5.2.1 Base Model Creation

Base model was established for each case utilizing building drawings acquired from the Licensing Department at Hebron Municipality, supplemented by the researcher's on-site observational investigations for real case plans and drawings. To validate each model, the annual average electricity bills for the year 2023 were obtained from the datasheet. Total energy consumption per square meter was then computed using Design Builder software version 6.1 and Excel sheets to determine the annual average energy costs for each office relative to its total area. The data for creating the base model for each case is provided in the appendices. Any slight variance between the average annual energy bill per square meter in the real case and in the model may be attributed to human behavior adapting to thermal discomfort rather than adjusting the internal environment.

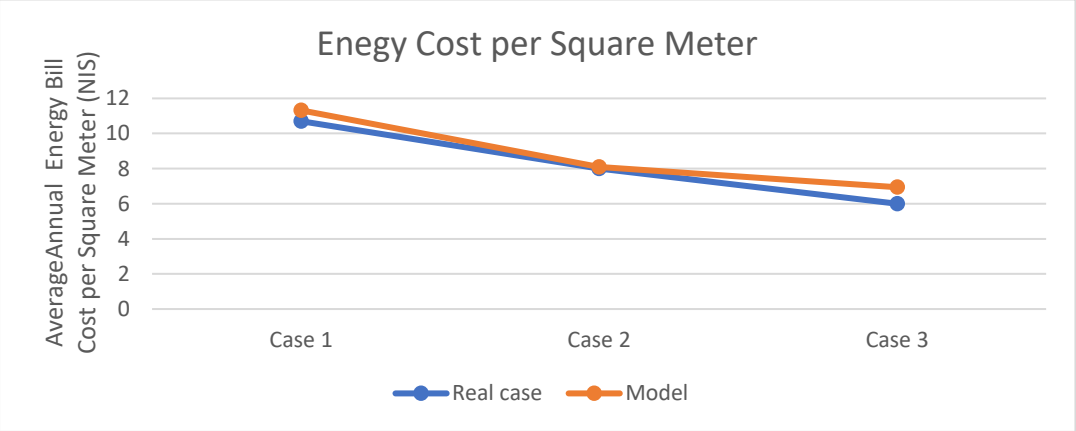


Figure 5.25 Case Studies Validation

5.2.2 Preliminary Design Environmental Considerations

In this section, environmental preliminary design considerations were applied to the base model of each case. these edits were the available and most commonly used environmental features in the Palestinian market and were applied as an example of the indication of initial costs increase in comparison to their energy consumption compared with the base case.

1. Thermal Comfort Considerations

Applied here are the features associated with thermal comfort. These features are only concerned with preliminary design parameters. While chapter 2 proposed other employee behavior and use of space features that are directly associated with thermal comfort, these will not be examined in this section as they are not proposed in the preliminary design stage.

1. Thermal-Break Window Frame

Thermal break aluminum window frames are available in the Palestinian market with several options. The results of applying these frames to the offices did now make any noticeable change on the heating or cooling loads, nor any obvious savings on the total energy loads. On the contrary, the analysis showed a slight increase on the loads in case 2. The only improvement that resulted from applying this feature was on the yearly average internal air temperature with an increase of 0.01 C^o. However, there are no savings associated with this improvement and it is not feasible compared with the 30-50% increase on initial costs.

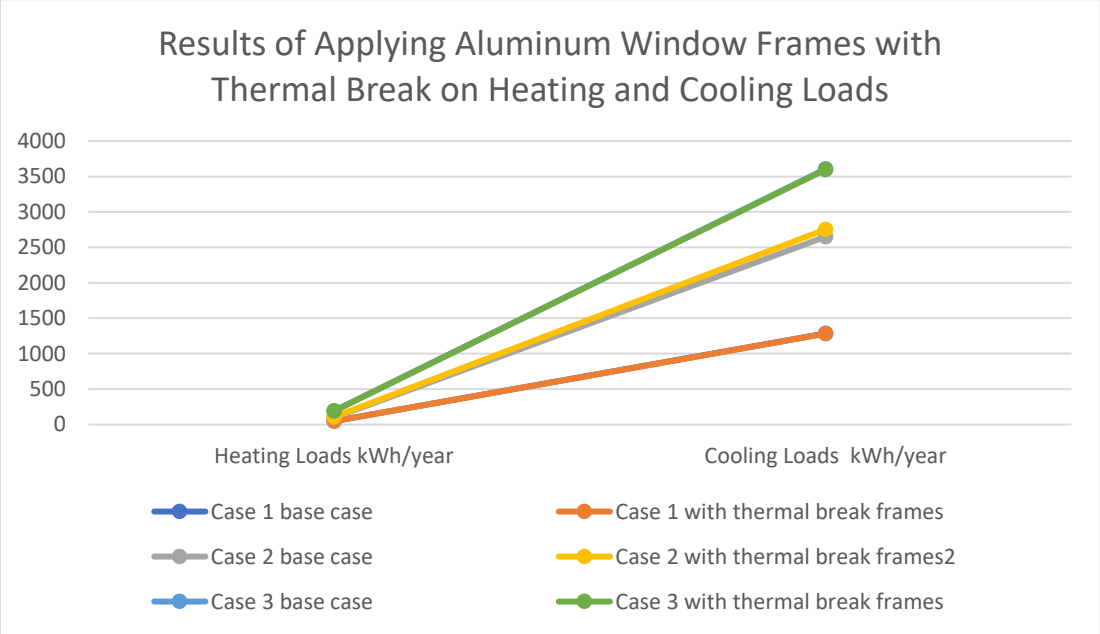


Figure 5.26 Results of Applying Aluminum Window Frames with Thermal Break

2. Thermal Insulation

Three examples of thermal insulation were applied to the base case of each office, those were the most common thermal insulation materials in the Palestinian market. Applying 0.04 m glass wool, polyurethane foam, and polystyrene boards (the minimum optimum thickness for buildings in Palestine) resulted savings of up to 85% on the heating loads and up to 30% on the cooling loads in one of the cases. Insulation application resulted an up to 10% decrease on the total annual electricity bill, and an increase of up to 4% on the average annual air temperature. However, there was no noticeable difference between the three types of insulation.

Table 5.13 Thermal Insulation Savings

Savings in	Base case	Glass wool	Polyurethane	Polystyrene
Case 1				
Heating loads	47.56 kWh	76%	77%	76%
Cooling loads	1285.22 kWh	29%	29%	28%
Total loads	5015.56 kWh	8%	8%	8%
Annual electricity bill	3410.58 NIS	273.36 NIS	275.84 NIS	271.85 NIS
Case 2				
Heating loads	96.29 kWh	85%	85%	85%
Cooling loads	2649.93 kWh	30%	30%	30%
Total loads	11189.5 kWh	8%	8%	8%
Annual electricity bill	7608.83 NIS	629.91 NIS	629.69 NIS	629.88 NIS
Case 3				
Heating loads	190.9 kWh	72%	72%	72%
Cooling loads	3605.56 kWh	19%	19%	19%
Total loads	8149.11 kWh	10%	10%	10%
Annual electricity bill	5541.39 NIS	556.54 NIS	556.13 NIS	556.38 NIS

3. Window to Wall Ratio (WWR)

Changing WWR is associated with heat transfer through the glazed parts of the office. Thus, it directly affects the occupant's thermal comfort. Regardless of the daylight analysis for each office at this step, this section only proposes the results for WWR effect on heating and cooling loads, total loads, and annual electricity bill savings.

Decrease in the heating and cooling loads resulted from changing the WWR with up to 89% decrease in heating loads, and 62% decrease on cooling loads. Unsurprisingly, reducing the WWR

from 41% to 20% in case 1 resulted an increase of 41% on the heating loads of this case due to less solar gain through glass.

Table 5.14 WWR Savings

Savings in	Base case WWR	WWR change	
Case 1			
	41%	WWR 20%	WWR 30%
Heating loads		-41%	89%
Cooling loads		5%	14%
Total loads		1%	4%
Annual electricity bill		29 NIS	152 NIS
Case 2			
	19%	WWR 30%	WWR 40%
Heating loads		60%	68%
Cooling loads		46%	62%
Total loads		12%	16%
Annual electricity bill		896 NIS	1218 NIS
Case 3			
	9%	WWR 20%	WWR 30%
Heating loads		51%	88%
Cooling loads		39%	7%
Total loads		18%	5%
Annual electricity bill		1022	292

4. PPD and PMV

PPD serves as an indicator representing the percentage of occupants dissatisfied with the thermal conditions in a given space. To qualify as thermally acceptable, the PPD percentage should not surpass 20%. However, the Predicted Mean Vote (PMV) must fall within the range of -1 to 1. A PMV measurement between 1 and 3 suggests occupants perceive the space as hot, while -1 to -3 indicates a sensation of extreme cold (Cheung et al., 2019). PPD and PMV analysis for the IEQ of the base models for each case indicated very high percentage of dissatisfaction that exceeded half of the occupants in winter and reached more than 80% in summer which confirms the results of the questionnaires for each office. Turning HVAC devices did make improvements on the base cases though, but these improvements still exceeded the standard percentage except for case 1 that showed a PPD of 9.81% when HVAC was on in summer. Nonetheless the load needed to achieve this percentage was presented in table 5.11. However, changing the glazing type did not affect the PPD and PMV results.

Table 5.15 PPD and PMV Results

	PPD %						PMV					
Case 1												
	January			July			January			July		
Base case	54.71			68.09			-1.57			1.82		
HVAC on base case	52.78			9.81			-1.53			0.48		
Thermal insulation	GW	PUR	PS	GW	PUR	PS	GW	PUR	PS	GW	PUR	PS
	13.35	13.26	13.35	6.15	6.11	6.15	-0.63			-0.23		
WWR Change	20%		30%	20%		30%	20%		30%	20%		30%
	11.97		14.48	11.06		8.05	-0.58		-0.67	0.54		0.38
Case 2												
	January			July			January			July		
Base case	53.14			45.88			-1.54			1.41		
HVAC on base case	51.85			21.90			-1.52			0.89		
Thermal insulation	GW	PUR	PS	GW	PUR	PS	GW	PUR	PS	GW	PUR	PS
	12.82			7.69			-0.61			-0.36		
WWR Change	30%		40%	30%		40%	30%		40%	30%		40%
	10.95		9.47	60.92		8.53	-0.53		-0.46	0.30		0.41
Case 3												
	January			July			January			July		
Base case	46.41			85.24			-1.42			2.21		
HVAC on base case	40.52			54.51			-1.30			1.57		
Thermal insulation	GW	PUR	PS	GW	PUR	PS	GW	PUR	PS	GW	PUR	PS
	7.83	7.81	7.83	10.98	11.03	10.98	-0.37			0.53	0.54	0.53
WWR Change	20%		30%	20%		30%	20%		30%	20%		30%
	6.95		7.53	89.42		92.82	-0.31		-0.35	2.34		2.47

5. Glazing Type

By interviewing the leading glazing manufacturers in the context of the study, the most common glazing types were obtained and confirmed with the theoretical background findings. The most common glazing types that are used in projects are:

- Ordinary glazing: this glazing comes clear or tinted with no thermal treatments and the thickness used in Hebron is 6 mm glazing – 6 mm air gap – 6 mm glazing for commercial projects and 9 mm air gap with the same glazing thickness for residential projects.

- Laminated glazing: this is a treated type of glazing that provides better sound insulation rather than heat treatments

- Tampered glass: is heat treated with 700 C^{o} oven to form a very strong glazing formula that works best for safety considerations. However, this glazing type is considered expensive by customers and only high-end residential buildings use it. The thermal performance of tampered glass however does not differ from the ordinary glazing.
- Low emissivity glazing: is considered the best thermally performing type of glazing, manufacturers confirmed heating loads savings with this type may be up to 50%. While the simulation results for applying double clear and tinted low-e 6 mm glazing with 6 mm air gap provided less savings. Attached in the appendices is the results of applying two different glazing types to the case studies.

2. Daylight Considerations

Considerations during the preliminary design phase that directly impact daylight distribution in buildings include the window-to-wall ratio, window-to-floor ratio, building orientation, and glazing type. While all these factors are relevant to daylighting, not all of them exhibit associated cost differences. Some factors lack direct cost measurements, such as those influencing lost sellable office area, and these will not be explicitly discussed in this section.

1. Window to Wall Ratio (WWR)

Changing WWR did not only benefit increasing the solar gain and thus decreasing heating loads, but it also enhanced the internal daylight distribution in all the cases. Attached in the appendices are daylight analysis figures for each case before and after edits on WWR. Table 5.16 below shows the percentage of 300 lux illuminance distribution in each case according to WWR. It is noteworthy to highlight that despite the simulation results indicating a suboptimal daylight factor distribution, mostly in Case 3, employees in all cases expressed satisfaction with the natural light distribution in their offices in the questionnaire.

Table 5.16 Daylight Analysis Results

Case	Daylight factor distribution		
Case 1	Base case WWR 41%	WWR 20%	WWR 30%
	53.5%	40.7%	52.3%
Case 2	Base case WWR 19%	WWR 30%	WWR 40%
	68.14%	98%	99% (with glare)
Case 3	Base case WWR 9%	WWR 20%	WWR 30%
	28.75%	61.25%	68.75%

2. Glazing Type

Changing the glazing to low-e double clear glass showed no effect on the daylight analysis for any of the cases. However, the low-e double grey tinted improved the daylight analysis in case 1 to be 57% with 30% WWR and reduced the glare in case 2 with the same illuminance distribution.

5.2.3 Optimization Process Results

As discussed in the chapter 4, this section encompassed two steps of optimization, environmental parametric and optimization simulation analysis for preliminary design suggestions, followed by financial optimization.

1. Parametric Environmental Analysis

As part of the confirmation stages, parametric analysis was conducted for each of the preliminary design edits to later compare them in the subsequent computerized optimization, ensuring the consistency and matching of the results.

1. Thermal Insulation

The parametric analysis for the three types of thermal insulation showed very close results. By observing the effect on heating and cooling loads, it is noticed any type of insulation would provide the same annual saving.

Thus, applying thermal insulation of a certain type depends completely on economic concerns.

2. Window to Wall Ratio (WWR)

This parametric analysis of the Window-to-Wall Ratio (WWR) involved two stages. The first stage aimed to identify the optimal WWR for reducing cooling, heating, and total energy loads, considering Predicted Percentage of Dissatisfied (PPD) and Predicted Mean Vote (PMV) results. The second stage focused on daylight analysis, considering potential glare issues. In Case 1, a 30% WWR achieved significant savings in cooling (14%) and heating (89%) loads, with acceptable PPD and PMV results. However, 20% WWR exhibited better PPD and PMV, and 30% WWR performed better in daylight analysis. In Case 2, 40% WWR outperformed 30% WWR in load savings, but faced glare issues despite better PPD results. In case 3, 20% WWR outperformed the 30% WWR in loads reduction, PPD and PMV analysis, while 30% WWR performed better in terms of daylight analysis.

Table 5.17 WWR Parametric Analysis

Case	Stage 1 - loads	Stage 1 – PMV & PPD	Stage 2 - daylight
Case 1	WWR 30%	WWR 20%	WWR 30%
Case 2	WWR 40%	WWR 40%	WWR 40%
Case 3	WWR 20%	WWR 20%	WWR 30%

3. Glazing Type

In terms of daylight analysis, results have shown no change when using low-e double clear glazing, while using low-e double grey tinted glazing improved the daylight analysis in case 2, and reduced the glare in case 3 for 40% WWR.

2. Environmental Optimization

This stage conducted computerized optimization for the best-case scenario including the three types of insulation, all suggested edits on WWR including base-case WWR and glazing type examples. The optimization resulted various options for each case in terms of IEQ improvements and loads decrement. However, only those with the highest saving in cooling loads (primarily), and heating loads consequently, were proposed in table 5.18 below. Case 3 had only one optimum chosen scenario as all the other scenarios had noticeable less savings.

Table 5.18 Preliminary Design Environmental Optimization

Scenario	Thermal insulation	WWR%	Glazing type	Cooling loads savings (NIS)	Heating loads savings (NIS)
Case 1					
1	Polystyrene	20%	Double low-e tinted	125	31
2	Polyurethane	20%	Double low-e clear	135	31
3	Polyurethane	30%	Double low-e tinted	263	31.5
4	Glass wool	30%	Double low-e tinted	254	31.5
5	Polyurethane	40%	Double clear 6 mm air	252	25
Case 2					
1	Polyurethane	20%	Double low-e tinted	568	61
2	Glass wool	20%	Double low-e clear	569	61
3	Polystyrene	20%	Double low-e tinted	569	61
4	Polyurethane	40%	Double low-e clear	1819.5	69
5	Glass wool	40%	Double low-e tinted	1798	69
6	Polystyrene	40%	Double low-e clear	1790	69
Case 3					
1	Polystyrene	20%	Double low-e tinted	1893	112

The highlighted scenarios in table 5.18 are the ones that resulted the highest savings in the cooling loads then in the heating loads, table 5.19 below shows the daylight analysis for each scenario. It is noteworthy that both Case 1 and Case 2 did not meet the standard daylight distribution for offices, emphasizing the importance of preliminary design considerations such as plan depth and Window-to-Floor Ratio (WFR). Despite this, the achieved percentages are relatively close to the standard of 300 lux distributed over 75% of the plan. Designing buildings with an environmental design approach can enhance performance in terms of daylight and cross natural ventilation, although it may involve a slight compromise in terms of spatial dimensions to align with environmental preferences.

Table 5.19 Daylight Analysis for Optimum Environmental Scenarios

Scenario	Thermal insulation	WWR%	Glazing type	Cooling loads savings (NIS)	Heating loads savings (NIS)
Case 1					
1	Polyurethane	30%	Double low-e tinted	263	31.5
2	Glass wool	30%	Double low-e tinted	254	31.5
Daylight Distribution			57%		
Case 2					
1	Polyurethane	40%	Double low-e clear	1819.5	69
2	Glass wool	40%	Double low-e tinted	1798	69
Daylight Distribution			99%		
Case 3					
1	Polystyrene	20%	Double low-e tinted	1893	112
Daylight Distribution			68.25%		

3. Financial Calculations

This segment focuses on linking the suggested environmental scenarios with their respective costs, ultimately optimizing a single scenario for each case. The optimal scenario is characterized by the lowest investment cost, coupled with the attainment of the highest benefits, Return on Investment (ROI), and the shortest payback period. Table 5.20 delves into these financial advantages, overlooking social costs, as they remain consistent across all cases, and because the calculations proved the viability and short payback periods even before applying social costs calculations.

It is worth noting that the prices used in the calculations were the ones that were proposed earlier in chapter 2 and were obtained from the Palestinian Green Council Feasibility Study. Those prices were also compared with different merchants and manufacturers in the context of the study. (Reference 2.5)

Table 5.20 Financial Calculations for Optimum Scenarios

Case 1 – base	WWR: 41%	Glazing area: 4.4 m^2	Wall area: 6.3 m^2
Scenario 1 + 2	WWR: 30%	Glazing area: 3.21 m^2	Wall area: 7.49 m^2
Scenario 1 - added cost (NIS)	Glazing: 405	Insulation: 180	Total added initial cost: 585
Annual savings: 294.5	Benefit (3 years): 298.5	ROI (3 years): 51%	Payback period: 23 months
Scenario 2 – added cost (NIS)	Glazing: 405	Insulation: 67	Total added initial costs: 472
Annual savings: 285.5	Benefit (3 years): 384.5	ROI (3 years): 81.5%	Payback period: 20 months
Case 2 – base	WWR: 19%	Glazing area: 9 m^2	Wall area: 48 m^2
Scenario 1 + 2	WWR: 40%	Glazing area: 19.2 m^2	Wall area: 28.8 m^2
Scenario 1 - added cost (NIS)	Glazing: 4667	Insulation: 691	Total added initial cost: 5358
Annual savings: 1888.5	Benefit (3 years): 307.5	ROI (3 years): 5.7%	Payback period: 34 months
Scenario 2 – added cost (NIS)	Glazing: 4667	Insulation: 258	Total added initial costs: 4925
Annual savings: 1867	Benefit (3 years): 676	ROI (3 years): 13.7%	Payback period: 32 months
Case 3 – base	WWR: 9%	Glazing area: 1.3 m^2	Wall area: 13.4 m^2
Scenario 1	WWR: 20%	Glazing area: 2.68 m^2	Wall area: 10.72 m^2
Scenario 1 - added cost (NIS)	Glazing: 646	Insulation: 129	Total added initial cost: 775
Annual savings: 2005	Benefit (3 years): 5240	ROI (3 years): 676%	Payback period: 5 months

The findings indicate that increasing the investment costs in Case 1 by 18.15 NIS/m2 ensures investors recover their investment within six months, yielding a profit of up to 381.5 NIS within the first three years. In Case 2, the higher investment costs, up to 76.36 NIS/m2, can be recouped within the initial 32 months. In Case 3, the additional investment costs of 27.68 NIS/m2 are recovered within 5 months. All payback periods align with client's stated acceptable payback period between 2-3 years or higher.

Table 5.21 Average Increase on Initial Costs

	Case 1	Case 2	Case 3	Average
Increase on initial costs ($/m^2)	4.9	20.6	7.47	10.99

The variability in the initial investment cost across the three cases is attributed to factors such as the external wall area and office orientation. Despite these differences, the premium investment percentage remains below 2% relative to the average initial investment cost per square meter of $1000. This average is derived from interviews with investors of the study buildings. Other additional costs are implicit in achieving optimal environmental practices for office buildings, often manifesting as a reduction in square meterage when implementing environmentally active floor areas. Yet, quantifying the reduction in office space resulting from the incorporation of environmental techniques depends on the original design. When contrasting the resulting percentage with the table outlined in Chapter 3, the observed increase in upfront costs closely aligns with European standards rather than those of Jordan, despite the geographical proximity. This discrepancy may be attributed to distinct initial costs in Jordan, where the construction and design patterns for office buildings differ significantly from those in Palestine, often featuring extensive glazing and taller structures.

4. Final Optimization Results

It is important to highlight that the research objective is to assess the viability of initial environmental design proposals, rather than identifying optimal environmental solutions. To attain the optimum foundational environmental requirements for a design, environmental solutions must be introduced early in the design process. While the theoretical framework does not offer a universal solution for all preliminary design phases in offices, it does provide standard values for evaluating environmental performance. Consequently, to ensure precise financial calculations, environmental optimization became essential.

Ultimately, there is no one-size-fits-all solution for environmental considerations in preliminary design. Attaining the desired environmental performance for office buildings necessitates thorough preliminary design consideration and simulation through trial and error. The optimal

preferences for each building depend on factors such as orientation, area, location, and preferred design parameters.

5.3 Conclusion

The financial calculations associated with incorporating environmental design preferences reveal a modest increase of no more than 2% on initial costs, notwithstanding the reduction in floor area. This aspect will be further investigated in the following chapter. Despite investors generally endorsing a premium increase of 10-20%, the resulting percentage proves significantly lower. Investors can capitalize on this addition by incorporating the increase into the office's selling price. Given that clients are amenable to a 10-20% hike in the initial price, investors can reap double or triple profits without compromising environmental considerations, and it still would be considered acceptable by clients. Furthermore, this represents the additional initial expenditure incurred in establishing a workplace that aligns with environmental preferences as voiced by employees. Among the various preferences expressed, daylight and thermal comfort emerged as the two most crucial factors. These preferences were accorded significant weight in determining the essential environmental features to be implemented.

Returning to the hypothesis of this study, it is evident that the additional cost associated with the implementation of environmental preliminary design techniques is lower than the initially presumed 10%. Moreover, the viability of adopting this cost-effective environmental approach appears to be significantly more favorable.

An alternative method to assess the viability of implementing environmental features involves comparing its payback period with the widely accepted payback period for solar energy systems in the current Palestinian community, which stands at 7 years. Surprisingly, the payback period resulting from the integration of preliminary design environmental features into office buildings is less than half of the duration already embraced by the community.

Opting for environmental preferences ensures a quicker sale of properties, leading to a higher time value of money, increased occupancy rates, enhanced cash flow, and overall success for the entire building. These preferences also secure elevated selling and rental values for property investment clients while concurrently reducing energy consumption and electricity bills. The social benefits include a lower employee absenteeism rate, improved performance, heightened productivity, and overall satisfaction, ultimately translating into company gains in the form of higher revenue.

Chapter 6

Conclusion and Recommendations

6.1 Preface

The process in this stage followed the Lean Six Sigma (DMAIC) method to analyze the real estate business sector in the study context and be able to come out with defined influential factors and recommendations to improve and control the early stages of the business as follows:

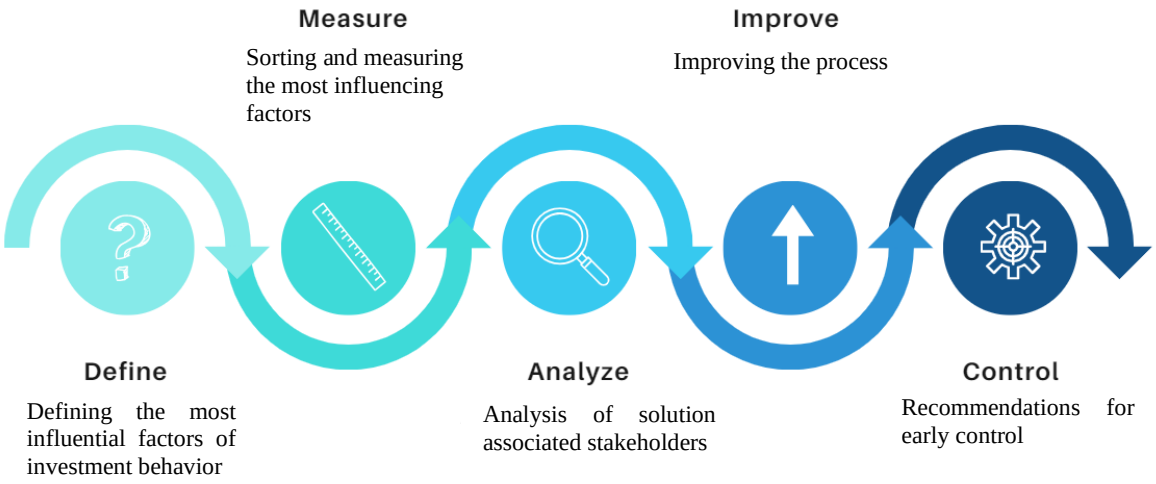


Figure 6.1 DMAIC Process for Conclusions and Recommendations

6.2 Defining the Influential Factors of Investment Behavior

Building upon the barriers outlined in Chapter 3 that impact investments in environmental buildings, this section identifies the key factors that significantly hinder the implementation of environmentally friendly office buildings in the Palestinian context. The insights presented were derived from the findings obtained through interviews and questionnaires conducted in the preceding chapter. The influencing factors highlighted in table 6.1 below are the ones that previously formed the labels and patterns in Delve software thematical analysis.

Influential factors were categorized across different stakeholders in the context of environmental office buildings in Palestine. Key stakeholders are the ones with whom the interviews were held, they include engineering offices, Hebron Municipality, investors, and clients. All data under each stakeholder similarly explore the interplay of factors extracted from all interviews in the form of themes and labels, providing a comprehensive understanding of the dynamics shaping the investment behavior and decision-making processes in the realm of environmental office buildings. An explanation of the provided color scheme will follow in table 6.2, section 6.3.

Table 6.1 Influential Factors of Investment Behavior in Palestine Defined Themes

Engineering offices	Hebron Municipality	Investors	Clients
Engineering staff knowledge of environmental practices	Lack of law implication	Knowledge of environmental buildings	Accurate definition of environmental buildings
enforced laws for implementing environmental strategies	Lack of incentives	Accurate definition of environmental practices	Environmental preferences and needs
Up to date engineering staff	Building ownership (private, public, governmental ..)	The engineering staff	Clients' willingness to pay
Capability of environmental technologies application	Funding availability	Previous exposure to environmental buildings	Services vs environmental?
Recent real estate vs older real estate	Investment behavior - real execution vs licensing	Previous expertise and owned buildings	Payback period variation
Personal assumptions on the feasibility of environmental features	Client's willingness to pay – market demand	Intersected influence with engineers and their preferable investment	
Investors personal preferences based on their expertise in the market	Occupation and lack of available lands	Clients want environmental designs and services	
Noise for natural ventilation application	Advantage to the municipality through energy reduction	Economic preferences rather than environmental	
Investors prefer design over environmental	Multiple stakeholders' framework	Investor time in the market and their reputation	
	Workshops and awareness raising	Buildings are becoming environmental	
	Economic influence on investors rather than social or environmental	Real execution difference from licensed drawings	
		Environmental practices priorities	
		Losing office area	
		Lack of incentives	
		Environmental buildings sell faster	

6.3 Sorting and Measuring the Most Influencing Factors

All the previously defined influential factors align under five main categories that are:

1. Economic factors.
2. Knowledge and awareness.
3. Preferences, assumptions, and social practices.
4. Laws, incentives, and governmental factors.
5. Engineering staff related factors.

These five categories have been identified and defined as the primary influential factors shaping real estate investment behavior in the Palestinian market. Notably, the economic factor was debunked in the preceding chapter through a comprehensive process involving interviews, simulations, and calculations. The outcome revealed a premium increase of no more than 2% when adopting optimal practices for achieving daylight and thermal performance. Furthermore, the considerations of both economic and financial aspects, whether from investors or their clients, are significantly influenced by the fourth factor. This factor pertains to the enforcement of laws, provision of incentives, and other governmental measures aimed at offsetting higher investment costs and motivating all stakeholders to actively engage in the implementation of environmental practices.

Similarly, these five factors are interlinked, with each exerting influence on the others. Financial considerations, coupled with knowledge and awareness, collectively shape investment behavior. Simultaneously, the proficiency of engineering plays a direct role in shaping awareness and, consequently, influencing investment behavior. It is a collaborative and intertwined process that encompasses all considerations to effectively integrate environmental factors, with each factor initiating the process.

While past research often emphasized assigning weights to influential factors, this thesis's approach reveals the significant impact each factor holds within a circular process, highlighting the crucial relevance of every individual factor in the overall dynamics.

Yet, to gauge the significance of each primary factor category, the frequency with which sub-influential factors were cited across various interviewee categories was adopted as a metric for its importance. However, other measurement methods can also be considered.

Table 6.2 Sorting the Most Influential Factors into Common Categories

Economic Factors	◆◆◆
- Client's willingness to pay and market demand - Payback period and time to sell - Losing office area - Talking economic not environmental - Funding availability - Services vs environmental? - Occupation and lack of lands	
Knowledge and Awareness	◆◆◆
- Recent real estate vs older real estate - Workshops and awareness raising - Accurate definition of environmental buildings - Previous exposure to environmental buildings - Previous expertise and owned buildings - Investor time in the market and their reputation	
Preferences, Assumptions, and Social Practices	◆◆◆◆
- Investors personal preferences - Personal assumptions on the feasibility of environmental features - Client's environmental preferences and needs - Clients want environmental designs and services - Real execution differs from licensed buildings - Building ownership - Building use behavior	
Laws, Incentives, and Governmental Factors	◆◆◆
- Enforced laws for implementing environmental strategies - Lack of incentives - Benefit to municipality	
Engineering Staff Related Factors	◆◆◆
- Engineering staff expertise - Up to date engineers - Capability of environmental practices application - Multiple stakeholders' framework	
*◆ : frequently mentioned	

Given the significance of the aforementioned factors to the majority of interviewees, they all underwent the process of scrutinizing the solution and subsequent steps for enhancement and control.

6.4 Analysis of Solution Associated Stakeholders and Entities

Embracing a solution-oriented mindset marks the initial phase in comprehending the origin of the issue. As previously discussed, integrating environmental principles into a mindset, rather than merely adopting them as an investment strategy, is a complex process involving multiple stakeholders beyond the investor.

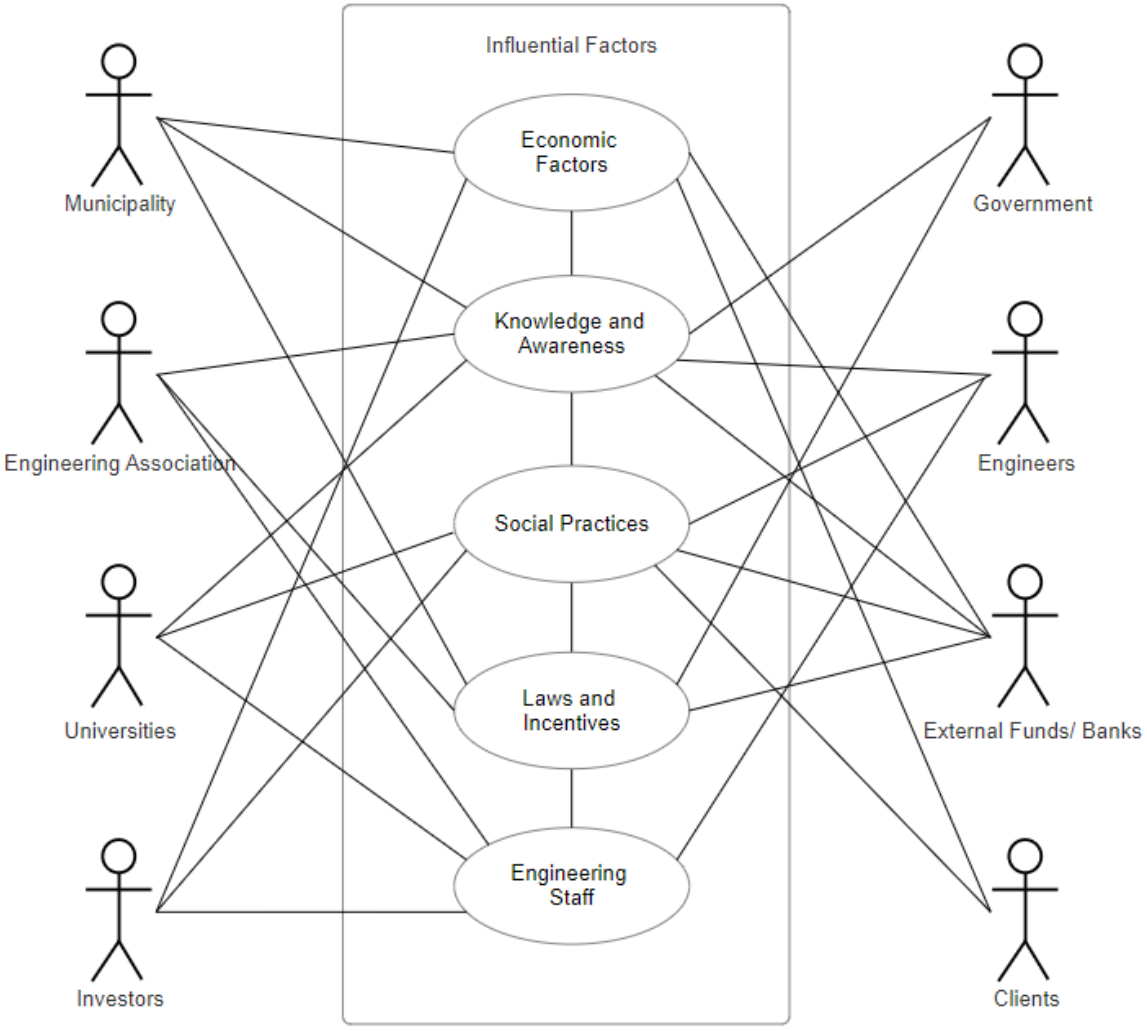


Figure 6.2 Use Case Diagram for Stakeholders and the Influential Factors

The journey commences at educational institutions, where engineers and architects graduate, carrying the thoughts and ideas instilled by their educators, whose perspectives may not align with the latest environmental requirements. When engineers graduate equipped with comprehensive knowledge of environmental design thinking, they can impart this understanding to investors commissioning their building designs. However, investors may harbor traditional mindsets resistant to embracing new ways of thinking, shaped by their expertise and past experiences in the market. This is where the role of the engineering association, and other responsible entities become crucial in disseminating awareness and knowledge among investors, emphasizing the significance of integrating environmental considerations into real estate investments despite financial and economic challenges. While awareness campaigns may incur expenses, local banks' sustainability development plans, along with external funding, play a vital role in contributing to the overall sustainability of the local community.

6.5 Improving the Process

To enhance the process and offer a comprehensive set of recommendations for future control and error prevention in the environmental real estate sector in Palestine, it is crucial to allocate each task to its respective stakeholder responsible for addressing it proactively. The improvement process initiates with the involvement of relevant stakeholders for each factor, outlined in table 6.3 as follows:

Table 6.3 Improving the Influential Factors

Influential factor	Responsible Stakeholder	Recommendations
Economic Factors (Chapter 6 – Section 6.6 - 1)		
Client's willingness to pay and market demand	Investors, awareness factor associated stakeholders	Effective marketing campaigns that highlight the environmental features + awareness campaigns
Payback period and time to sell	Investors, clients	Highlighting that the payback period does not exceed 32 months
Losing office area	Municipality, clients	Office price covers lost meters + municipality represents investors with Ministry of Local Governorate
Talking economic not environmental	Engineering offices	Adopt a feasibility study for environmental features as a case
Funding availability	External funds	External funds should apply to environmental buildings of private sector as well
Services vs environmental?	Investors + Engineering Association + municipality	Services are not to be compromised
Occupation and lack of lands	-	-
Knowledge and Awareness (Chapter 6 – Section 6.6 - 2)		
Recent real estate vs older real estate	Municipality, Engineering Association, engineers, universities …	Clear definition of environmental buildings
Accurate definition of environmental buildings		
Previous exposure to environmental buildings	Investors, municipality	Knowledge exchange
Previous expertise and owned buildings		
Investor time in the market and their reputation		
Workshops and awareness raising	Municipality, Engineering Association, engineers...	Awareness campaigns
Preferences, Assumptions, and Social Practices (Chapter 6 – Section 6.6 - 3)		
Personal assumptions on the feasibility of environmental features	Engineers, universities	Awareness, feasibility planning, studies proposing
Investors personal preferences	Engineers	Environmental and aesthetic should not contradict
Clients want environmental designs and services	Engineering Association, municipality…	Services are not compromised in favor of environmental designs
Client's environmental preferences and needs	Investors, engineers	Investors and engineers should perform market studies to know the needs and preferences of their clients without assumptions.
Building ownership	Municipality	Certain stake is kept for investor
Real execution differs from licensed buildings	Municipality	Better control, enforcement of law
Building use behavior	Clients and municipality	Awareness campaigns
Laws, Incentives, and Governmental Factors (Chapter 6 – Section 6.6 - 4)		
Enforced laws for implementing environmental strategies	Government, municipality, Engineering Association, external funds	Environmental buildings department
Lack of incentives		Creation of incentives system
Benefit to municipality	Municipality	Benefits system with points
Engineering Staff Related Factors (Chapter 6 – Section 6.6 - 5)		
Engineering staff expertise	Engineering Association, university	Regular workshops, awareness campaigns, technical support
Up to date engineers		
Capability of environmental practices application		
Multiple stakeholders' framework	Engineering Association	Regular meetings to bridge the gap between investors and engineers

6.6 Recommendations for Early Control

The recommendations presented in this section aim to expand the main points presented in the last column in table 6.3 for enhancing each category of the influential factors mentioned earlier in relation to the respective stakeholders.

1. Economic Factor recommendations:

- Client’s willingness to pay and market demand:

  To underscore the significance of environmental features, investors should execute robust marketing campaigns emphasizing the value they bring in terms of potential energy savings and internal environmental quality. Marketing initiatives should tap into well-established knowledge stemming from awareness programs and the prevalent environmental thinking culture disseminated by universities, reaching every student, not solely those in architecture. The responsibility for promoting the environmental aspect of sustainability awareness campaigns should extend to every company, particularly those benefitting from external funds, as part of their social responsibility.

- Payback period and time to sell:

  The research findings affirm a reasonable payback period for office users, capped at 32 months, aligning with clients' expectations as revealed in interviews. However, clients require reassurance of this timeframe, as it remains unfamiliar to them, leading to apprehensions about potential additional costs for environmental features. For clients considering these offices for investment purposes, it is crucial to assure them that environmentally conscious offices have a quicker selling pace, supported by unanimous investor confirmation and corroborated by the research findings.

- Losing office area:

  A default outcome of achieving environmental features is the loss of sellable office area. While one meter may cost $1000, the potential recouped value can reach $2000, which

investors perceive as a substantial loss. To address this, a dual approach involving client understanding and collaboration from responsible entities through incentives is necessary. Clients could absorb a portion of this increase, as detailed in the previous chapter. However, a more substantial role falls on the Ministry of Local Governance, which can facilitate additional land use percentages or vertical expansion, depending on the case, through density bonus incentives.

- Talking economic not environmental:

  Engineering offices should communicate in the language of finance to effectively engage with investors. It is imperative for these offices to incorporate a professional environmental engineer well-versed in the economic sustainability aspects linked to the implementation of environmental features. This expert can present compelling proposals to investors, encouraging them to embrace an environmentally conscious mindset.

- Funding availability:

  External funding for the construction of new buildings or retrofitting is accessible to the public sector. It is recommended that external funding entities promote investor participation by extending the availability of these funds to the private sector. This can be achieved through government or municipal incentives under proper control and regulation.

- Services vs environmental?

  Services shouldn’t be compromised in the first place. They must be regulated by governmental and local entities to assure the well execution of comfortable services and then clients wouldn’t have a choice of a premium increase but to pay for environmental features.

2. Knowledge and Awareness

- Accurate definition of environmental buildings:

Given the ambiguity surrounding the precise definition of environmental buildings among investors and clients, it is crucial to provide a clear and comprehensive definition of the term and its associated features. This ensures that every stakeholder is well-informed about what to request, look for in a property, and be willing to pay for.

- Previous expertise of older investors:

  Older investors with prior experience in the same sector, those who have traveled and encountered various environmental buildings in different regions, and individuals who prioritize their market reputation and aim for a premium standing should engage with new investors in the market. They can share their knowledge through organized workshops and meetings, facilitated with the support of the municipality as part of the collective social responsibility of all stakeholders. Implementing a scoring scheme for each stakeholder can further incentivize such knowledge transfer, potentially leading to discounts and other incentives as a form of acknowledgment.

- Workshops and awareness raising:

  Vital to the real estate investment cycle, comprehensive awareness campaigns, led by experts and targeted at engineers and all stakeholders in the local community, play a crucial role in disseminating awareness about the environmental aspect of sustainability. These campaigns should be extensive, seeking support from major companies and banks as part of their social responsibility to the local community. By doing so, these initiatives aim to bridge the significant gap among the stakeholders involved in the environmental real estate investment process.

3. Preferences, Assumptions, and Social Practices

- Personal assumptions on the feasibility of environmental features:

  Within the awareness campaigns, there should be a focus on altering social practices and mindsets to enhance flexibility and foster greater acceptance of change. Investor assumptions regarding the costs of environmental features should be corrected through tangible evidence such as feasibility studies, as previously discussed.

- Investors personal preferences:

  Investors prioritize the aesthetic appeal of buildings over environmental considerations, often opting for aesthetics if forced to choose between the two. Aesthetic choices may involve sacrificing sellable area for a grand entrance, but investors are less willing to accept such losses for environmental features. Therefore, engineers should strive to achieve aesthetic values at minimal costs, allowing room for the implementation of environmental practices without compromising on aesthetics.

- Clients want environmental designs and services:

  As previously noted, when services are inherent in buildings, clients do not face a choice between compromising on one of the two fundamental needs: services and the environment.

- Client’s environmental preferences and needs:

  This study, through questionnaires, has provided an initial insight into the requirements and preferences of clients concerning basic environmental needs. A broader survey encompassing all employees within the study's context or, at the very least, a representative sample, could be conducted regularly to ensure an up-to-date understanding of the preferences of clients in the real estate sector.

- Building ownership:

  Municipalities should oversee the property ownership dynamics between investors and their clients. All interviewees emphasized the significance of an investor maintaining a stake in their investment property. Therefore, it could be advantageous for municipalities to implement measures preventing investors from selling a specific percentage of buildings, ensuring the overall maintenance and upkeep of the entire structure.

- Real execution differs from licensed buildings:

  Several investors deviate from the licensed drawings during the execution of their buildings. While this matter is not directly associated with environmental building

practices, it impacts spaces, parking, and services. However, when this mindset and social practice are extended to environmental design drawings post-licensing, the intended purpose is compromised. Stringent monitoring and law enforcement by the municipality are essential to ensure alignment between the licensed plans and the actual execution.

- Building use behavior:
  Occupants vary in their preferences for building use, with some favoring natural ventilation and others opting for the HVAC system. However, basic environmental requirements should be incorporated into buildings, irrespective of individual preferences. For instance, night natural ventilation could be utilized instead of daytime natural ventilation to improve indoor air quality (IAQ) and reduce energy consumption for heating and cooling during the day.

4. Laws, Incentives, and Governmental Factors

- The government should establish a comprehensive legislative framework mandating basic environmental requirements for investors in new construction projects. Oversight and enforcement can be managed by a dedicated department, the Environmental Buildings Department, which collaborates with both the Buildings Department and the Licensing Department in municipalities, ensuring an environmentally oriented approach. This department's responsibilities extend beyond enforcing environmental laws; it includes creating an incentive system to foster environmentally conscious behavior among investors and their clients.

- The establishment of an Environmental Buildings Department is critical, given its role in organizing awareness campaigns, workshops, and community engagement. Its functions go beyond mere system creation and event planning, encompassing fundraising and facilitating connections between investors and entities supporting environmental initiatives, such as the Green Buildings Council.

- The Palestinian Investment Promotion Agency can play a crucial role in promoting environmental development and investment. A dedicated department focused on environmental initiatives and investments could be established to incentivize environmental strategies among investors. This incentive scheme might involve collaborations with municipalities to monitor the positive impacts achieved through investors' environmentally conscious behavior. Investors could then receive incentives for their next investment as a gesture of appreciation for their commitment to environmental practices. This collaborative system could extend to other governmental departments, fostering cooperation between local municipalities and the government to address environmental challenges faced by investors. Points earned through the benefits system could be utilized as discounts in various governmental departments.

- Incentives can take various forms based on the preferences of investors. The incentive system should be customized in collaboration with each municipality, tailoring it to what the local authorities can provide to support their investors. For instance, some municipalities may offer a density bonus, such as a specified percentage like 2%. Others might provide technological assistance and support. Additional incentives could involve eco-labeling, where investors or clients earning a certain number of eco-labels receive a 100% discount on their next investment licensing or a similar benefit. The options are diverse, and the design of this system could involve input from the local community through surveys and interviews facilitated by the Environmental Buildings Department.

5. Engineering Staff Related Factor

- Engineers should establish connections with one another to benefit from shared expertise and stay informed about the latest trends and advancements in the engineering field. It is crucial to organize networking workshops facilitated by the Engineering Association, fostering connections between seasoned engineers and those just entering the field. These workshops should extend to universities, fostering collaboration between undergraduate engineers and experienced professionals, creating valuable knowledge exchange opportunities for all engineers.

- Additional workshops can take the form of technical support sessions and explanations of new technologies. With support from the local market, these workshops can help engineers stay updated on new environmental services, materials, and sustainable construction methods. Collaborative efforts between the Engineering Association and local businesses can facilitate comprehensive learning about emerging technologies.

- Beyond connecting engineering experts, establishing links between engineers and investors can bridge the gap between economic considerations and environmental sustainability. This connection provides investors with insights to make informed decisions about the path they want to pursue.

6.7 Future Extension

Subsequent investigations could delve into the discoveries uncovered in this research, expanding upon the identified results. Alternatively, specific aspects of the findings may serve as a foundation for further exploration, leading to more targeted and nuanced conclusions;

- A future study could consider the Voice of Customer (VOC) of all employees in the region to specifically indicate their preferences and employ the multi-decision selection criteria to give weights to those preferences along with their associated costs and thus be able to choose which environmental feature could get higher incentives.

- Future extension could delve deeper into the lost sellable area as a result of environmental design strategies application and value its financial considerations to get a more accurate number of the increase in environmental buildings investment.

- Future extension could be the designing of the incentives system with collaboration with the municipality and the local community (another Triple Bottom Line TBL study)

Bibliography

ABU HANIEH, A., KARAEEN, M. & HASAN, A. 2022. International Journal of Sustainable Construction Engineering and Technology Sustainability Model from Cradle-to-Gate: Residential Buildings in Palestine. *International Journal of Sustainable Construction Engineering Technology,* 13**,** 1-14.

AFSHARI, A., ANDERSON, H., COHEN, A., DE OLIVEIRA FERNANDES, E., DOUWES, J., GÓRNY, R., HIRVONEN, M.-R., JAAKKOLA, J., KIRCHNER, S., KURNITSKI, J., LEVIN, H., MENDELL, M., MØLHAVE, L., MORAWSKA, L., NEVALAINEN, A., RICHARDSON, M., RUDNAI, P., SCHLEIBINGER, H., SCHWARZE, P. & KRZYZANOWSKI, M. 2009. *WHO guidelines for indoor air quality: dampness and mould*.

AHSAN, M., ZULQARNAIN, M., AHMAD, H., ALI WAJID, B., SHAHZAD, S. & HUSSAIN, M. 2019. Reducing the Operational Energy Consumption in Buildings by Passive Cooling Techniques Using Building Information Modelling Tools. *International Journal of Renewable Energy Research,* 9**,** 343-353.

ALESSANDRINI, F., JONDEAU, E., LANG, G. & REINS, E. J. E. F. I. P. P. S. F. I. R. P. 2022. How Sustainable Is Swiss Real Estate? Evidence from Institutional Property Portfolios.

ALONGE, D., AYOOLA, A. & BALA MUHAMMAD, I. 2023. *Factors that Influence Workspace Planning and Design in Government Offices Buildings of Lagos*.

ALSURAKJI, I., ABDALLAH, R., ASSAD, M. & EL-QANNI, A. 2021. *Energy Savings and Optimum Insulation Thickness in External Walls in Palestinian Buildings*.

ALTOMONTE, S. 2023. Daylight and the Occupant Visual and physio-psychological well-being in built environments.

ALTOMONTE, S., ALLEN, J., BLUYSSEN, P., BRAGER, G., HESCHONG, L., LODER, A., VEITCH, J., WANG, L. & WARGOCKI, P. 2020. Ten Questions Concerning Well-Being in the Built Environment. *Building and Environment,* 180**,** 106949.

Bibliography

ALTOMONTE, S., KENT, M. & BRAGER, G. 2017. Indoor environmental quality and occupant satisfaction in green-certified buildings. *Building Research & Information,* 47.

AMARIPADATH, D., PAOLINI, R., SAILOR, D. & ATTIA, S. 2023. Comparative assessment of night ventilation performance in a nearly zero-energy office building during heat waves in Brussels. *Journal of Building Engineering,* 78**,** 107611.

AMRIYATI, A. 2022. The Rights to Health Of Worker From the Perspective of Indoor Air Quality. *Eduvest - Journal of Universal Studies,* 2**,** 842-852.

ASSOCIATION, E. 2013. Green Buildings Guidelines - State of Palestine.

BAKUMENKO, M., SIGAL, A. & TITARENKO, D. About the need to develop an intelligent information system to evaluate investment project environmental effectiveness. E3S Web of Conferences, 2023. EDP Sciences, 02002.

BANJADE, S., PAUDEL, S. & SOCIAL DEVELOPMENT, J. O. 2023. Factors Affecting Employee Absenteeism in Nepalese Commercial Banks.

BENLI, H. & GÜRTÜRK, M. J. I. J. O. I. E. A. 2021. Investigation of The Effect of Pv Panel Efficiency Parameter on Investment Payback Period. 5**,** 88-92.

BERARDI, U. J. S. D. 2012. Sustainability assessment in the construction sector: rating systems and rated buildings. 20**,** 411-424.

BLUYSSEN, P. 2019. The need for understanding the indoor environmental factors and its effects on occupants through an integrated analysis. *IOP Conference Series: Materials Science and Engineering,* 609**,** 022001.

BOUSBIA LAICHE, A., DAHLAN, N., SHARI, Z. & JAAFAR, M. F. Z. 2023. Perception of Overall Quality of Life Among Occupants of Green and Non-Green Office Buildings in Malaysia. *Nakhara : Journal of Environmental Design and Planning,* 22**,** 307.

Bibliography

BULFONE, T. C., MALEKINEJAD, M., RUTHERFORD, G. W. & RAZANI, N. J. T. J. O. I. D. 2021. Outdoor transmission of SARS-CoV-2 and other respiratory viruses: a systematic review. 223**,** 550-561.

CHANG, T. & KAJACKAITE, A. 2019. Battle for the thermostat: Gender and the effect of temperature on cognitive performance. *PLOS ONE,* 14**,** e0216362.

CHEUNG, C. T., GRAHAM, L. & THAM, K. 2020. Occupant satisfaction with the indoor environment in seven commercial buildings in Singapore. *Building and Environment,* 188.

CHEUNG, C. T., PARKINSON, T., LI, P. & BRAGER, G. 2019. Analysis of the accuracy on PMV – PPD model using the ASHRAE Global Thermal Comfort Database II. *Building and Environment,* 153.

CHRISTENSEN, P., ROBINSON, S. & SIMONS, R. 2016. The Application of Mixed Methods: Using a Crossover Analysis Strategy for Product Development in Real Estate. *Journal of Real Estate Literature,* 24.

COUNCIL, P. G. B. 2022. Green Building Feasibility Study Palestinian Green Building Council.

DAUGĖLAITĖ, A. J. J. O. S. A. & ENGINEERING, C. 2023. Psychological Acceptance of Sustainable Architecture in Lithuania: a Qualitative Study. 32**,** 41-57.

DENG, Z., DONG, B., GUO, X. & ZHANG, J. 2023. A Pilot Study on the Combined Multi-domain Impact of Indoor Air Quality and Noise on Office Productivity. *E3S Web of Conferences,* 396**,** 01047.

DEVINE, A., YÖNDER, E. J. T. J. O. R. E. F. & ECONOMICS 2021. Impact of environmental investments on corporate financial performance: Decomposing valuation and cash flow effects. 1-28.

DIMITROULOPOULOU, C., DUDZIŃSKA, M., GUNNARSEN, L., HÄGERHED, L., MAULA, H., VISUALISATION, R., TOYINBO, O. & HAVERINEN-SHAUGHNESSY, U. 2023. Indoor air quality guidelines from across the world: An appraisal considering energy saving, health, productivity, and comfort. *Environment International,* 178**,** 108127.

FEIGE, A., MCALLISTER, P., WALLBAUM, H. J. C. M. & ECONOMICS 2013. Rental price and sustainability ratings: which sustainability criteria are really paying back? 31**,** 322-334.

FRANCESCATTO, M., NEUENFELDT JÚNIOR, A., KUBOTA, F., GUIMARÃES, G. & RIGON DE OLIVEIRA, B. 2022. Lean Six Sigma case studies literature overview: Critical success factors and difficulties. *International Journal of Productivity and Performance Management,* 72.

FRIEDMAN, M. 2007. The social responsibility of business is to increase its profits. *Corporate ethics and corporate governance.* Springer.

GARCÍA-FERNÁNDEZ, B. & OMAR, O. 2023. Sustainable performance in public buildings supported by daylighting technology. *Solar Energy,* 264**,** 112068.

GERMANÀ, M. L. & ALATAWNEH, B. 2016. *Reviving earthen architecture in palestine: The added significances of the building sustainability and an opportunity for the future*.

GHAFFAR, M. M. A. A., EL AZIZ, N. A. A. J. J. O. E. & SCIENCE, A. 2021. Urban form and economic sustainability in housing projects. 68**,** 1-16.

GUTTERMAN, A. J. A. A. S. 2022. Sustainability.

HA, C., TERH JING, K. & KOO, Z. 2023a. Current status of green building development in Malaysia. *Progress in Energy and Environment,* 25**,** 1-9.

HA, C., TERH JING, K. & LOH, J. 2023b. Barriers to green building implementation in Malaysia: A systematic review. *Progress in Energy and Environment,* 24**,** 11-21.

HARČÁROVÁ, K. & VILCEKOVA, S. 2022. Indoor environmental quality in green certified office buildings. *IOP Conference Series: Materials Science and Engineering,* 1252**,** 012054.

HEREU-MORALES, J. & VALDERRAMA, C. J. S. 2022. Towards a Sustainability-Based Society: An Analysis of Fundamental Values from the Perspective of Economics and Philosophy. 14**,** 8722.

HUSHLAMOUN, S. 2020. ENHANCING ENERGY PERFORMANCE OF HIGHLY GLAZED FACADES.

IGWE, A., EZEOBI, A., OKEKE, F., IBEM, E. & EZEMA, E. 2023. Causes and remedies of sick building syndrome: A systematic review. *E3S Web of Conferences,* 434**,** 02007.

ILTER, D. A., ERGEN, E., TEKCE, I. & YıLMAZ, N. 2022. *Influence of building design on the satisfaction of office building occupants*.

ITMA, M. & WASIM, S. 2023. Building Regulations Assessment in Terms of Affordability Values. Towards Sustainable Housing Supplying in Palestine. *International Journal of Sustainable Development and Planning,* 18**,** 793-804.

JACOBS, J. 2002. The Profit Formula® - Test and Proof. *SSRN Electronic Journal*.

JAMALA B, N., HAMZAH, B., MULYADI, R. & CAHYANI, I. 2023. The Architectural Design of Building Façade Models Related to Optimizing Daylight Distribution. *Journal of Daylighting,* 10**,** 60-71.

JEROME, A., FEMENÍAS, P., THUVANDER, L., WAHLGREN, P. & JOHANSSON, P. J. H. 2021. Exploring the Relationship between Environmental and Economic Payback Times, and Heritage Values in an Energy Renovation of a Multi-Residential Pre-War Building. 4**,** 3652-3675.

JIANG, C., LIANG, X., ZHOU, Y.-C., TIAN, Y., XU, S., LIN, J.-R., MA, Z., YANG, S. & ZHOU, H. 2023. *A Multilayer Perceptron-based Fast Sunlight Assessment for the Conceptual Design of Residential Neighborhoods under Chinese Policy*.

KAMALI, M., HEWAGE, K. & SADIQ, R. J. J. O. C. P. 2022. Economic sustainability benchmarking of modular homes: A life cycle thinking approach. 348**,** 131290.

KARAEVA, A. P., MAGARIL, E. R., KISELEV, A. V., CIOCA, L.-I. J. I. J. O. E. R. & HEALTH, P. 2022. Screening of factors for assessing the environmental and economic efficiency of investment projects in the energy sector. 19**,** 11716.

KARDA, S., NAGY-GYÖRGY, T. & BOROS, I. J. S. 2023. Evolution of the Payback Period for Energy-Efficient Residential Buildings in Romania in the Last Decade. 15**,** 8986.

KAYA, R. & CAGLAYAN, S. 2023. Potential Benefits of Thermal Insulation in Public Buildings: Case of a University Building. *Buildings*, 13**,** 2586.

KHADKA, S., RIJAL, H., AMANO, K., SAITO, T., IMAGAWA, H., UNO, T., GENJO, K., TAKATA, H., TSUZUKI, K., NAKAYA, T., NISHINA, D., HASEGAWA, K. & MORI, T. 2022. Study on Winter Comfort Temperature in Mixed Mode and HVAC Office Buildings in Japan. *Energies*, 15**,** 7331.

KHAN, M. M. H., BASHIR, M., SIKANDAR, M., ALROWAIS, R., SYED, S., ZAHID, N., ABBAS, I., KHAN, W. & ZAWAR, A. 2023. *Green Buildings and Indoor Air Quality: A Health and Technological Review*.

KIRCHER, M. J. A. E. S. 2022. The bioeconomy needs economic, ecological and social sustainability. 9**,** 33-50.

KUMAH, V., AGYEKUM, K., BOTCHWAY, E., PITTRI, H. & DANSO, F. 2022. Examining Built Environment Professionals′ Willingness to Pay for Green Buildings in Ghana. *Buildings*, 12**,** 2097.

KUMAR, P. & PANDEY, D. 2022. A theoretical framework on return on investment (ROI) in academic libraries. *Library Hi Tech News*, ahead-of-print.

LAMSAL, P., BAJRACHARYA, S. & RIJAL, H. 2023. A Review on Adaptive Thermal Comfort of Office Building for Energy-Saving Building Design. *Energies*, 16**,** 1524.

LAVEGLIA, A., SAMBATARO, L., UKRAINCZYK, N., ORTEL, T., DE BELIE, N. & KOENDERS, E. Environmental and Economic Sustainability Aspects in Lime-Based Construction Materials. MATEC Web of Conferences. EDP Sciences, 06005.

LING, K. C., CHENG, M. L. S., YI, T. X. J. J. O. M. & SUSTAINABILITY 2023. Determinants of Corporate Sustainability in the Malaysian Construction Industry. 13**,** 166-166.

LISA, N. & ZURAIHAN, Z. 2014. IMPACT ON THE APPLICATION OF INSULATION IN BUILDINGS TO ACHIEVE THERMAL COMFORT (A CASE STUDY: LAUSER OFFICE BUILDING IN BANDA ACEH). *Journal of Islamic Architecture,* 3**,** 94.

LIU, Y., WANG, W., LI, Z., SONG, J., FANG, Z., PANG, D. & CHEN, Y. 2023. Daylighting Performance and Thermal Comfort Performance Analysis of West-Facing External Shading for School Office Buildings in Cold and Severe Cold Regions of China. *Sustainability,* 15**,** 14458.

LU, J. 2018. The value of a south-facing orientation: A hedonic pricing analysis of the Shanghai housing market. *Habitat International,* 81.

MATHISEN, J., NGUYEN, T.-L., JENSEN, J., MEHTA, A., RUGULIES, R. & ROD, N. 2022. Impact of hypothetical improvements in the psychosocial work environment on sickness absence rates: a simulation study. *European Journal of Public Health,* 32.

MONNA, S., JUAIDI, A., KHALDI, R., ALBATAYNEH, A., DUTOURNIE, P. & JEGUIRIM, M. 2021. Towards Sustainable Energy Retrofitting, a Simulation for Potential Energy Use Reduction in Residential Buildings in Palestine. *Energies,* 14.

MUDHEHER, I. & NOBANEE, H. 2022. On the Time Value of Money.

MURAJ, I., OSTOJIĆ, S. & VERŠIĆ, Z. 2023. An environmental quality assessment of office buildings: The impact of glass façade on internal and external users. *IOP Conference Series: Earth and Environmental Science,* 1196**,** 012060.

NAILI, B., HABER, I. & KISTELEGDI, I. 2023. Natural ventilation in high-rise office building – Comfort and energy performance. *Pollack Periodica,* 18.

NAMAYANJA, L. & MUBIRU, M. 2023. *The effect of space flexibility and building orientation on grade-B office building occupancy rate in Kampala City*.

NASEREDDIN, H. & DWEIK, G. 2021. *EVALUATING THE OCCUPANTS SATISFACTION REGARDING THE THERMAL PERFORMANCE OF COMMON PRACTICES IN APARTMENT BUILDINGS' ENVELOPES IN HEBRON, PALESTINE*.

ONABANJO, A., ADENIYI, OLANIPEKUN, L., OKIKIOLA, OLANIPEKUN, D. & OLUWAYIMIKA 2023. EFFECTS OF INDOOR AIR QUALITY, HUMIDITY AND TEMPERATURE ON EMPLOYEES HEALTH AND PERFORMANCE. 1**,** 8-18.

PASQUALINO, J. C., ORTIZ, O. O. & CASTELLS, F. 2008. 556. Life cycle assessment as a tool for material selection and waste management within the building sector.

PCBS. 2022. Available: https://www.pcbs.gov.ps/default.aspx [Accessed].

PETTINGER, T. 2024. *Economics Help* [Online]. [Accessed 25/01 2024].

PRASETYAWAN, S., MACHFUDIYANTO, R. A. & RACHMAWATI, T. 2023. Incentives and Barriers to Green Building Implementation: The Case of Jakarta. *Journal of the Civil Engineering Forum***,** 287-302.

PSYCHOYIOS, D. 2023. Income growth, forecasting and stock valuation. *IMA Journal of Management Mathematics*.

RANA, A., SADIQ, R., ALAM, M. S., KARUNATHILAKE, H. & HEWAGE, K. 2021. Evaluation of financial incentives for green buildings in Canadian landscape. *Renewable and Sustainable Energy Reviews,* 135**,** 110199.

ROBINSON, S., SIMONS, R. & LEE, E. 2014. Green Office Buildings: A Qualitative Exploration of Green Office Building Attributes. *Journal of Sustainable Real Estate,* 6**,** 211-232.

ROBINSON, S., SIMONS, R., LEE, E. & KERN, A. 2016. Demand for Green Buildings: Office Tenants' Stated Willingness-to-Pay for Green Features. *Journal of Real Estate Research,* 38.

SAKA, N., OLANIPEKUN, A. & OMOTAYO, T. 2021. Reward and compensation incentives for enhancing green building construction. *Environmental and Sustainability Indicators,* 11**,** 100138.

SCHLUER, J., RÜTTI-JOY, O. & UNGER, V. 2023. Feedback Literacy.

SCHWEIKER, M., HUEBNER, G., KINGMA, B., KRAMER, R. & PALLUBINSKY, H. 2018. Drivers of diversity in human thermal perception – A review for holistic comfort models. *Temperature,* 5.

SOYDAN, Y., DEMIRER, A., KAPTI, A., ENGIN, T. & KANDILLI, C. 2012. Lighting of Commercial Buildings by Conveying Sunlight. 1.

TABOROSI, S., MALJUGIĆ, B., LAJIĆ, Z., RAJKOVIĆ, J. & MITIĆ, S. 2023. *EMPLOYEE TURNOVER DURING THE GREAT RESIGNATION*.

TEKCE, I., ILTER, D. A. & ERGEN, E. 2020. An Empirical Study of Visual Comfort in Office Buildings.

TEMBO, M., MWANAUMO, E. M. U., KAHANJI, C. J. I. J. O. D. & SUSTAINABILITY, E. 2023. Impact of Tender Price Variability on Economic Sustainability of Construction Sector in Developing Countries. 11**,** 50-80.

TENGTARTO, M., SINGGIH, M., SISWANTO, N. & SUWIGNJO, P. 2023. Literature Review of Lean Manufacturing, Six Sigma and Lean Six Sigma Benefit.

THONGSUMRIT, J., CHANTARA, S., NAKSEN, W., BOOTDEE, S., PAYAM, M. & WIRIYA, W. 2023. Indoor air quality assessment to design a model for indoor air quality management and health impact assessment in Northern Thailand. *E3S Web of Conferences,* 396.

VASILE, V., IORDACHE, V. & RADU, V. 2023. The influence of ventilation on indoor air quality in buildings with variable pollutant emissions. *IOP Conference Series: Earth and Environmental Science,* 1185**,** 012006.

VELLEI, M., CHINAZZO, G., ZITTING, K.-M. & HUBBARD, J. 2021. Human thermal perception and time of day: A review. *Temperature,* 8.

VISHWANATH, S. R. 2009. Valuation Using Multiples. *Investment Management: A Modern Guide to Security Analysis and Stock Selection***,** 261-281.

WANG, J., WEI, Z., YAO, N., LI, C. & SUN, L. 2023. Association Between Sunlight Exposure and Mental Health: Evidence from a Special Population Without Sunlight in Work. *Risk management and healthcare policy,* 16**,** 1049-1057.

WANG, Z., DE DEAR, R., LUO, M., LIN, B., HE, Y., GHAHRAMANI, A. & ZHU, Y. 2018. Individual difference in thermal comfort: A literature review. *Building and Environment,* 138.

ZHONG, Y., LU, J. & LI, Z. 2022. Impact of access to sunlight on residential property values: an empirical analysis of the housing market in Shanghai. *International Journal of Strategic Property Management,* 26**,** 385-396.

ZHOU, Y. 2020. *Interpreting the Correlation between Sunlight Performance, Building Form and Building Intervals*.

Appendices

Appendix 1: Offices Data Sheet

Palestine Polytechnic University

جامعة بوليتكنك فلسطين / الخليل
عمادة الدراسات العليا
كلية الهندسة والتكنولوجيا
قسم الهندسة المعمارية

نموذج قياسات ومعلومات **التاريخ:**

وصف المكتب

اسم المجمع التجاري								
اسم الشركة								
الطابق	1	2	3	4	5	6	7	8
اتجاه المكتب	شمالي	شرقي	عربي	جنوبي	شمالي شرقي	شمالي عربي	جنوبي شرقي	جنوبي عربي
مساحة المكتب								
طبيعة المكتب	مكتب مغلق						مكتب مفتوح	
عدد الموظفين	1		2		3	4	5	6 فأكثر
عدد النوافذ	0	1	2	3	4			
موقع النوافذ	موجهة للخارج				موجهة للداخل			
واجهة النوافذ	شمالي	شرقي	عربي	جنوبي	شمالي شرقي	شمالي عربي	جنوبي شرقي	جنوبي عربي
أبعاد النوافذ								
الزجاج المستخدم								
التهوية في المكتب	طبيعية	ميكانيكية						
التدفئة في المكتب	لا يحتاج لتدفئة	وحده تكييف	تكييف مركزي	تدفئة مركزية	مدفئة كهربائية	مدفئة غاز		
التبريد في المكتب	لا يحتاج للتبريد	وحده تكييف	تكييف مركزي	مروحة				
الإضاءة في المكتب	طبيعية	صناعية	طبيعية وصناعية					
أشعة الشمس	تدخل المكتب بشكل كاف		لا تدخل المكتب بشكل كاف			لا تدخل المكتب اصلا	مزعجة	
فاتورة الكهرباء شتاء								
فاتورة الكهرباء صيفا								

Appendix 2: Users Questionnaire

Palestine Polytechnic University

جامعة بوليتكنك فلسطين / الخليل
عمادة الدراسات العليا
كلية الهندسة والتكنولوجيا
قسم الهندسة المعمارية

استبانة لبحث علمي **التاريخ:**

تهدف هذه الاستبانة الى دراسة العلاقة بين تصميم المباني الإدارية والتكاليف الاجتماعية المختلفة للموظفين المستخدمين للمبنى في مدينة الخليل، لذا نرجو منكم التفضل بالاطلاع على هذه الاستبانة والاجابة على أسئلتها بكل دقة وموضوعية باختيار الاجابة التي ترونها مناسبة من وجهة نظركم وتعكس الوضع الفعلي في مكتبكم، وذلك من أجل خدمة البحث العلمي وتطويره بالشكل الأمثل ومن ثم خدمتكم، مع العلم ب أن كافة البيانات والمعلومات المقدمة من قبلكم لن تستخدم الا لأغراض البحث العلمي فقط.

1. معلومات شخصية

الجنس	ذكر			انثى
العمر	30-22	40-31	50-41	51 فأكثر
عدد ساعات الدوام	8 او أقل	9	10	10 فأكثر
عدد سنوات العمل في الشركة الحالية	1-0 سنة	3-1	5-3	5 سنوات فأكثر
طبيعة العمل				

2. الإضاءة الطبيعية

الإضاءة الطبيعية في المكتب كافية وجيدة	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
اعتمد على الإضاءة الطبيعية أكثر من الصناعية	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
أستطيع العمل في مكتب لا توجد فيه اضاءة طبيعية	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
غياب الإضاءة الطبيعية في المكتب يؤثر على انتاجيتي في العمل	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
غياب الإضاءة الطبيعية في المكتب سبب لبحثي عن عمل اخر	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
اختير مكان عملي لآخر فيه اضاءة طبيعية ولو كان الراتب اقل	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
غياب الإضاءة الطبيعية في المكتب يؤثر على صحتي العامة النفسية والجسدية	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
غياب الإضاءة الطبيعية يؤثر على تقييمي لمكان عملي	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة

3. التهوية الطبيعية

التهوية الطبيعية في المكتب كافية وجيدة	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
اعتمد على التهوية الطبيعية أكثر من الصناعية	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
أستطيع العمل في مكتب لا توجد فيه تهوية طبيعية	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
غياب التهوية الطبيعية في المكتب يؤثر على انتاجيتي في العمل	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
غياب التهوية الطبيعية في المكتب سبب لبحثي عن عمل اخر	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
اختير مكان عملي لآخر فيه تهوية طبيعية ولو كان الراتب اقل	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
غياب التهوية الطبيعية في المكتب يؤثر على صحتي العامة النفسية والجسدية	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
غياب التهوية الطبيعية يؤثر على تقييمي لمكان عملي	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة

Palestine Polytechnic University

جامعة بوليتكنك فلسطين / الخليل
عمادة الدراسات العليا
كلية الهندسة والتكنولوجيا
قسم الهندسة المعمارية

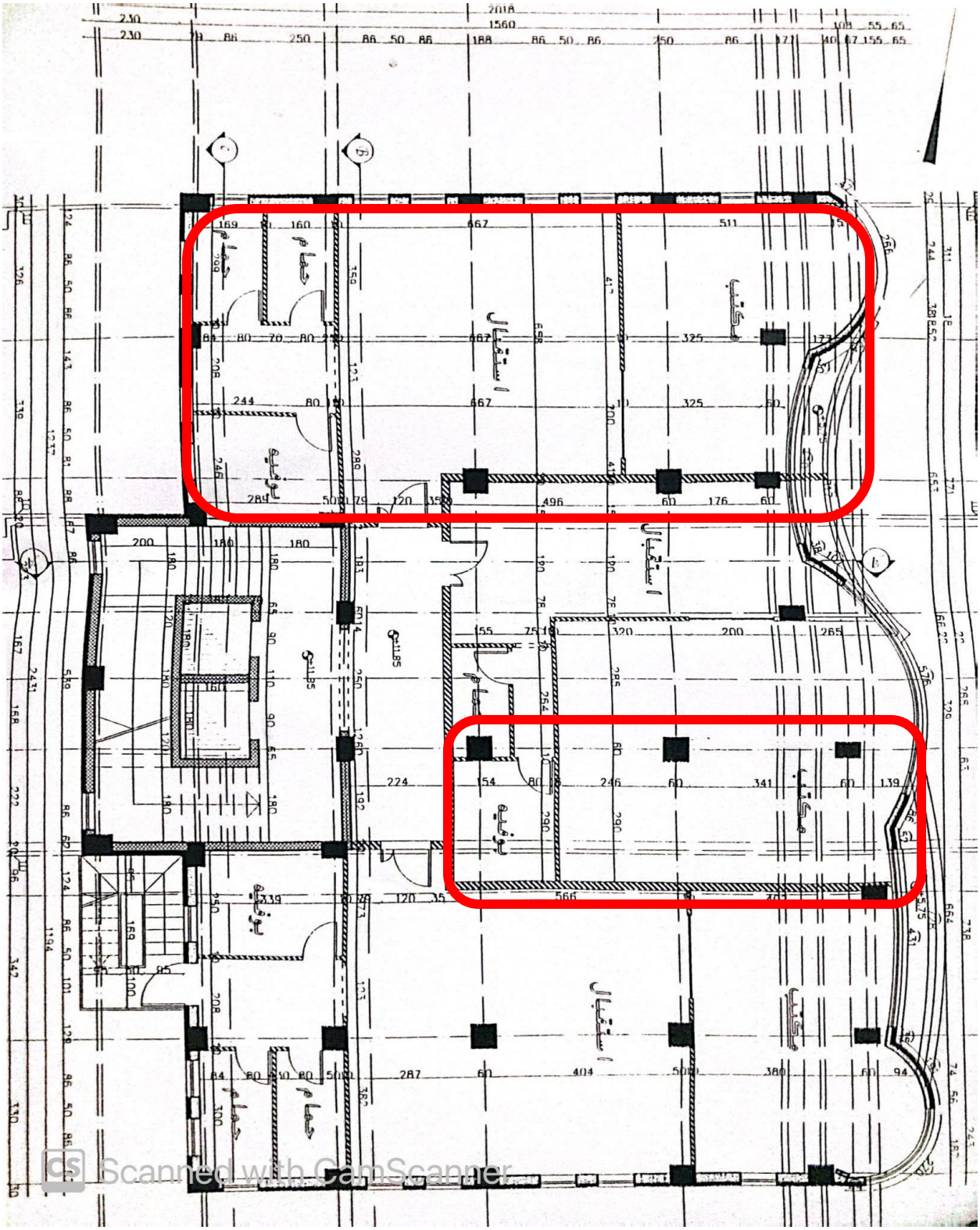
4. أشعة الشمس

اشعة الشمس الداخلة الى المكتب كافية وجيدة	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
احتاج اشعة الشمس بشكل يومي في المكتب	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
أستطيع العمل في مكتب لا تدخله اشعة الشمس	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
واحد او أكثر من جدران المكتب يعاني من مشكلة الرطوبة	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
غياب اشعة الشمس في المكتب يؤثر على انتاجيتي في العمل	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
غياب اشعة الشمس في المكتب سبب لبحثي عن عمل اخر	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
اغير مكان عملي لآخر تدخله الشمس ولو كان الراتب اقل	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
غياب اشعة الشمس في المكتب يؤثر على صحتي العامة النفسية والجسدية	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
غياب اشعة الشمس يؤثر على تقييمي لمكان عملي	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
للحصول على اشعة الشمس أزور مكاتب زملائي ممن تدخل اشعة الشمس مكاتبهم	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
للحصول على اشعة الشمس اخرج من المبنى	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة

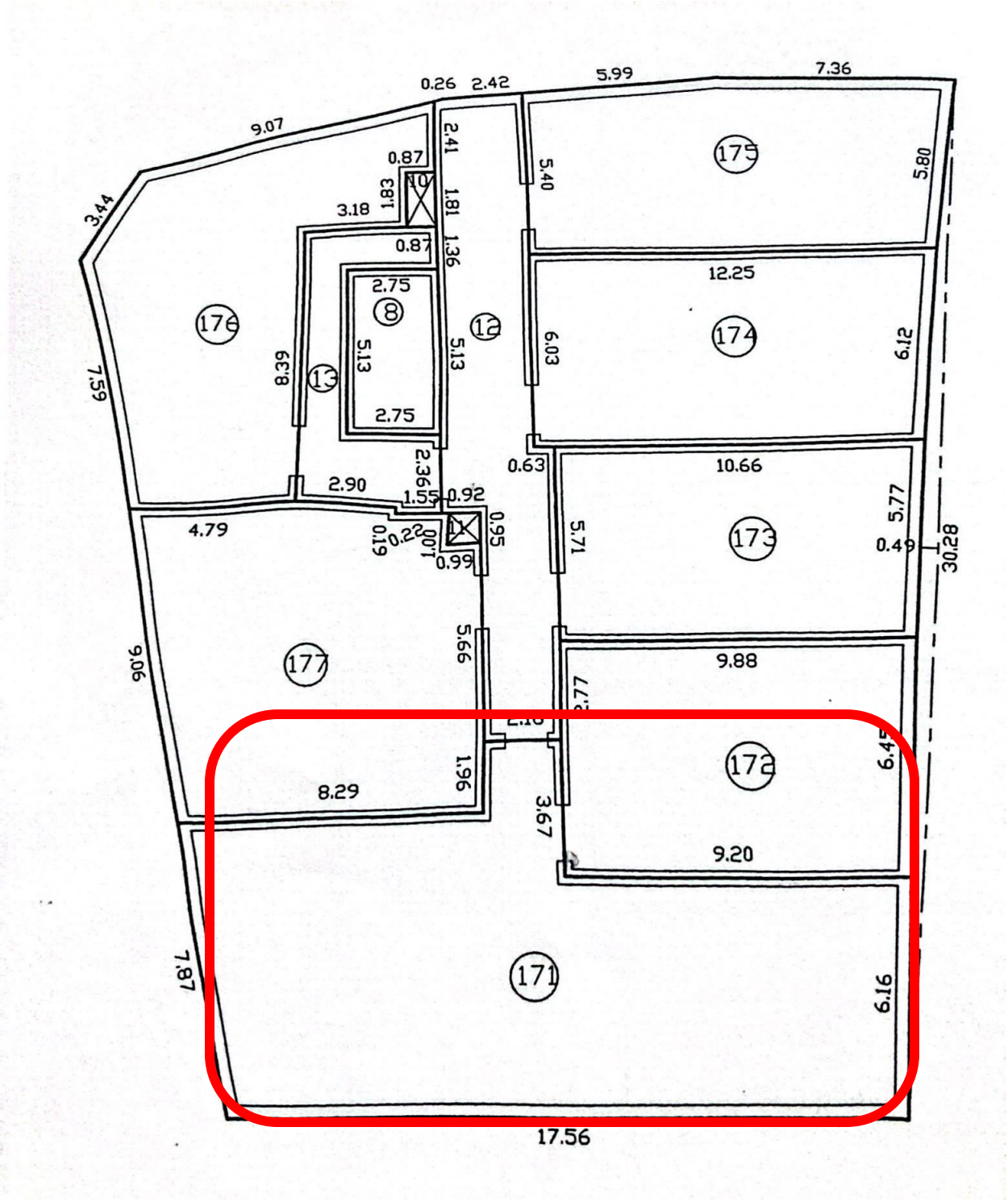
5. الارتياح الحراري

انا مرتاح حراريا في المكتب	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
اعتمد على انظمة التدفئة والتكييف للوصول الى راحة حرارية في المكتب	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
أستطيع العمل في مكتب لست مرتاحا فيه حراريا	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
غياب الارتياح الحراري في المكتب يؤثر على انتاجيتي في العمل	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
غياب الارتياح الحراري في المكتب سبب لبحثي عن عمل اخر	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
اغير مكان عملي لآخر مريح حراريا ولو كان الراتب اقل	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
غياب الارتياح الحراري في المكتب يؤثر على صحتي العامة النفسية والجسدية	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة
غياب الارتياح الحراري يؤثر على تقييمي لمكان عملي	أوافق بشدة	اوافق	محايد	لا اوافق	لا أوافق بشدة

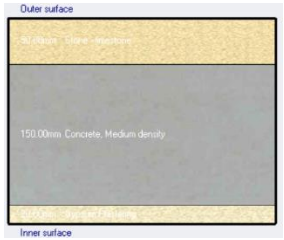
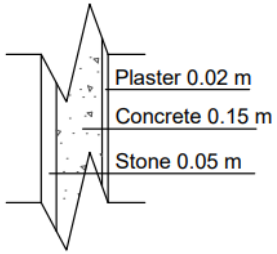
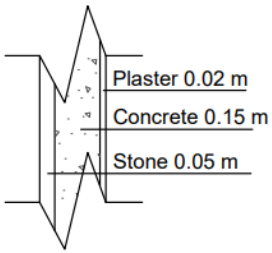
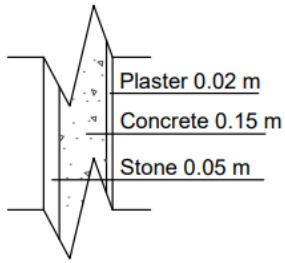
Appendix 3: Building 1 Floor Plan – Buildings Department (differs from the execution)



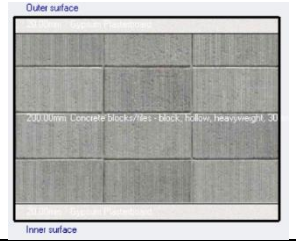
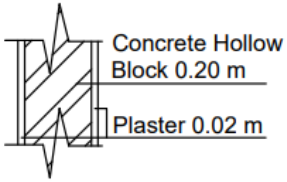
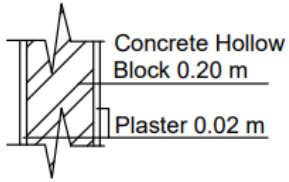
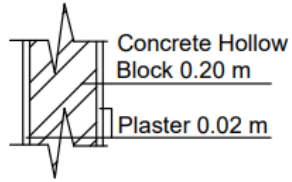
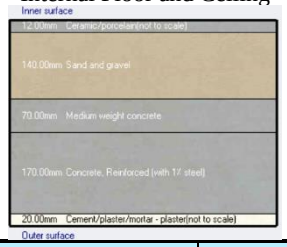
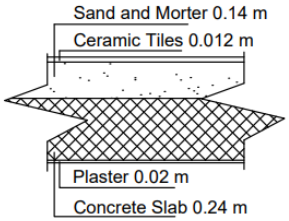
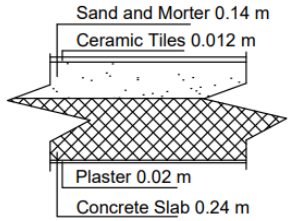
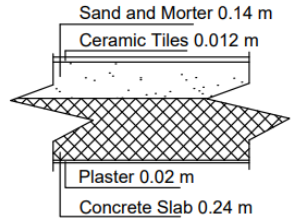
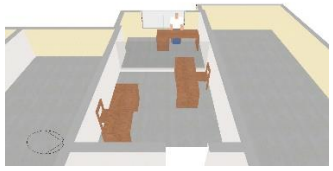
Appendix 4: Building 2 Floor Plan – Buildings Department (differs from the execution)



Appendix 5: Base Model Data

			Case 1	Case 2	Case 3
Location	Location		Jerusalem Airport	Jerusalem Airport	Jerusalem Airport
	Analysis type		EnergyPlus	EnergyPlus	EnergyPlus
	ASHRAE 90.1 building type		Proposed	Proposed	Proposed
	Primary building condition category		Non-residential	Non-residential	Non-residential
	Sector		B1 Office and Workshop business	B1 Office and Workshop business	B1 Office and Workshop business
Activity	Occupancy	Rate	0.0937	0.0625	0.1150
		Schedule	Sat-Thu/8:00-16:00	Sat-Thu/8:00-16:00	Sat-Thu/8:00-16:00
	Activity	Activity	Typing	Typing	Typing
		Gender Factor	0.95	0.97	1.00
	Clothing		Generic summer and winter	Generic summer and winter	Generic summer and winter
	Holidays		16 days in 2023	16 days in 2023	16 days in 2023
	Computers	ON	Sat-Thu/8:00-16:00	Sat-Thu/8:00-16:00	Sat-Thu/8:00-16:00
	Office equipment	ON	Sat-Thu/8:00-16:00	Sat-Thu/8:00-16:00	Sat-Thu/8:00-16:00
HVAC	Mechanical ventilation		OFF	OFF	OFF
	Heating		Heated – Electricity from grid	Heated – Electricity from grid	Heated – Electricity from grid
	Supply air conditioning max.		35 Cº	35 Cº	35 Cº
	Supply air conditioning min.		12 Cº	12 Cº	12 Cº
	DHW	ON	Electricity from grid	Electricity from grid	Electricity from grid
	Natural Ventilation		OFF	OFF	OFF
Lighting	General lighting		ON	ON	ON
	Lighting control		OFF	OFF	OFF
	Task and display lighting				
	Exterior lighting				
Construction	External wall 				

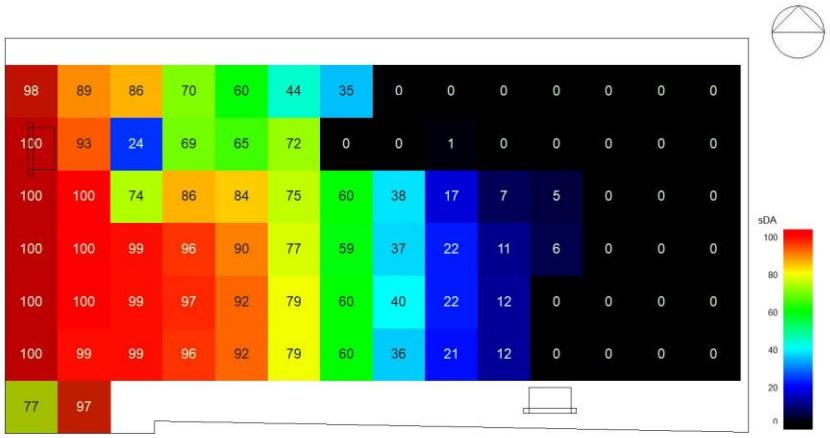
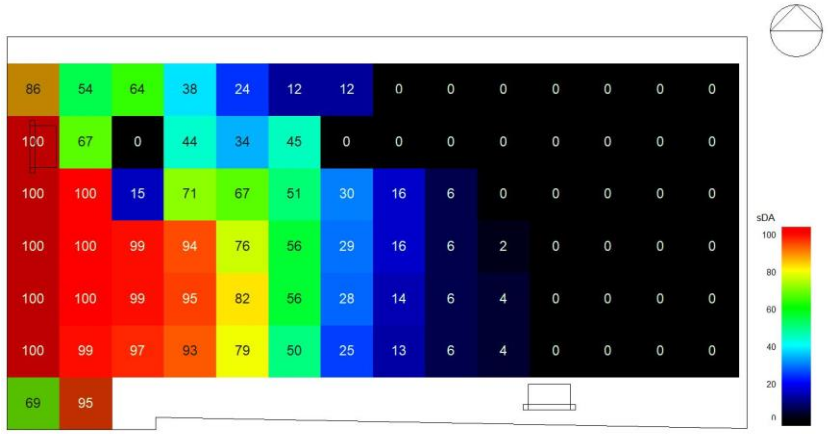
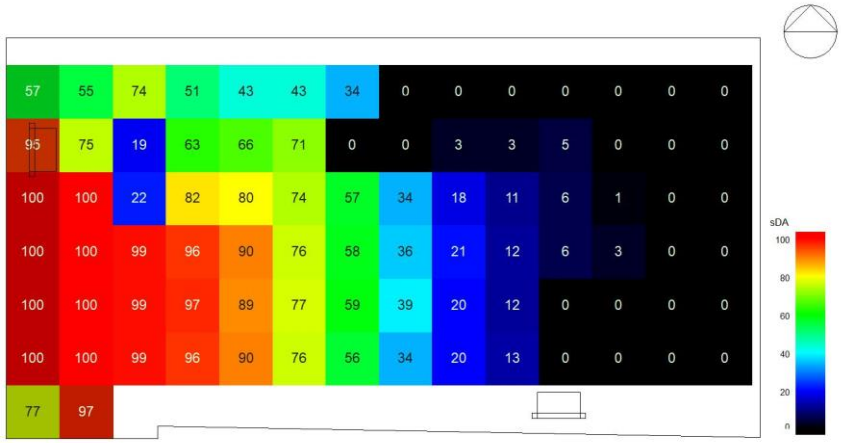
Appendices

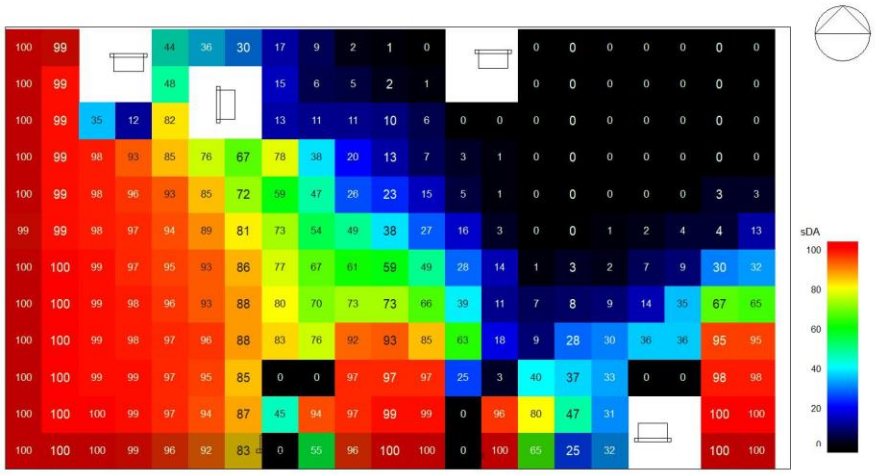
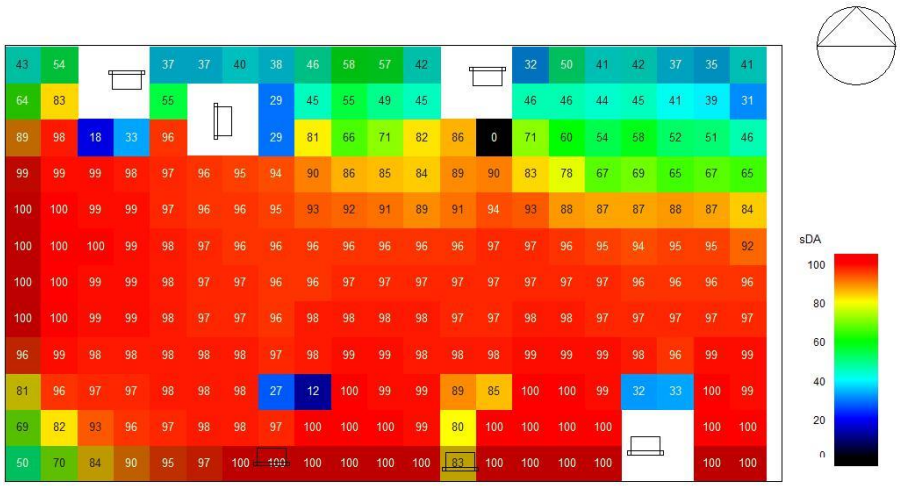
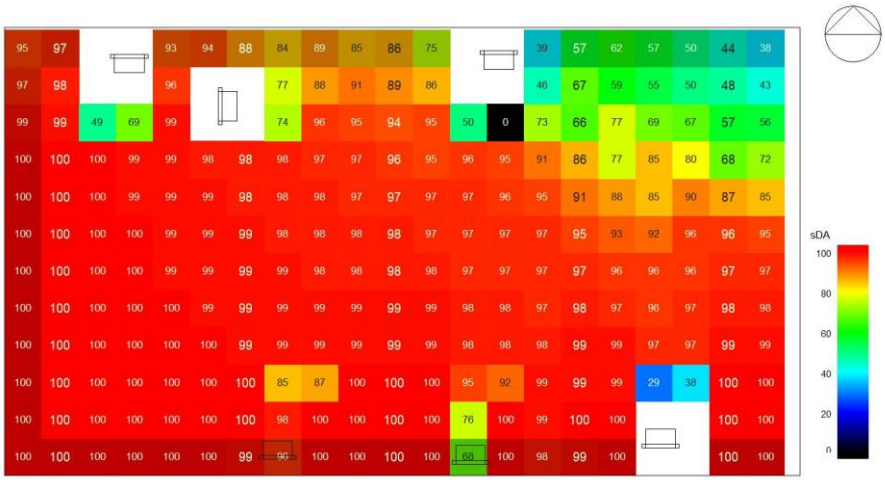
	Internal wall				
	Internal Floor and Ceiling				
Glazing	External Glazing	Double glazing: generic clear 4mm glass – 6mm air gap – generic clear 4 mm glass	Double glazing: generic clear 4mm glass – 6mm air gap – generic clear 4 mm glass	Double glazing: generic clear 4mm glass – 6mm air gap – generic clear 4 mm glass	Double glazing - brown tint: 6mm glass - 12 mm air gap – 6mm glass
	Internal Glazing	Generic clear 6mm	Generic clear 6mm	None	Generic clear 6mm
	Frame	Aluminum frame – no break	Aluminum frame – no break	Aluminum frame – no break	Aluminum frame – no break
	Dividers	20 mm	20 mm	20 mm	None
	Simulation Rendered Scene				

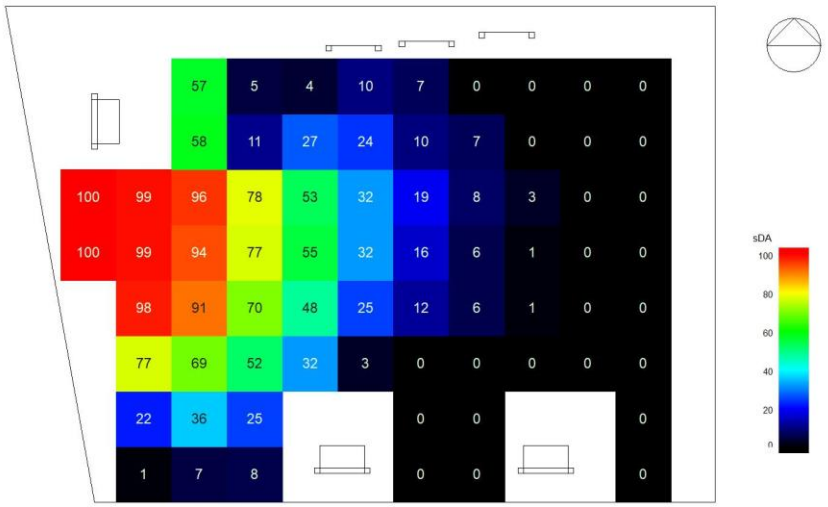
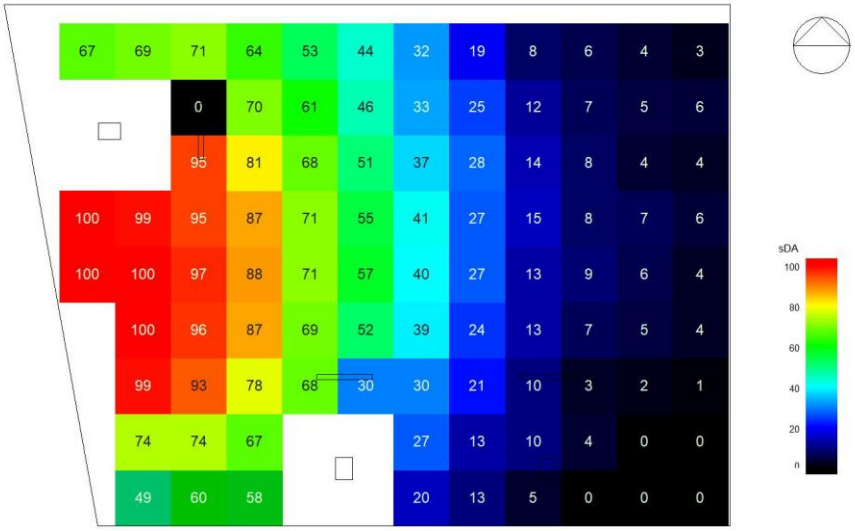
Appendix 6: Simulation Results

Case 1	Base case	Aluminum thermal break window frame	Insulation			WWR			Glazing Type	
			Glass wool	Polyurethane	Polystyrene	20%	30%	40%	6 mm low-e clear 6 mm air gap	6 mm low-e tint 6 mm air gap
Air temperature C°	23.34	23.34	23.9	23.92	23.9	24.59	24.9	Base case	23.16	22.86
Cooling loads (kWh/ year)	1285.22	1283.08	921.56	916.05	921.49	1223.44	1103.32		1360.66	1229.59
Heating loads (kWh/ year)	47.56	47.62	11.42	11.14	11.57	67.04	5.4		51.71	63.18
Total loads (kWh/ year)	5015.56	5014.45	4613.56	4609.91	4615.78	4973.2	4791.44		5097.23	5084.61
Electricity bill (NIS/ year)	3410.58	3409.83	3137.22	3134.74	3138.73	3381.78	3258.18		3466.12	3457.53
Case 2										
Air temperature C°	23.05	23.1	23.99	23.99	23.99	Base case	24.73	24.99	22.91	22.63
Cooling loads (kWh/ year)	2649.93	27454	1813.75	1814.05	1813.72		1395.62	929.9	2739.55	2797.65
Heating loads (kWh/ year)	96.29	105.56	15.40	15.43	15.43		63.07	34.20	118.45	148.6
Total loads (kWh/ year)	11189.5	11297.9	10.263.16	10263.49	10263.21		9872.12	9398.11	11292.01	11380.26
Electricity bill (NIS/ year)	7608.83	7682.57	6978.92	6979.14	6978.95		6713.01	6390.68	7678.54	7738.55
Case 3										
Air temperature C°	24.91	24.91	25.45	25.46	25.45	27.86	25.74	Base case	24.71	24.33
Cooling loads (kWh/ year)	3605.56	3599.03	2925.2	2925.54	2925.24	2199.43	3343.55		3599.13	4017.83
Heating loads (kWh/ year)	190.9	190.65	52.83	53.08	53.01	94.4	23.29		191.55	233.52
Total loads (kWh/ year)	8149.11	8142.28	7330.67	7331.27	7330.9	6646.48	7719.49		8143.33	8604
Electricity bill (NIS/ year)	5541.39	5536.75	4984.85	4985.26	4985.01	4519.6	5249.25		5537.46	5850.71

Appendix 7: Daylight Simulation Results

Case 1	
Case 1 – Base Case Annual Daylight Analysis	
Case 1 – 20% WWR Annual Daylight Analysis	
Case 1 – 30% WWR Annual Daylight Analysis	

Case 2	
Case 2 – Base Case Annual Daylight Analysis	
Case 2 – 30% WWR Annual Daylight Analysis	
Case 2 – 40% WWR Annual Daylight Analysis	

Case 3	
Case 3 – Base Case Annual Daylight Analysis	
Case 3 – 20% WWR Annual Daylight Analysis	
Case 3 – 30% WWR Annual Daylight Analysis