LIFE CYCLE COST AND BUDGET ANALYSIS OF A GREEN BUILDING – A CASE STUDY

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Approval sheet of the Thesis

This is to certify that we have read this thesis entitled **“**Life Cycle Cost and Budget Analysis of Green Building– A Case Study**”** and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

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ABSTRACT

LIFE CYCLE COST AND BUDGET ANALYSIS OF A GREEN BUILDING – A CASE STUDY

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Green Buildings (GB) are practice of making structures that are environment friendly, resources and energy efficient throughout the life cycle of structures. Life Cycle Cost Assessment (LCCA) is a technique which is used to estimatethe cost assessment, during the complete lifespan of a building. It measures the total cost required during design, construction, operation, maintenance, and decommissioning of a building system. Construction projects needs proper planning, management, and risk assessments so that we utilize our time, budget, and resources in suitable way.In this researchLife Cycle Cost Analysis (LCCA) and Life Cycle Budget Analysis (LCBA) is carried out ofIsh Profarma 8 story frame structure green building located in Tirana Albania.This researchproposes a study that determines in what manner the life cycle cost analysis was conducted for a green building and shows how the life cycle cost variables were identified and used to develop a life cycle budget for the whole life cycle of a green building for sustainable development. It is found in this research that the future costs of the inspected GB are high as its initial design and construction costs. It is also examined that the energy cost constitutes a weight of almost more than 28% of the total life cycle budget for the building. It is also found that reduced energy consumption in the GB is the most influential factor to reduce its total life cycle cost. It is noted that the natural resources that we use in the GB reduced the electricity consumption and reduced energy consumption which has positive impact on environment which leads to sustainability.

Keywords:*Green Buildings, Life Cycle Cost Analysis, Energy Consumption, Sustainable.*

ABSTRAKT

ANALIZA E KOSTOS TË CIKLIT JETËSOR DHE ANALIZA BUXHETORE E NDËRTESËS SË GJELBËR – NJË STUDIM RAST

RAKIPAJ, GERON

Master Shkencor, Departamenti i Inxhinierisë sëNdërtimit

Udhëheqësi: Dr. Julinda Keci

Ndërtesat e gjelbra (GB) janë praktikë e bërjes së strukturave që janë miqësore me mjedisin, burimet dhe energjia efikase gjatë gjithë ciklit jetësor të strukturave. Vlerësimi i Kostos së Ciklit të Jetës (LCCA) është një teknikë e cila përdoret për të vlerësuar vlerësimin e kostos, gjatë jetëgjatësisë së plotë të një ndërtese. Ai mat koston totale të kërkuar gjatë projektimit, ndërtimit, funksionimit, mirëmbajtjes dhe çmontimit të një sistemi ndërtimi. Projektet e ndërtimit kanë nevojë për planifikim, menaxhim dhe vlerësim të duhur të rrezikut në mënyrë që ne të përdorim kohën, buxhetin dhe burimet tona në mënyrën e duhur. Në këtë kërkim, Analiza e Kostos së Ciklit të Jetës (LCCA) dhe Analiza e Buxhetit të Ciklit të Jetës (LCBA) është kryer në ndërtesën e gjelbër të Ish Profarma me strukturë kornizë 8 katëshe me vendndodhje në Tiranë, Shqipëri. Ky hulumtim propozon një studim që përcakton se në çfarë mënyre është kryer analiza e kostos së ciklit jetësor për një ndërtesë të gjelbër dhe tregon se si variablat e kostos së ciklit jetësor janë identifikuar dhe përdorur për të zhvilluar një buxhet të ciklit jetësor për të gjithë ciklin jetësor të një ndërtese të gjelbër për të qëndrueshme. zhvillimin. Në këtë hulumtim është konstatuar se kostot e ardhshme të GB të inspektuar janë të larta sa kostot fillestare të projektimit dhe ndërtimit. Është ekzaminuar gjithashtu se kostoja e energjisë përbën një peshë prej pothuajse më shumë se 28% të buxhetit total të ciklit jetësor të ndërtesës. Është gjetur gjithashtu se konsumi i reduktuar i energjisë në GB është faktori më me ndikim për të reduktuar koston totale të ciklit jetësor. Vërehet se burimet natyrore që ne përdorim në MB kanë reduktuar konsumin e energjisë elektrike dhe kanë reduktuar konsumin e energjisë që ka ndikim pozitiv në mjedis që çon në qëndrueshmëri.

Fjalët kyçe: *Ndërtesat e gjelbra, Analiza e kostos së ciklit jetësor, Konsumi i energjisë, i qëndrueshëm.*

All want to dedicate my research to my beloved teachers, parents and all my friends and family who support me in every aspect of life. I am also very thankful to Allah Almighty for my success and all achievements in life.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Introduction:

Life-cycle cost assessment (LCCA) is a method or technique which is usedto estimatethecost assessment, during the building's lifespan. It measures the total cost required during construction, operations, decommissioning of a building system. LCCA is particularly useful when projects alternatives are available which fulfill the same performance requirements, but their construction and operations cost is different.The main objective is to find that project, which is economically viable, meets all the necessities, have less environmental impacts, andsaves energy. LCCA is the most straightforward and easy method to incorporates techniques for economic evaluations. In buildings designing the three parametersareconsidered i.e.,safety, economy, and serviceability. So, the most economical design can be determined only by comprising the approximate cost of different design. The price of resources: materials, manpower, machinery determine the overall cost of a building. So, in LCCA the most challenging task is the economical evaluations.

In Europe and other countries green buildings are practice of making structures that are environmentally friendly, resources and energy efficient throughout the life cycle of structures from sitting to design, construction, operation, maintenance, and decommissioning. The aim of green buildings is to diminish the influence of buildings on environment and human health as well as to use maximum natural resources in buildings to save energy.The tradition of constructing structures and utilizing practices that are environmentally friendly and resource-efficient during a building's life cycle fromcradle to grave i.e., construction,operation, maintenance, renovation, and deconstruction.This knowledge develops and complements the typical building design concerns ofeconomy, utility, durability, andcomfort.".Implementing green building brings many benefits which are assembled in threeareas: environmental, economic, and social benefits. According to Ahn and Y. H.Pearce et al. (2009) [1]these benefits include:

Environmental benefits of GB are to improve and defend ecosystems and biodiversity. It has also a vital role to improve air and water quality, reduce solid waste. These main benefits of GB are that they conserve maximum natural resources including air, water, sunlight, gasses to minimize global warming and improve sustainability of environment.

Economic benefits of GB includes that it reducesoperating costs, enhance asset value and profits but it has high initial construction cost due to advance construction techniques. These buildings also improve occupant productivity and satisfaction because these buildings have Optimize life-cycle economic performance.

Social benefits include improve air, thermal and acoustic environments. These buildings enhance occupant comfort and health, minimize strain on local infrastructure, contribute to overall quality of life. It also improves community and social benefits.

Even though executing Green Building by incorporating Green Building Strategies and Technologies (GBSTs) into facilities has many advantages, there are frequent paybacks related with green building. One of the major concerns related to executing green building is the increase of the first cost of a facility because of incorporating GBSTs, even though it is possible to reduce Life Cycle Costs (LCC) over the life of the facility [1]. This predominating credence of high first cost is the one of most serious barriers of implementing green building in the construction industry, including the public sector [1]. Many other researchers likewise demonstrated that the initial cost of GB is quite high as compared to conventional buildings. Form three streams of lifecycle studies (Life-cycle cost, life-cycle energy consumption andlife cycle GHG emissions assessments) have been utilized to estimate environmentalimpactsof building construction [2].Fig. 1.1 shows the theoretical practiceof LCA, which evaluates all the resources inputs of a productincluding energy consumption, water,materials,GHGemissions, solid and liquid wastes, at many stages such as production, construction, use andend of life stage of building. While life-cycle energy analysis is a strategy that records for all energy commitments to a building in its life cycle, GHG emissions are reviewed as the construction output to the environment from cradle to the grave of the building [3].

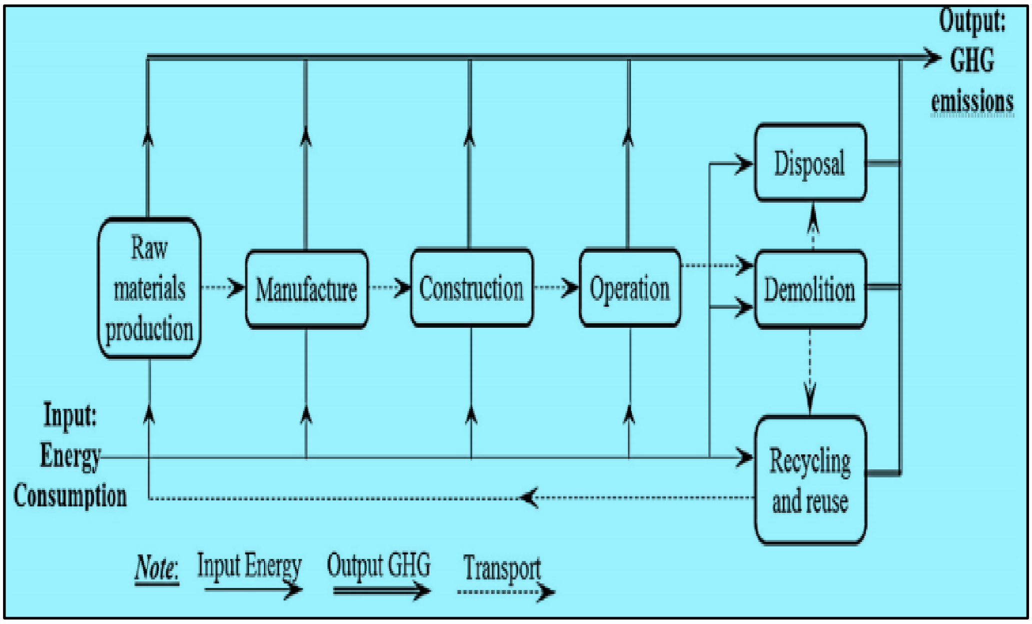


Figure 1.1. Theoretical process of Life-cycle assessment (LCA) [2]

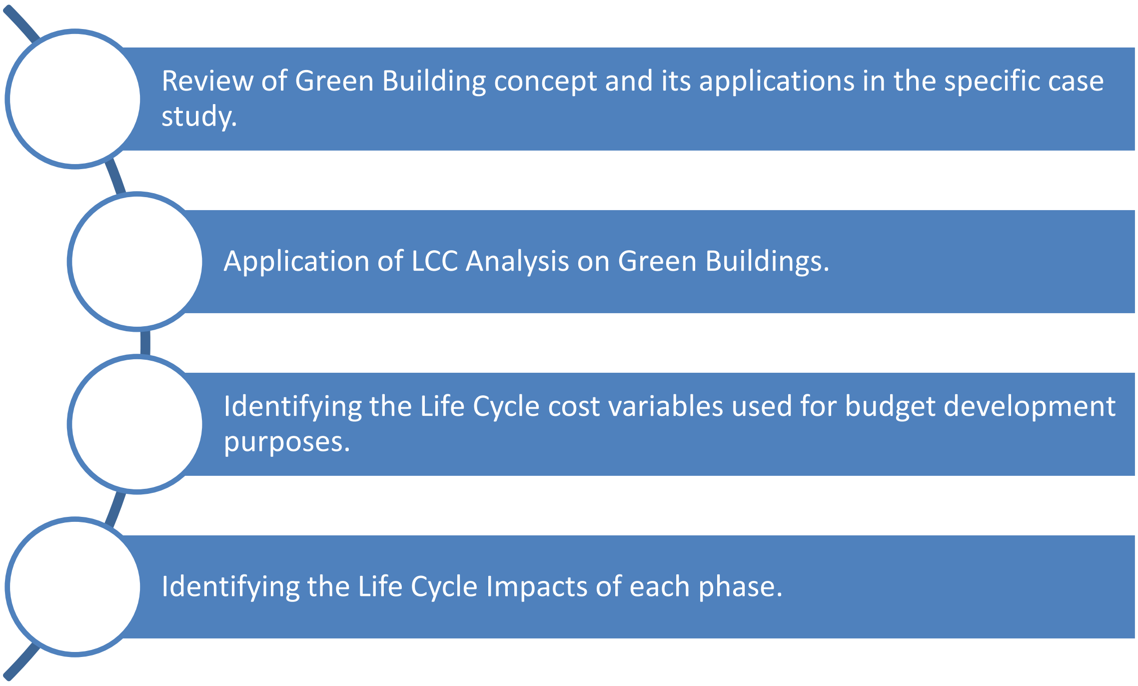
1.2 Thesis Objective

The concept of construction sustainability has been acquiring attention from many decades since numerous reports were published concerning the enhancement of social, economic, and environmental sustainability bottom lines in the construction industry [3]. The main objective of this research thesis is to conduct the LCCA of Green Building. This cost analysis is carried out for the 40 years, that is the total serviceable life of a structure.This research proposes a study that determines in what manner the life cycle cost analysis was conducted for a green building and shows how the life cycle cost variables were identified and used to develop a life cycle budget for the whole life cycle of a green building for sustainable development. LCCA is an investigative method used for evaluating the total cost of a system or product over its complete life cycle. The construction industry involves a complex process of design, material selection, construction methodology, operation, and maintenance. Therefore, LCCA determines the total life cycle cost from construction to demolishing.

1.3 Scope of work

This research will focus on using a comprehensive LCA approach to assess the impacts of green buildings from cradle-to-grave. As discussed above, for the case study considered a green building in Tirana Albania. The case study used in this research is, Ish Profarma 8 story frame structure green building with a grossarea of950 m². In line with theconcept of the green building, Ish Profarma was designed to adopt green technologies and eco-friendlyfeatures such as double-skin external walls to reduce heat gain,water features forcooling, mini rooftop garden, rainwater harvesting systems.

In responding to these inquiries, this research helps in giving a better maintainability evaluation of green structure frameworks over conventional structures. Although various phases of life cycle of green buildings have been considered in previous studies, the complete life cycle from raw material extraction to the demolition phase or cradle-to-grave approach, hasbeen poorly addressed inresearch studies. Additionally, life cycle costs of Green Buildings in comparison with Conventional Buildings is also the scope of research conducted. The following literature review will explore different research efforts which have addressed similar problems and will support the novelty of this study. To address the identified research problems, the following research objectives may be developed.



1.4 Organization of the thesis

This thesis is divided in 5 chapters.In Chapter 1, the problem statement, thesis objective and scope of works is presented. Chapter 2 includes the literature review. Chapter 3consists of the methodology followed in this research.In Chapter 4, the case study resultsarediscussed. In Chapter 5, conclusions and recommendations for further research are stated.

CHAPTER 2

LITERATURE REVIEW

2.1 Comparison

Table 8: Total life cycle budget summary for the case study

No Description Total life cycle cost ($) Weight

1 Design and construction cost 3,666,518 22%

2 Building energy cost 8,076,352 48%

3 Building water and sewerage cost 337,911 2%

4 Building maintenance cost 4,631,839 27%

5 End of life cost 173,014 1%

6 Total life cycle cost 16,885,634 100%

If the comparison is made between a building in Malaysia and a building in Albania some factor will affect to take a conclusion. In Malaysia is analysed a green building in the same way I have analysed mine. Design Cost in Malaysia is 2 times expensive than here. Price of the energy is 2 times expensive also but energy consumption is almost the same. Water and sewerage cost is almost the same in the price and consumption. End of life cost or demolition in Albania is more expensive than in Malaysia.

So the building that I have comprared with my buiding has 2695 m^2 Area that is 3 times smaller than mine. The future inflation rate is 2.4% in Malaysia and in Albania future inflation rate is 3.2% this change affect to much in calculations.

If we make a comparison it is obvious that area between the buildings is 3 times in diference. But in water and sewerage cost, energy cost and maintenance cost consumption is more higher in Malaysia than in Albania. Persentage of energy change because the price is 2 times higher than in Albania and consumption in Malaysia is also 2 times higher. There are to many factor that indicate in this different countrys but the weight of each cost is almost the same. Energy consumption has the greatest weight in operation cost, after that is water cost then sewerage cost and in the end is demolition part that have the smallest weight in the life cycle cost of the building.

2.2 Introduction

The concept of Life cycle assessments and its different stages will be discuss in this chapter. LCA is mainly divided into different stages to check thoroughly the suitability and serviceability of green and conventional buildings project and then the comparison will be done based on these assessments. LCA on green buildings projects will be reviewed and future scope of this type of buildings in Europe will be concluded in this study.

2.3 Life Cycle Sustainability Assessment (LCSA)

Life cycle sustainability assessment composed of three terms which are life cycle assessment LCA 2^{nd} one is life cycle cost assessment (LCCA) and 3^{rd} one is social life cycle assessment (S-LCA). In LCSA the evaluation is done to study all environmental, economic & social benefits and negative impacts which are directly or indirectly effects the sustainability of project through their life cycle from cradle to grave [4]. LCSA determines the project efficiency socially and economically. It measures which project is more cost effective & eco efficient and socially responsible for sustainable development. LCSA helps the entrepreneur to raise their confidence of choosing project efficiency, credibility and enabling the entrepreneur to identify past weaknesses in the projects and proposed the further improvements that has been done to raise the assets by minimizing the future deficiency.

Figure 2.0 Life cycle Sustainability Assessment [2]

2.4 Life Cycle Assessment

LCA is the international standardized environmental life cycle assessments method which is defined by ISO 14040 as the "compilation and evaluation of all inputs, outputs and potential environmental impacts of a product system throughout its life cycle" ISO, 2006 [7]. LCA is widely applied to investigate and examining the environmental effects by resources and materials used from raw materials attainment stage to end-of-life stages. In other words, LCA method measure the total credibility of project from construction phase to demolished phase of building, throughout its complete life cycle and thus it is considered a "cradle to grave" approach [5]. LCA is very useful for environmental consideration of green buildings because in most countries including Europe the green buildings are not adopted due to its high initial and maintenance cost. But if we study the LCA than it has revealed in different research that the green buildings are energy and cost efficient and has less environmental effects due to maximum usage of natural resources.

2.5 Life Cycle Cost Analysis (LCCA)

LCCA of a project or system represents the total project cost of that results from procurement, operation, maintenance, and demolish [8]. Thus, LCCA is the total cost of a project from cradle to grave. The main persistence of LCCA is comparing cost-effectiveness of spending in alternate decisions as it accounts for all the direct cost or benefits to a decision maker during the investment/asset complete economic life. LCCA has been considered an essential tactic in previous research and has been extensively applied for empirical research for green and conventional buildings, this method prescribed the cost comparison of recent construction and able us to choose the best option from alternatives approaches [5]. The results of LCCA depends on the number and accuracy of its input parameters, sometimes it is required to input previous years statics and data to compute accurate and precise evaluation of LCCA.

The costs summarized in the LCCA phase includes of construction, agency, and environmental costs. LCCA is needed during the choosing of project when there are certain alternatives available, and you must choose the one which has less cost and more effective. In this situation LCCA are considered to compare the different alternatives and to choose the best project which has less operating and maintenance cost. So, in other words LCCA is used for budget allocation of specific projects.Different term involves in LCCA is shown in Figure 2.1. LCCA follows the following stages starting from Design and Construction Cost, maintenance cost, operational cost and End of Life Cost, and then again started from the beginning it is a complete life cycle. Initial and maintenance explorations involve the cost during acquiring and maintenance of building. Operational cost consists of the cost during working and operating of building, it is less in case of green buildings. End of life Cost include the cost when the building has finished his process of working and will demolish. In LCCA the salvage value also considered to check the cost of buildings which has almost complete his useful life.

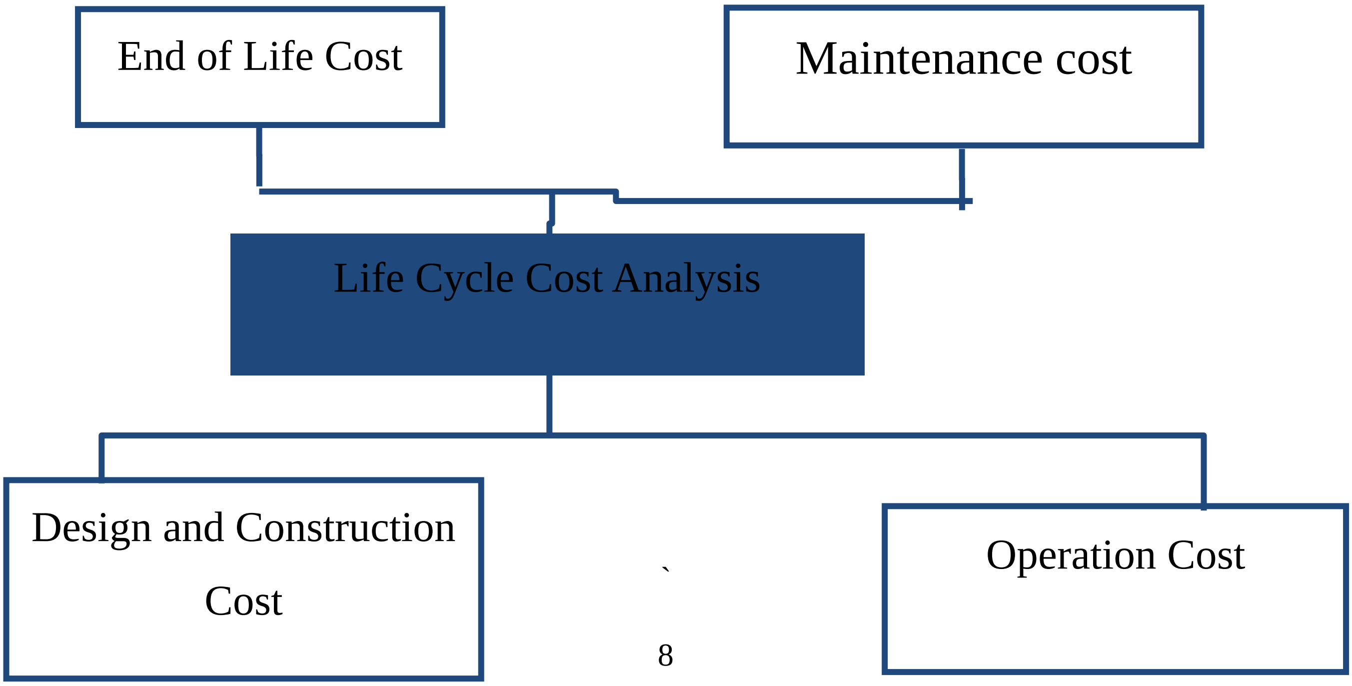


Figure 2.1. LCCA complete life cycle stages [6]

The first step in LCCA is the selection of alternate design options using economic principles and identifying best suitable alternate design options. The second step consist of including activity durations of each alternate identified in the first step. The estimation of directand indirect costs of each alternate activity is the third step [6]. Finally, the total life-cycle cost associated with each item is calculated after considering the costs represented in land procurement, design, equipment, material, workers, and operational costs. It is also imperative to consider several uncertainty sources while applying LCCA, such as life span of building, future costs, discount rate and inflation rate [8].

2.6 Social Life Cycle Assessment (SLCA)

SLCA is a decision-making approach which is directly or indirectly relates to social and sociological impacts of products, considering all life-cycle stages from cradle to grave. For better application of SLCA, a combined (problem and damage) midpoints and end point indicators should be well defined to study the positive and negative social impacts. SLCA also follow the same four step approach as in LCA: goal and scope definition, inventory analysis, impact assessment, and interpretation. SLCA does not provide information about the project usefulness it gives information about project social impacts which directly or indirectly effects on project credibility and sociology. SLCA provide information about "food for thought" this is very helpful for project decisions either it will be useful or not. The SLCA is considered during the mining and processing of raw materials, constructions, operations, maintenance and finally at the disposal of project.[6]

2.7 Green Building:

US Environmental Protection Agency EPA [4] defines the Green Building (GB) as "it is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life cycle from siting to design, construction, operation, maintenance, renovation, and deconstruction". This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. GB is also known as a sustainable or high-performance building". Although the initial cost of constructing GB is maximum but in coming years the demand of GB is increasing attractively.In GB the use of natural resources is maximum, i.e., wind, water, solar energy, plants etc. Based on the concept of Green Building the adoption of green technologies and eco-friendly features are described below:

2.7.1 Rain Harvesting System:

In GB, the rain harvesting systems also called rainwater collection system are installed to control the wastage of rainwater. Rainwater harvesting system is a technique which can be used in any sort of building either it is commercial or residential. This system collects or catch the rainwater through roof and then store this water to storage tank and use for non-domestic purposes. This rainwater may be used in toilets, gardens, clothes, and car washing etc. Due to high consumption and wastage of water this system is best way to utilize rainwater during rainy seasons. The typical process of rainwater harvesting system is shown in figure 2.2. It starts from roof inlet, rainwater that collects from roof makes its way through that inlet pipe. This inlet pipe connected with suction tank which clears the impurities from rainwater through filter media. This treated water is then sent to collection tank which is designed based on extreme rainwater capacity to store maximum amount of water during rainy season. From this collection tank water is then sent to the roof top storage tank based on desired water requirements, which can be used for non-domestic purposes. The significant benefits and the effectiveness of rainwater harvesting system and its requirements for thegreen buildings can be justified by following reasons:

1. It is quite easy to implement on rooftop and not required much effort to maintain. It does not require much cost, so it is cost effective.

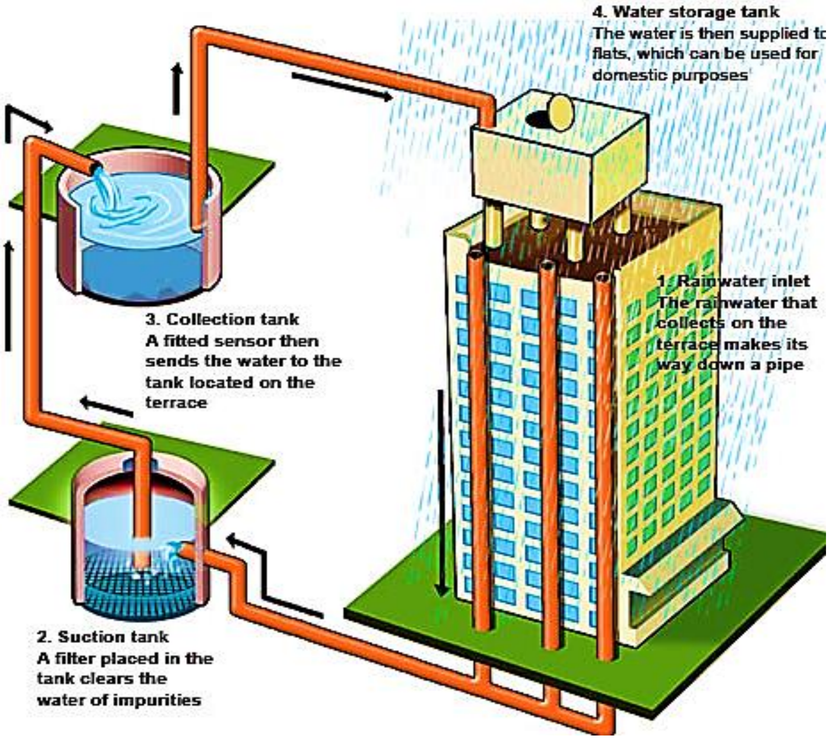


Figure 2.2 Rainwater harvesting system [9]

2. It is a disturbance-free method of preservingrainwater and directing it to storage tanks for non-domestic use. It controls the wastage of rainwater.
3. Sometimes with the usage of rainwater for non-domestic purpose this water may also be used for recharge of groundwater table by directly percolate the water through underground water tank.
4. Rainwater harvesting system reduces the usage of potable water by providing filtered rainwater by harvesting system, so it saves the water bill. It makes the community self-sufficient and naturally sustainable.

2.7.2 Double Skin Facades (DSF):

Double Skin Facades (DSF) external walls consists of 2 skins or facades 1st the external glazing 2nd the inner façade and there in an intermediate gap between these two skins. The external layers consist of tempered, durable, and laminated safety glass which offers the shield against climates changes and wind pressure. The 2nd layer usually consists of relatively less quality glass then outer layer. The intermediate cavity or gap in this wall reduces the sound & heat transfer, and act as insulation between these two skins. The DSF preferred in green buildings to lessen heat gain and use of natural sunlight in building to reduce the electricity consumption to minimum. DSF is usually responsible of less heat gain of building during summer season and provide better aesthetic look to building from inside and outside also decrease the electricity consumption by providing direct sunlight in the building. This system also provides nigh-time cooling, act as pollution barrier between building and outside, daytime, and night-time views, natural cross ventilation system and overall increase sustainability of environment. Typical example of DSF is shown in figure 2.3.

Figure 2.3 Double Skin Façade wall in Building (DSF)

There are many types of DSF depending upon the number of facades layers. It starts from doble layers to multi layers DSF System. Multi-layer DSF system used in location where there is polluted environment, ventilation problems, vehicular and noise pollution etc. Number of facades layer externally protect the building and make it more noise and heat proof. Even though there are certain advantages of DSF, but there are some disadvantages too. The glass used in this system is very costly and need skilled labor to install it, so it increases the overall construction cost. Moreover, due to smoothy nature of glass it required proper maintenance and cleanliness. In DSF if proper insulation is not provided than it has overheating problems which alters the temperature of building. This system also has fire protection problems, due to combustible nature of glass once the building gets fire it difficult to extinguish and eventually cause the spread of smoke and fire throughout the whole building. Moreover, this type of system also has condensation which due to higher temperature at outside and lower on inside it gets condensation of water vapors on inside face of glass wall, which obstruct the visibility. No doubt there are certain disadvantages but if DSF is properly designed and maintain then this system pays off various social benefits which increase the sustainability. Weather this system is needed or not, it requires several considerations before choosing, if there is no issue of initial cost, labor, planning, operating, and maintaining than this system is best suited for next generation of infrastructures.

2.7.3 Mini Rooftop Garden:

Mini roof top garden usually consists of grass, plants, flowers, and bunches. It is constructed at green building roof which is environment friendly and part of sustainable architecture. It increases the aesthetics, comfortable and feels functional and is the best way to utilize the roof in proper manner. The green roofs are responsible of healthier environment in the congested urban areas where there no way to control pollution. It collects the sun heat directly and overall reduce the temperature of surroundings which cause ecofriendly environment. Green roof top with grass and flowers feels natural and environment friendly, it reduces the temperature of building during summer, so this cooling way considerable decrease the air conditioning, heating & electricity cost which leads this system to sustainable development. This system also purifies the air by (producing oxygen, absorbing carbon dioxide) which cause fresh breath for humans [6]. During rains and snow storms this garden reduce the runoff of rainwater in streets and roads. Proper maintenance and caretaking are required for this rooftop garden. If proper roof treatment is not provided on rooftop, then this causes the dampness in the building.

2.7.4 Water Features in GB:

There are several features which can be installed in GB to control consumption of natural resources i.e., water, air, energy etc. Water is one of the most abundant natural resources but with the passage of time the amount of water in decreasing day by day. To control the amount of water there are several features which can be installed in GB like, rainwater harvesting, grey water recycling, cooling towers & pressure reduction valves. Rainwater harvesting system has already studied in detail. Grey water is defined as the water which discharge from showers, kitchens, bathtubs, washbasins etc. and directly come contact with sewers without treated. This water can be treated by water treatments plant through settlement of solids, flocculation, coagulation, digestions, filtration, and disinfection. Although this treated water in pure enough but cannot be used for drinking purposes, it can be used for toilets, washing clothes & cars and plantings. This system reduces the overall consumption of water and increase the sustainability. Cooling towers in GB use evaporation cooling techniques to lowers the temperature of building and surroundings. In this system non potable water is used for evaporation purposes. Water vapors can be produced by fountains, these vapors lower the temperature and increase humidity of surroundings. Air conditions used in that building now works at lower temperature to cool the building. In this way this system lowers the cost of air conditioning and saves electricity. Pressure reductions valves are used in water fixtures to maintain the consistent water pressure across the entire building. Water release from these fixtures mostly has high pressure as compared to required, so this releases the extra amount of water from fixtures which cause wastage of water. Moreover, this high pressure also damaged the pipes joint and bents. To control this wastage the pressure reduction valves are attached with each fixture, these valves are commonly used in residential as well as commercial buildings. A complete example of water featuring is shown in figure 2.4

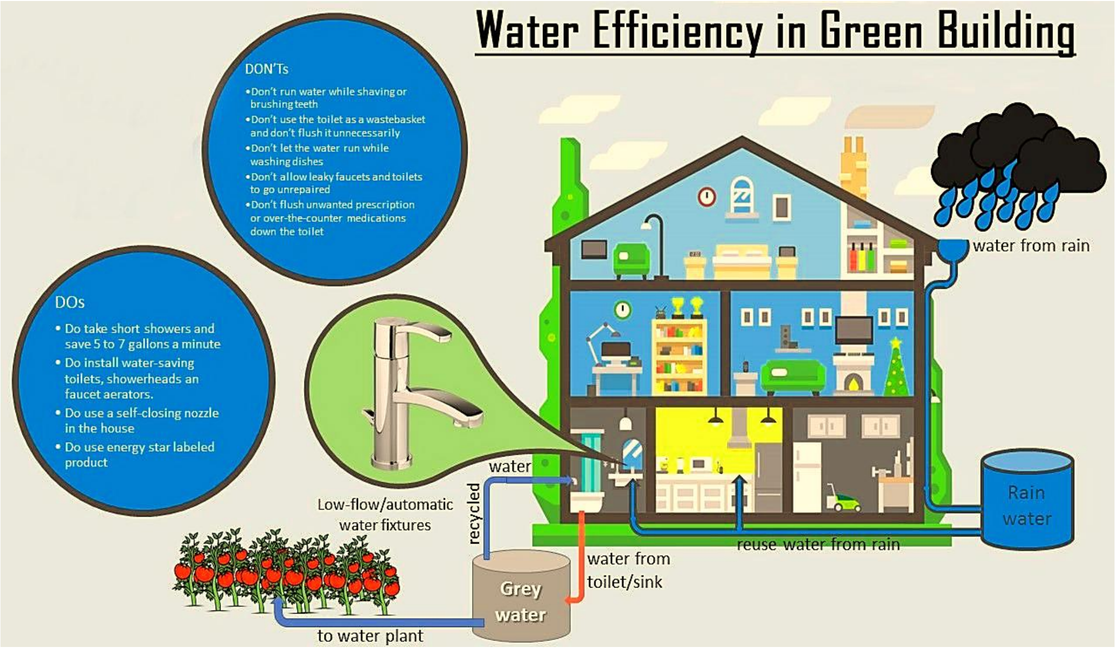


Figure 2.4 Water Featuring in Green Building [9]

2.7 Case Study Description:

The case study which is examined in this research thesis is theIsh Profarma 8 story frame structure green building with a covered area of 950m². The 1st and 2nd story height are 5.25 meter while the rest are 3.15 meter shown in figure 2.5. The total floor area including basement is 9100 m^2. There is total 56 residential flats and 6 commercial stores in this building. In line with theconcept of the green buildings,Ish Profarma was designed to adopt green technologies and eco-friendlyfeatures such as double-skin external facade walls, different water features (grey water recycling, cooling towers & pressure reduction valves), mini rooftop garden and rainwater harvesting systems. According to the design criteria, theestimated total annual energy demand by the buildingis calculated in next section. This building is constructed between the period from 2019 – 2021.

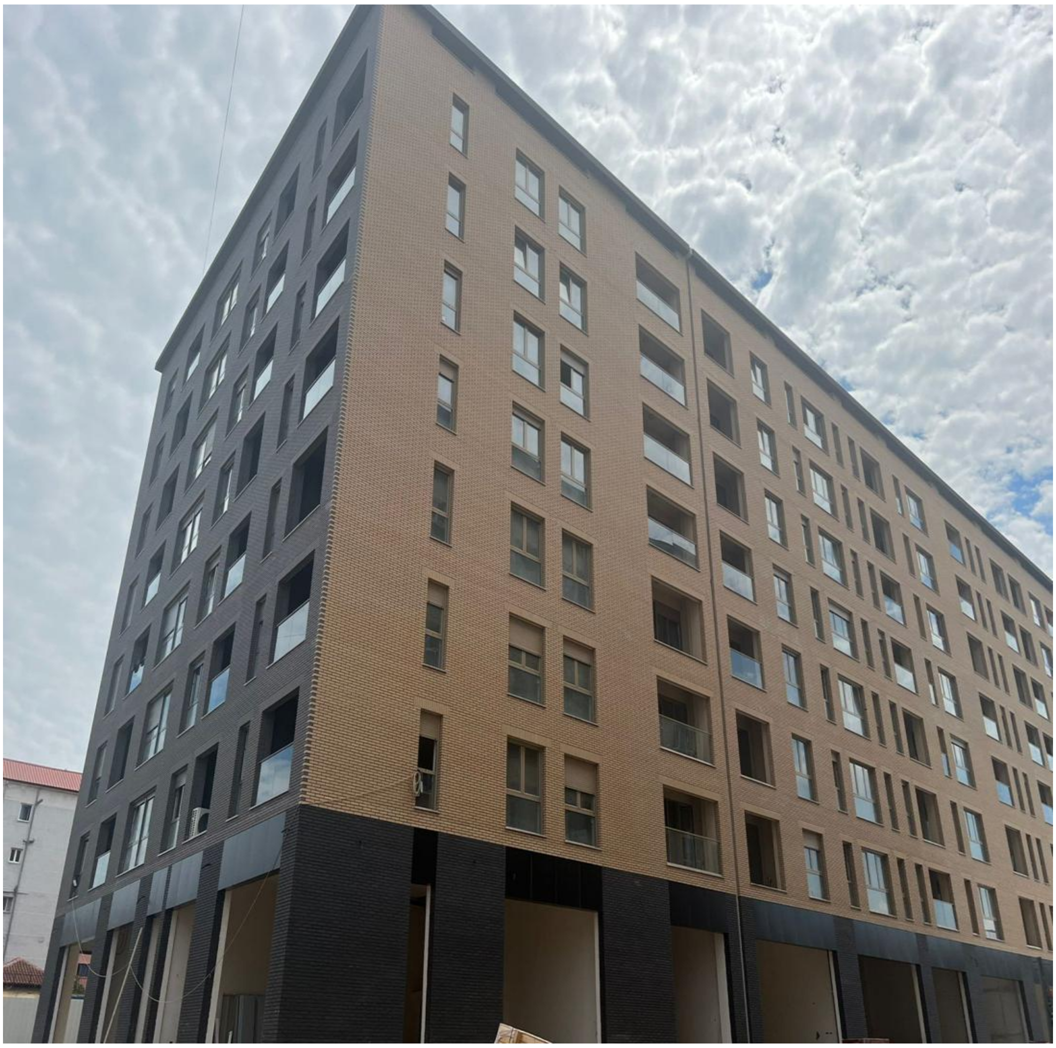
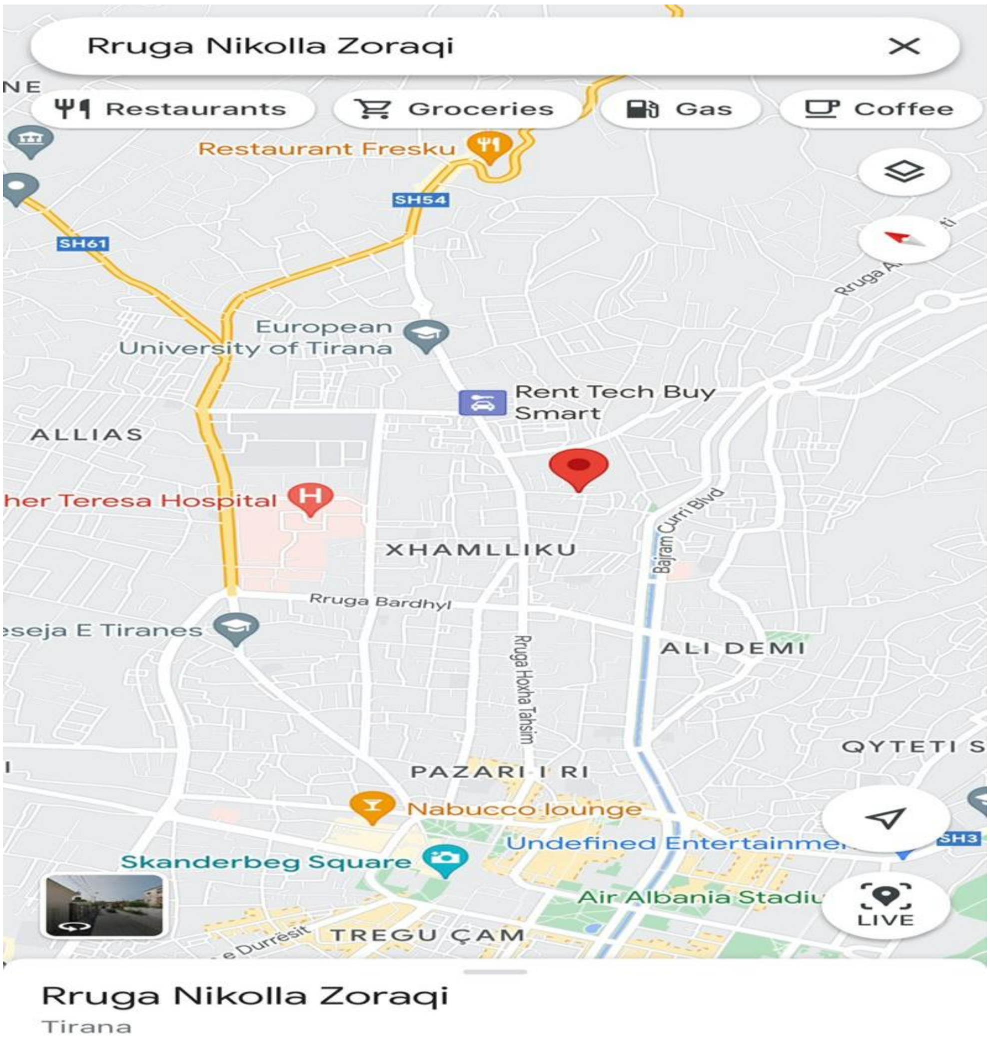


Figure 2.5. Ish Profarma 8 story frame structure green building under construction



Location of the building is in Tirana , Albania in road "Nikolla Zoraqi"

2.8 Building Life Cycle Cost Analysis:

Ish Profarma building was designed as green building &life cycle cost analysis was not carried out during this construction. In many countries life cycle costing is not a common practice, but now this analysis is carried out in Europe Regional Network (ERN) and followed by the World Green Building Council (WGBC). Europe Regional Network is composed of over 20 national Green Building Councils. Furthermore, in Europe there is growing market of green buildings, which are increasing day by day, so proper life cycle costing is required concern for further awareness of green buildings. However, there are certain design guidelines and codes available for both residential and nonresidential buildings. In assessing the total life cycle cost for the case study, building construction year

2021 will be used as the base date for LCCA data compilation and evaluation. LCCA will be considered in European currency Euro. In conducting the LCCA, the International Standard ISO 15686-5:2008 [7] was used as a reference to identify the LCC components and elements. For conducting the complete life cycle the following required data is compulsory:building service life,period of analysis,future inflation rate,discount rate,design, and constructioncost,building operating cost,building maintenance cost,end of life cost. The complete discussion will be done in next chapter.

CHAPTER 3

METHODOLOGY

In this chapter the complete and detailed research methodology will be discussed. The details investigate methodology is applied to do the LCCA of green buildings, without considering the specific details of design and implementation of a particular facility of construction project. There are certain software and direct approaches methods of performing LCC analysis of a specific project. In this study we will consider the direct approach for LCC analysis, and it is done to classify relationship between first cost of building features and cost after many years throughout their life cycle. In this research, the life cycle cost analysis of a green building is explained, which is used as a decision support argument before the investment stage. The life cycle cost analysis is used to examine cost impact of a green building throughout its entire life cycle, starting with the construction phase of the building and ending with its dismantling and recycling of the used materials in other words from cradle to grave. For this LCC different cost analysis will be carried out including construction and designing, operating, maintenance, dismantling and salvage cost per m^2 of the building. In building operating data there is involved serval items like, building rent, energy, water, sewage consumption annually.

3.1 Life Cycle Phases of Cost Analysis:

Within the latest developments and increased understanding, Machine Learning applications are being used for life cycle cost predictions by conducting research on different cost estimation models through historical data and measured their accuracy [10]. The insufficient understanding of the LCC and its methodology are considered as an obstacle to the widespread use of LCC applications. A comprehensive life cycle budget obtained with considering of design and construction cost, building operating costs including energy, water, sewerage costs, building maintenance costs and finally, end of life-demolition costs. A complete flow chart explaining life cycle phase of facility is shown in Figure 3.1. As there are comprehensive life cycle cost calculations for the entire building, a life cycle cost analysis can also be performed to evaluate the economical evaluation of specific components for the building. Researcher analyzed energy consumption amounts of different design cases with running them on an energy simulation software, then taking them into account as operation costs to life cycle cost analysis. The below flowchart is demonstrating life cycle phases from planning to disposal.

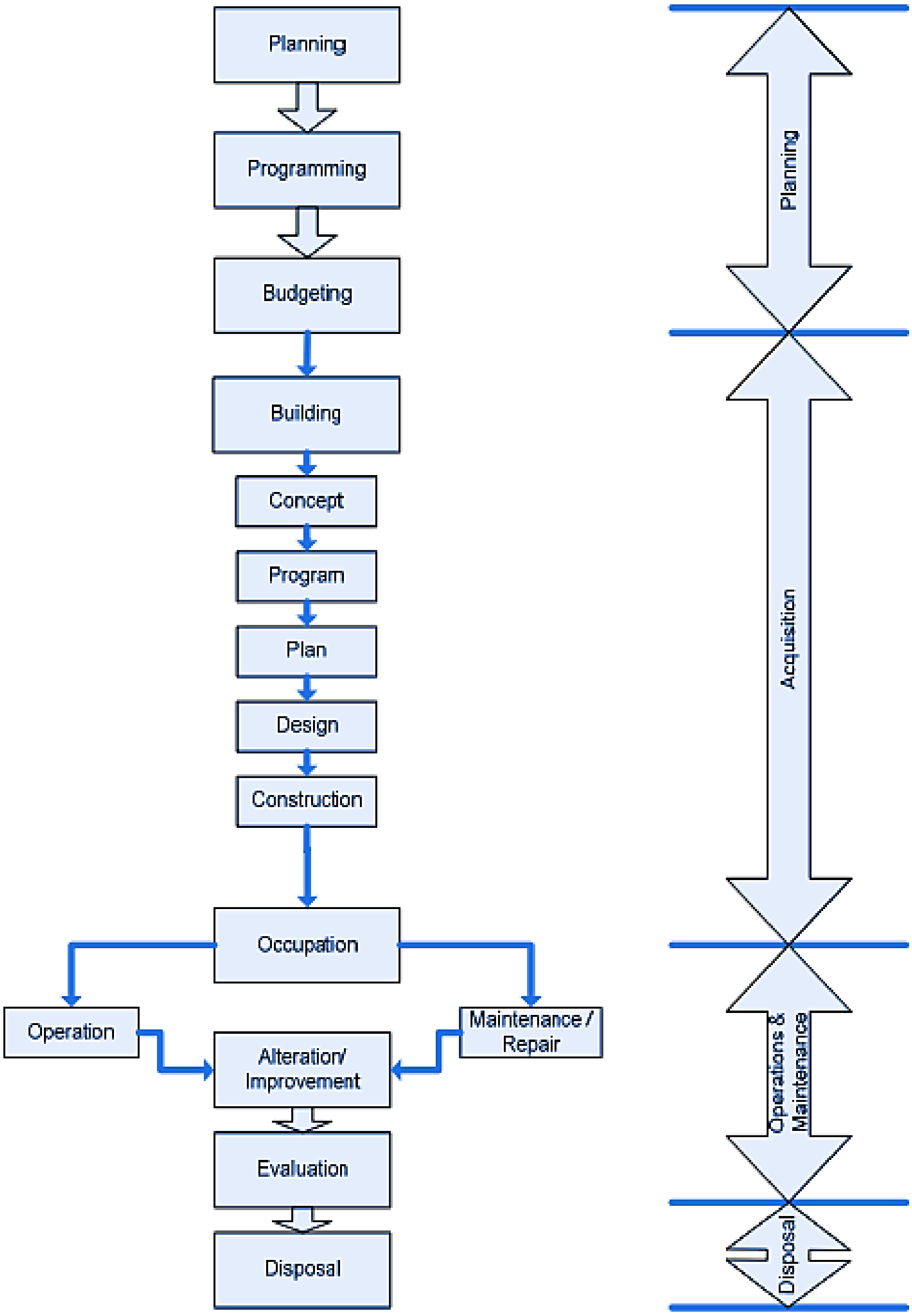


Figure 3.1 Life cycle phase of facility [11]

3.2 Costs Includes in LCCA:

The LCCA combines all costsinto net annual amounts, discounts them, usually to present value, and sums them to arrive at LCC. The flow chart in Figure 3.2 shows there are5 costs involving in LCC analysis i.e., initial cost, operation and maintenance cost,replacements cost, residuals values, and non-monetary costs. It is shown in flow chart that the initial cost of projects includes the 1st purchase cost and land acquisition cost. It is that cost which is required to purchase or acquired the land before the construction of any buildings, all the liabilities and paperwork charges are included in this initial cost. After the acquisition of land then the cost required for designing and construction of building is also included in this initial cost. The design work of building charge almost 10% of overall construction cost. While the reaming 90% cost is utilized in execution works, which includes the material charges, machinery expenses and labor [8].

Careful considerations are required during the construction phase of the building because during this there are different risks and problems that we must face, which effect the timeline and budget of project. These risks include the safety problems, variation orders, incomplete or mixing drawings, unknown site weather conditions, labor shortage and unanticipated increase of material cost etc. There are different ways to mitigate the risks and hazards by using latest construction management software and tools, which is now becoming trending and has wide applications in the construction industry. These tools are utilizing to manage and schedule the construction project by considering and mitigating all the risks. These risks are also managed by proper collaboration and meeting with all the company employees and share project schedule and timeline with subcontractor to stop the delay in the activities of construction project. The consideration of using these tools overall increase the efficiency of construction project and control the cost by minimizing the risks and hazards that are directly or indirectly effecting the project. There are certain software like, Riskwatch and Risk Managements Plan (RiskMP) & integrated with MS Project and Excel, which are widely used to guide the method of building risk management plans through the project duration. The 1st step in management of risk is to identify risks and hazards, then to classify and evaluate the intensity of the risk, then to make map risk triggers by providing potential risk indicator and risk awareness guides to improve planning against effective risks, then at the end presented the risk management and mitigations plans to decrease the probability of risk by implementing several controls measures or solutions.

This is the whole strategy of controlling the risks in construction to control the cost for sustainable LCC analysis.

Moreover, in LCC analysis the 2^{nd} cost includes is operation, maintenance, and repair cost during the whole life of project. Building maintenance is the cost required for the restoration or retain of the functionality of building or project. It involves various costs such as cleaning, landscaping, electrical system maintenance etc. In green building the maintenance and repair cost are more as compared to conventional buildings, because it comprises the various systems. i.e., rain harvesting system, double façade skin external wall, roof top garden, cooling and pressure relieving fixtures. The cost of cleaning, repairing, and fixing of glass façade wall is higher and take much of time and effort. Furthermore, the replacements cost comprises the cost required during demolishing of building and replacement and site improvements. This cost is significant at the end life and at the last duration of service life of building. Residual value is defined as the resale or salvage value at the end period of estimated useful life & serviceability of building & it decrease with the life of structures.

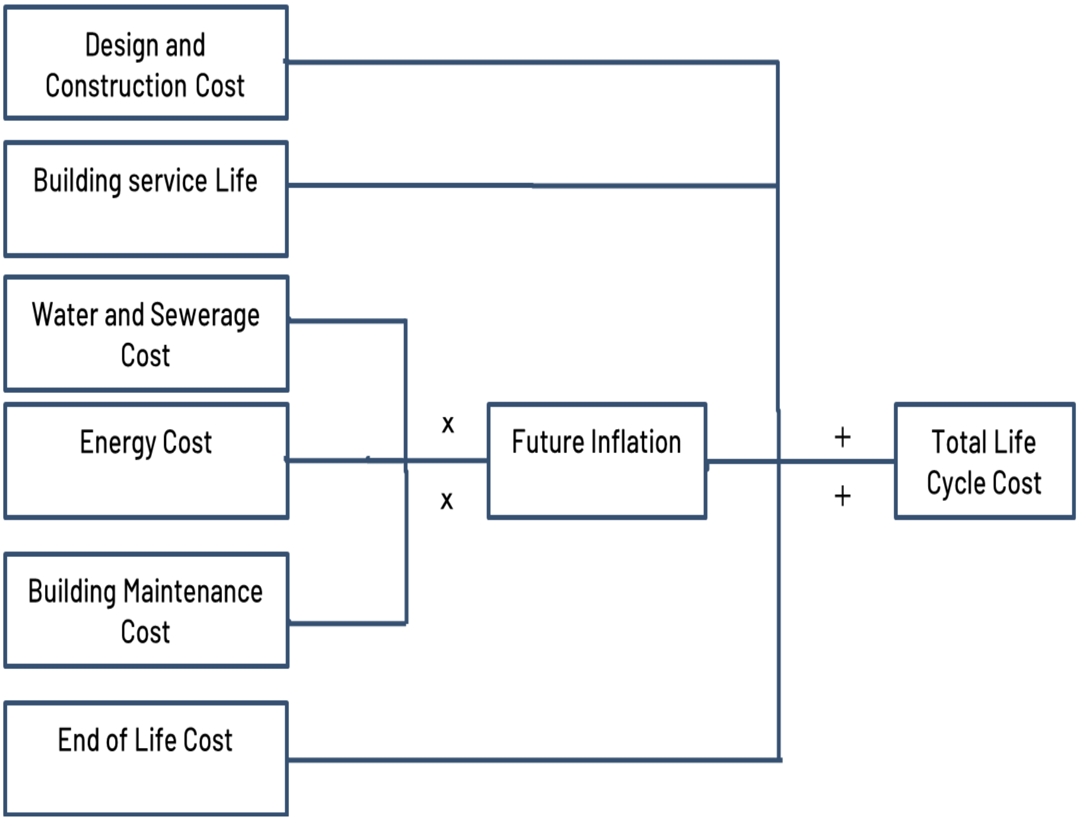


Figure 3.2 All costs in a LCCA [11]

3.3 Building Service Life:

The building service life is defined as the minimum time during which building is serviceable, acceptable and satisfy the minimum level of performance (ISO15686-1:2008) [7]. Basically, for defining LCCA, the building service life is important factor to recognize the time interval over which the complete life cycle of building can be carried out to cover the whole life of building. Nevertheless, approximating the service life of building involves various factors, i.e., annually maintenance, repairs, paint works, rehabilitation works. If these factors are properly performed and carefully consideration are taken, then life span of a building extend.

Concrete is most widely used material in buildings construction, the life of structure depends on the quality and life of concrete. Concrete on the other hand has high compressive strength and weak in tensile strength, to exceeds the tensile strength of concrete steel is embedded in it. Concrete required proper maintenance and preservations, if it is not made then with the passage of time the deterioration of concrete take place and steel used in concrete also gets corroded which lowers the strength of concrete. This directly affect the serviceability of building; service life of structure gets reduced. However, in green building there are several systems like rain harvesting system, rooftop garden and double façade external wall etc. which required proper maintenance and caring facilities, if it is not made than it reduces the life of building as compared to conventional building. The International standard ISO 15686-5:2008 endorses that the predictable service life of a green building should not be less than its design life. Based on the design specifications and ISO 15686-5:2008 standards of the building, a time of 40 years is recommended as the average service life of green building, and it will be used as base period in this study [7].

3.4Period of Analysis:

LCC analysis is done for specific time horizon which is called period of analysis. Service period begins when the client or owner occupied the system or building, and building start it services. Whole life cycle of green building may be greater than the period of analysis, if we are considering the period of analysis for LCCA, it doesn't not mean that it is equal to whole life cycle of building or product[11]. Different scholars recommend in their research the various values of period of analysis, and it is determined by checking the feasibility and economy of project [11]. Research is conducted a LCC analysis and suggested a specific period of analysis of 25 – 40 years for green buildings and stipulated in research that the current value of future costs that occur beyond a period of 40 years may be insignificant for buildings [12]. The international standard ISO 15686- 5:2008 recommends not to exceed 100 years for the same reason. The Federal Energy Management Program (FEPM) which provides sustainable solutions to meet energy requirements and goals to federal agencies and stakeholders, FEPM suggested the analysis period which is limited to 40 years. However, within the context of sustainable development, it is vigorously argued that life cycle cost analysis should include the whole life cycle of a building, or a product [13]. Since the persistence of the study is to progress a total life cycle cost budget for the case study, so in this case the total life cycle cost analysis will be carried out for a period of 40 years starts from the construction date of Ish Profarma building 2019 to 2060 which is expected end life of the building.

3.5Inflation Rate

The inflation rate refers to the continuous increase or decrease in the over-all price levels of goods and services of specific area (ISO 15686-1:2008). In conducting a LCCA for financial evaluation resolves, nominal or real costs of goods and services are used in the analysis, because the life with the passage of time the prices of petrol, energy, materials etc. increases and it directly affect the LCCA [14]. The inflation rate depends upon the Gross Domestic Products (GDP), imports and exports of the country. For any construction project, the three M are necessary Manpower, Machinery, Material on which the whole strength and duration of project is based. In construction the different materials (aggregates, sand, cement, admixtures, wood, paints etc.), machinery (Concrete plants, pumps, cranes, roller, loader, transit mixers etc.), and manpower (Engineers, labors, masons, welders, operators, technicians etc.) are used for running and conducting activities of any project.

The cost of fuel, i.e., petrol, diesel and gas are directly affecting the cost of construction projects because of utilization of maximum machinery in construction. The cost of fuel is increasing day by day due to this the construction, operating and maintenance cost of a specific project is also growing. The graph shows the crude oil price statistics of Europe in US Dollars (Energy Information Administration and Federal Reserve Economic Data) [15]in figure 3.3. The graph shows fluctuation in the price of crude oil per barrel from 1993 to 2021. The EU Refining production runs between two global, open, and transparent markets: the market for crude oil and the market for refined products. The main benchmarks are priced in dollars. The price of crude oil is set on international spot markets and reported by designated agencies. The price of oil is an important marker for the global economy and is closely watched by businesses and policymakers.

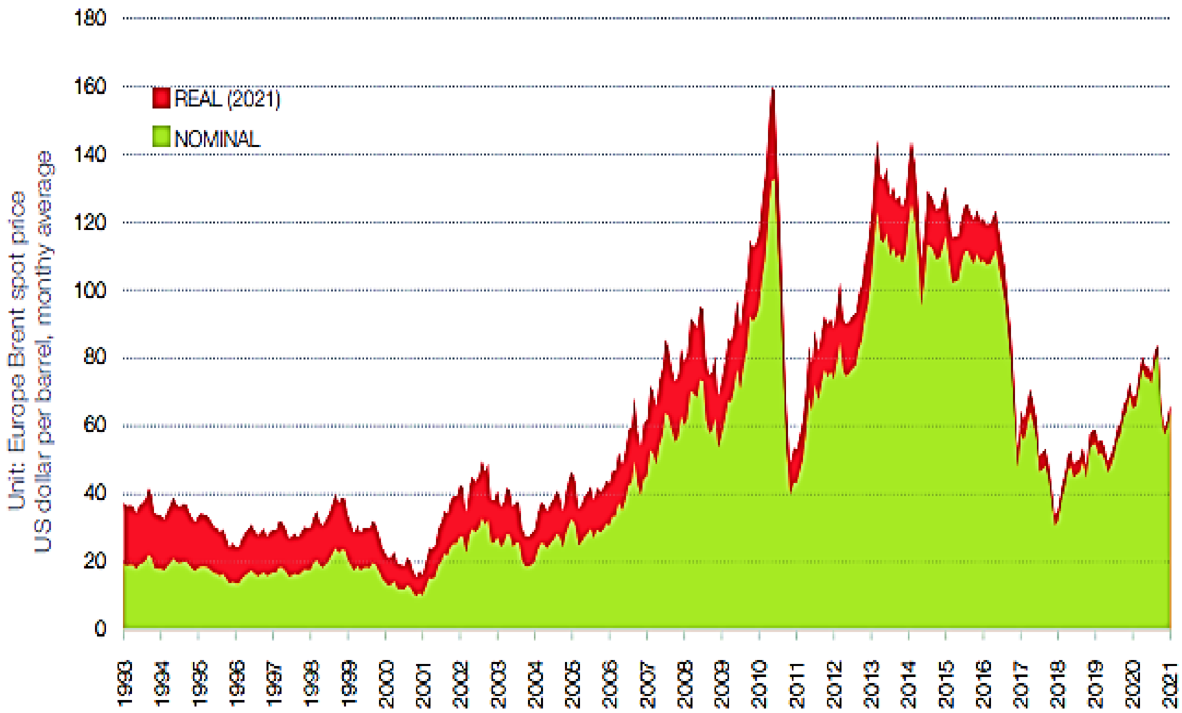


Figure 3.3 Crude oil price statics in Europe [15]

It is clearly visible from graph that the price of oil was almost 30$ per barrel in 1993 and then it was increasing in 2010 from 30$ to 160$ and then again now in 2021 it has the value of almost 60$ per barrel. This price will again fluctuate in 2022 due to high demand and price of oil in international market. [17]

There are two types of cost used in inflation rate the nominal and real cost. The real cost measures the current value of any goods and services while the nominal cost is defined as the paid cost during purchasing of any goods air services. Inflation rate is based on the real costs of goods or services. To reduce the uncertainties and fluctuations in the rates of items and service it is recommended to go through the real rates for conducting LCC analysis[10]. Contrarily, in LCC analysis while creating financial budgets in which future money outflow and variations are estimated then it is recommended to use nominal cost as current cost of goods and services (ISO 15686-5:2008). Since in the case study, for conducting LCC analysis for certain future period and service life, of Ish Profarma building, which is in Tirana, Albania, it is recommended to consider the current inflation rate of Albania for future results. For this inflation rate of last 26 years is considered for future LCC analysis. Trading Economic Statistics of Albania of last 26 years is shown in figure

3.4 from 1995 to 2021. The inflation rate in 1995 was 16.54 %, then it got increases from 1995 to 1997 up to 42.68%, it was the higher value in the history of Albania. Then it got decreases in 2000 at 1.71% and then again it rose to 8.52%, after this the inflation rate dropped down from 8.52 to 1.9%. In 2021 inflation rate was 2.4% value. From 2000 to 2021 there in not any abrupt changes in the inflation rate so the average value is calculated for next years as 3.2 % for future life cycle cost analysis.

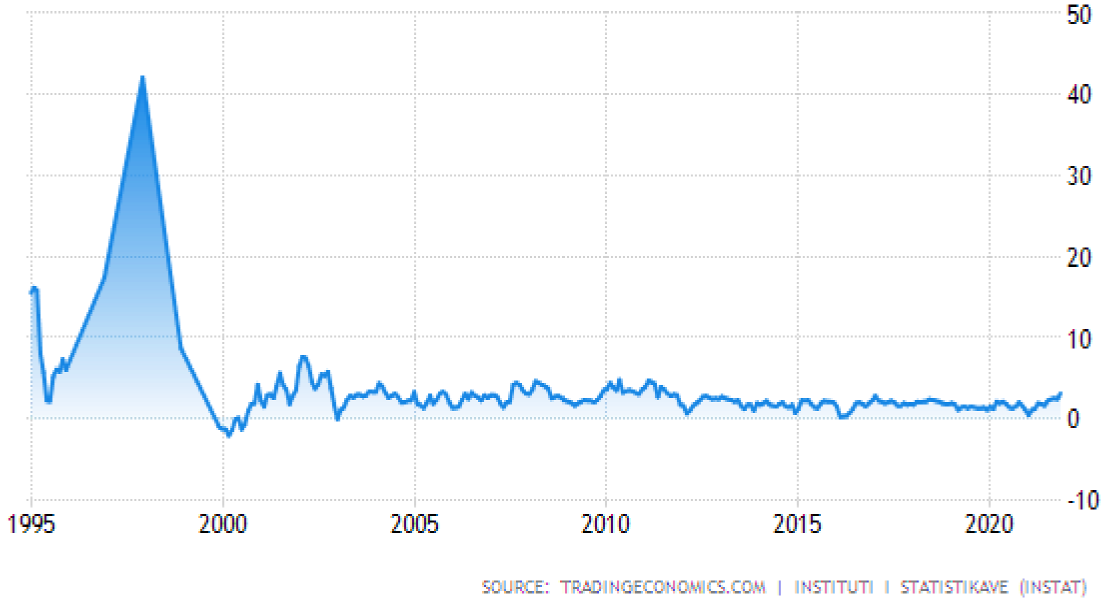


Figure 3.4 Trading Economic Inflation rate of Albania from 1995 to 2021 [16]

3.6 Consumer Price Index (CPI):

Historical data about the past inflation/deflation rates can be attained from periodic reports frequently issued by department of statistics or other relevant bodies in a country. Consumer Price Index (CPI) measures the fluctuation or rise and fall in the rates of various items and services, with the variation of time, in certain area or country. CPI is the most widely and frequent used method for calculating the rate of inflation in country, it gives a rough idea about the future inflation rate or predict how the prices of different goods and services will vary with the passage of time. It gives an idea to government or businessman about how the economy will vary in future and make them capable of making decisions about future cost. CPI is measured by mathematically & graphically with the help of past data of prices of different items & service and it annul variation rate. The consumer price index graph from Trading economic statistical data of Albania from 1989 to 2021 is shown in figure 3.5. In previous year 2020 CPI was 102.85 point and it increase from 103.72 in December 2021. The lowest value of CPI in the December of 1989 was 3.08 points in Albania. The average value of CPI from 1989 to 2021 is recorded as 70.88 points according to trading economic statistical data. In forecasting of previous CPI data, it is expected and predicted that the value will rise from 103.72 to 106.19 points in the end of 2022. In 2023 it will rise from 106.19 to 108.22 points and in 2024 it will be 110.50 points.

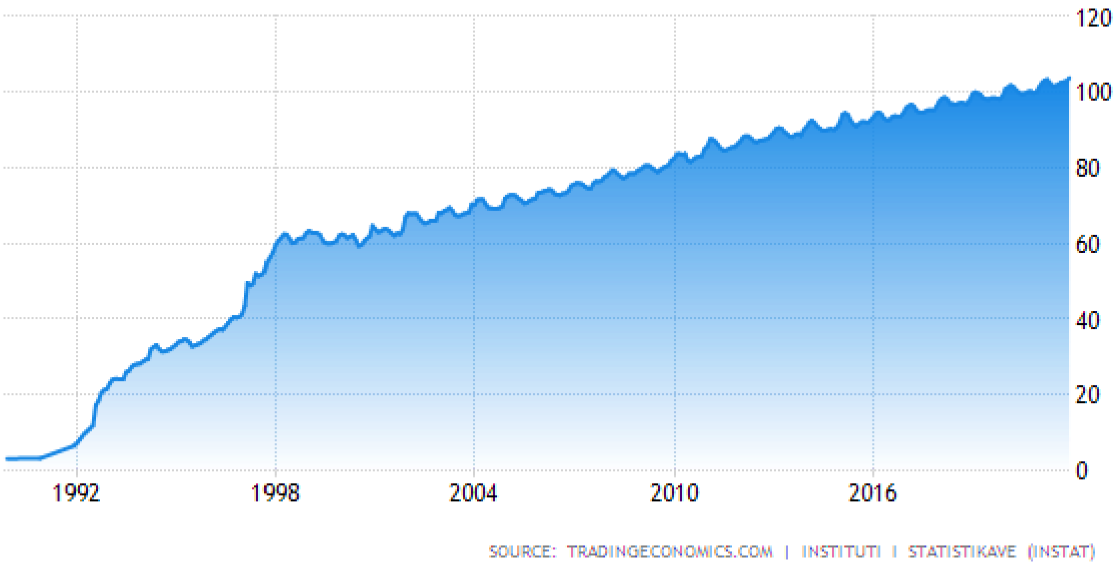


Figure 3.5 Trading economic statistical data of Albania CPI from 1989 to 2021 [16]

3.7 Discount rate:

Discount rate is defined as the present worth of certain item or services, or it is the time value of money. It determines or predicts the present value of future amounts of money and used to evaluate the future cost of goods or services. It is also referred to as interest rate if it is used to find the future equivalence for an amount of money now [17].In life cycle cost analysis,it is important to define a discount rate to obtain the equivalent value for each alternative to compare the amount of each alternative accurately and precisely. The International Standard ISO 15686-5:2008 commends that the discount rate is an alternate way of setting the way of rate of interest for all types of construction and business sector projects. This discount rate has vital importancefor the invested capital amount in any business project for calculating the interest cost. It is also having wide applications for calculating the interest lost from cash reductions from deposits, and to find out the actual return from new construction or business, and to calculate lost return from other possible investment. Discount rate determined by central governments used for public sector projects according to the ISO 15686-5:2008. The main objective of this thesis is to develop a life cycle budget for the building in the nominal terms showing the expected money outflow in the future, the discount rate has no function in the analysis. In other words, discounting the estimated life cycle costs in the nominal terms to find the present worth is not required since it is not intended in the research to conduct economic evaluation for different design alternatives.

3.8 Design and Construction Cost:

For conducting a complete LCC analysis the design and construction costs represent a primary and main cost element of green buildings. In this thesis the case study of Ish Profarma frame structure green building with a grossarea of 950m², is completed in the construction period of 2019 to 2021. The design of this building was done in 2019 and cost of design is prime consideration for conducting LCC analysis.Moreover, the construction cost of this building includes all costs that has spent during the phase of 2019 to 2021, that is calculated by individually finding all the cost estimation of material, manpower and machinery. The construction cost is also calculated during the feasibility studies of buildings.The operation and maintenance costs are also important phases of LCC analysis that are calculated after the construction phase has done & building starts operating. The scope of this thesis is to create a total life cycle cost analysis and budgetdevelopment for green buildings, for this the construction and design cost for the building is calculated in Albanian currency Lekand it is converted into Euros for this analysis. Thetotal estimatedconstruction cost for this building by the estimation team isabout € 3,153,843 and design € 85,500. Table 3.1 isused as the budgeted cost for building design and constructionn in the total life cycle costanalysis.

Table 3.1 Total Estimated Construction Cost of Ish Profarma Building [Appendix 1]

Sr	Description of Work		Amount in Euros
1	AMOUNT OF CONSTRUCTION WORKS CARBINES		900,809
2	AMOUNT OF CONSTRUCTION WORKS REFINED		1,326,724
3	AMOUNT OF PARKING CONSTRUCTION WORKS		68,989
4	AMOUNT OF ELECTRICAL WORKS		92,870
5	AMOUNT OF HYDRAULIC + HYDRO-SANITARY WORKS		199,008
6	FIRE PROTECTION		39,801
7	AMOUNT OF WORKS 1 + 2 + 3 + 4 + 5 + 6		2628202
8	T.V.SH (GOVERNMENT TAXES)	20%	525,641
9	TOTAL AMOUNT OF WORKS DONE INCLUDING TAXES		3,153,843

3.9 Building Operating Cost:

The building operating costs is defined as the cost that is required to run the building during its operation and it may include rent, energy, water, sewerage costs etc. According to the ISO standards 15686-5:2008 buildings operating costs consists of rent cost, insurance cost, repeated monitoring cost, utility cost, government taxes, and other operational costs that is required for all other purposes. In this thesis for case study, building operating costs includes only the utility costs which include energy/electricity and water utilize costs, and annually sewerage facilities fees. For the LCC analysis of green building these costs will be studied separately in each section.

3.9.1 Energy cost:

Different types of energy is used in buildings for different purposes, this is required to be find out for cost analysis. In case of green building the usage of energy is less, because of energy efficient features i.e., double façade external wall and solar system installed in it to utilize natural solar power to reduce the electricity consumption. To find out the energy cost two types of data is gathered for life cycle cost for this case study analysis:

- Total green building energy use for all purposes in kilo watt hour (kWh) per year
- Average electricity price in Albania €/kWh

Europe Green Building Council proposed different methods and procedures to calculate the energy consumption of green buildings. According to the design evaluation and different billing records, the total energy consumed in Ish Profarma building in all purposes is450 KWh/month. This value is taken from the average values of 30 past electricity bills of various business stores. So, annually for 62 stores 450KWh x 12 monthsx 62, which is equals to 334,800 kWh/year based on all usage aspects. Albania Power Corporation (KESH) [18] is the public sector organization and power generation industry which control, measures, distribute, transmit the electricity in the whole country. It works under the government of Albania and provides cheap, efficient, and safer energy resources to its citizen. According to the KESH the electricity prices for residential and commercial buildings tariffs in 2021 is about [18].

- 0.0542 €/kWh for residential buildings
- 0.0785 €/kWh for business/commercial buildings

Based on the commercial building's energy consumption, it is required to be find out the total annual building energy cost for thesis case study which will start from the base year 2021. It is calculated from the below formula as below [18]

Total annual energy cost = 334,800 kWh/year x 0.0785 €/kWh = 26,282 €/year (Approximate)

According to the KESH Energy prices affected by the variation of fuel prices and with the variation of inflation rate. Most of the trading of fuel is done in dollars so with the variation of dollars price the cost of fuel varies. The oil price movement in Europe has already been discussed in graph 3.3. Moreover, the average inflation rate in Albania is recorded as 3.2% for future life cycle cost analysis, and this will be taken for calculating the energy cost of building for the next 40 years from 2021 to 2060 shown in table 3.2. It is calculated based on inflation rate of 3.2%. For the 1st year this cost is 26,282 Euros. For the next year this is predicted as 27,123 Euros and similarly for 2060 it will be 89,777 Euros due to constant inflation rate of 3.2 %.

Table 3.2 Estimated life cycle energy cost for the case study

Estimated Annual Energy Cost in (Euros/Year) for 40 Years					
Year	**AnnualCost**	**Year**	**AnnualCost**	**Year**	**AnnualCost**
2021	26,282	2035	40848	2049	63488
2022	27123	2036	42155	2050	65519
2023	27991	2037	43504	2051	67616
2024	28887	2038	44897	2052	69780
2025	29811	2039	46333	2053	72013
2026	30765	2040	47816	2054	74317
2027	31749	2041	49346	2055	76695
2028	32765	2042	50925	2056	79149
2029	33814	2043	52555	2057	81682
2030	34896	2044	54236	2058	84296
2031	36013	2045	55972	2059	86994
2032	37165	2046	57763	2060	89777
2033	38354	2047	59612	**Total**	**2,074,006**
2034	39582	2048	61519		

It is estimated from the inflation rate of 3.2% that the total energy cost from 2021 to 2060 is 2,074,006 Euros. It increases with the rise of inflation rate and this estimation will be used for life cycle cost analysis for next 40 years period. It is the total amount of electricity that the building will consume for all purposes from 2021 to 2060.

3.9.2 Water Cost:

As it is calculated the energy consumption per year, in this similar way water consumption will be find out for complete life cycle cost analysis. In green building there are various techniques that are installed to reduce the wastage of water. Rainwater harvesting system collects or catch the rainwater through roof and then store this water to storage tank and use for non-domestic purposes. This rainwater may be used in toilets, gardens, clothes, and car washing. Pressure reductions valves are used in water fixtures to maintain the consistent water pressure across the entire building. Water release from these fixtures mostly has high pressure as compared to required, so this releases the extra amount of water from fixtures which cause wastage of water. Like energy cost estimate, two types of data were collected and used in estimating the total water life cyclecost for the Ish Profarma building:

- Total amount of building water uses for all purposes in (m^3/year)
- Water Price in Albania (€/m^3)

Europe Green Building Council proposed different methods and procedures to calculate the water consumption of green buildings. According to the design evaluation and different billing records of previous months is 0.75 m^3 / day, for one store. So, for 62 apartments and for a whole year this value becomes, 0.75 m^3 / day x 62 x 30 x 12 = 16,740m^3/year. This isthe total water consumed in Ish Profarma building in all purposes based on all usage aspects. It is calculated based on all usage days excluding Sunday, and all the public and private holidays.
Albania Water Regulatory Authority (WRA) is the national independent industry which supply, distribute, and control the water in Albania. It also controls the sanitation and sewerage treatment works in all over the country. According to the WRA the tariff of water for commercial building is0.628 €/m^3.[19]

According to the Albania National water supply authority the amount of water consumed by offices commercial green building during the base year 2021, is calculated in €/year as follows: [19]

Total annual water cost = 16,740m^3/year x 0.628 €/m^3= 10,513 €/year (Approximate)

According to the WRA water prices also affected by the variation of inflation rate just as energy prices fluctuate and vary with inflation rate. The main goal of WRA is to provide high quality and affordable water equally amongst the consumers of Albania and distribute the fresh water with proper and environment friendly way to control the public health. WRA also work on the laying and distribution of sewerage system, wastewater treatment plants, and final disposal of wastewater. Moreover, the average inflation rate in Albania is recorded as 3.2% for future life cycle cost analysis, and this will be taken for calculating the water cost of Ish Profarma building for the next 40 years from 2021 to 2060 shown in table 3.3. Using the inflation rate, the water total life cycle cost for the case study was projected over the period of analysis. Noting that all figures are rounded to the nearest whole number.

Table 3.3 Estimated life cycle water cost for the case study

Estimated Annual Water Cost in (€/Year) for 40 Years					
Year	**Annual Cost**	**Year**	**Annual Cost**	**Year**	**Annual Cost**
2021	10,513	2035	16340	2049	25396
2022	10849	2036	16863	2050	26208
2023	11197	2037	17402	2051	27047
2024	11555	2038	17959	2052	27912
2025	11925	2039	18534	2053	28806
2026	12306	2040	19127	2054	29727
2027	12700	2041	19739	2055	30679
2028	13106	2042	20370	2056	31660
2029	13526	2043	21022	2057	32674
2030	13959	2044	21695	2058	33719
2031	14405	2045	22389	2059	34798
2032	14866	2046	23106	2060	35912
2033	15342	2047	23845	**Total**	**829,618**
2034	15833	2048	24608		

It is estimated from the inflation rate of 3.2%, from 2021 it is calculated as 10,513 Euros, in 2060 it is predicted as 25,912 Euro and total water cost from 2021 to 2060 is 829,618 Euros. It increases with the rise of inflation rate and this estimation will be used for life cycle cost analysis for next 40 years period. It is the total amount of water cost that the building will consume for all purposes from 2021 to 2060.

3.9.3 Sewerage Cost:

Sewerage cost is that cost which is required to treat sewage through wastewater treatment plants and other treatment process. Sewage treatment involves various process that cost monthly to all commercial's buildings where the quantity of sewage is more as compared to residential buildings. In sewage treatment plant there are certain treatment process, i.e., Primary treatment, secondary treatment, wastewater stabilization ponds and aeration tanks. After this whole treatment this water is then dispose-off to river, sea, or any other water bodies. In Albania sewerage services are provided by Water Regulatory Authority (WRA) which is the national independent industry which also supply, distribute, and control the freshwater.The service charges arecalculated with the amount of wastewater collected from the buildings, more the amount of sewage more will be the charges. Moreover, in commercial buildings a small-scale wastewater treatment plant is also installed in it for primary treatment process, after this primary treatment this water is then get mixed with main sewer lines. In Albania the amount of sewerage is the sum of a basic charge, which is determined based on the annual value of the commercialpremises, plus an excess charge determined based on monthly water consumption(National Water Commission, Sewerage Charge, Sewerage Stat 2015). Water Regulatory Authority (WRA) prescribed a method which determined the cost of sewerage according to the types of buildings and the amount of sewage supplied. The quantity of sewage collected from Ish Profarma building from various sources, i.e., toilets, washbasins, kitchens, roof top gardens, rain etc., is measured in meter cube.

According to the design evaluation and different billing records of previous months the average sewerage quantity is 0.6815 m^3 / day, for one store. So, in complete year for 62 stores this value becomes, 0.6515 m^3 / day x 62 x 30 x 12 = 15,210m^3/year. This is the total sewerage water quantity of Ish Profarma building per year. It is generally recorded as the total amount of 15210 m^3/year and monthly it will turn into approximately 1268m^3. Albania Water Regulatory Authority (WRA) is the national agency which distribute and treat the wastewater in Albania. It also controls the sanitation and sewerage treatment works in all over the country. According to the WRA the tariff of wastewater for commercial building is 0.15 €/m^3[19].According to the Albania National wastewater treatment authority the cost of sewerage water consumed by offices commercial green building during the base year 2021, is calculated in €/year as follows:

Total annual water cost = 15210m^3/year x 0.15 €/m^3= 2282 €/year (Approximate)

Moreover, the average inflation rate in Albania is recorded as 3.2% for future life cycle cost analysis, and this will be taken for calculating the wastewater cost of Ish Profarma building for the next 40 years from 2021 to 2060 shown in table 3.4. Using the inflation rate, the wastewater total life cycle cost for the case study was projected over the period of analysis. Noting that all figures are rounded to the nearest whole number.

Table 3.4 Estimated life cycle sewerage cost for the case study

Estimated Annual Sewerage Cost in (€/Year) for 40 Years					
Year	**AnnualCost**	**Year**	**AnnualCost**	**Year**	**AnnualCost**
2021	2282	2035	3547	2049	5512
2022	2355	2036	3660	2050	5689
2023	2430	2037	3777	2051	5871
2024	2508	2038	3898	2052	6059
2025	2588	2039	4023	2053	6253
2026	2671	2040	4152	2054	6453
2027	2757	2041	4285	2055	6659
2028	2845	2042	4422	2056	6872
2029	2936	2043	4563	2057	7092
2030	3030	2044	4709	2058	7319
2031	3127	2045	4860	2059	7553
2032	3227	2046	5015	2060	7795
2033	3330	2047	5176	**Total**	**180,081**
2034	3437	2048	5342		

These values are calculated based on inflation rate of 3.2%. For example, for 2021 it was 2282 Euros and for the next year 2282 x 0.032 = 73.02 Euros, so in this way for the next year this value becomes 2282 + 73.02 = 2355 Euros. In the same way it is calculated for rest of the years. It is estimated from the inflation rate of 3.2% that the total sewerage cost from 2021 to 2060 is 180,081 Euros. It increases with the rise of inflation rate and this estimation will be used for life cycle cost analysis for next 40 years period. It is the total amount of sewerage cost that the building will consume for all purposes from 2021 to 2060.

3.10 Building Maintenance Cost:

Building maintenance cost is the part of buildings life cycle cost analysis, and it is defined as the cost of material and labor which is required during repair and protection purposes during the whole life span of building. In green buildings there are certain systems which are installed in it to make the structure sustainable or environment friendly. As compared to conventional buildings the cost refers to the green buildings required to maintain is more, for its components operational in amanner that meets the minimum performance requirements.This cost consists ofall the necessary works &activities to protectand maintain the building structural elements and components [20]. Maintenance cost of green buildings according to International Standard ISO 15686-5:2008includes thelabor, material, and all the other related costs associated with these activities. Building maintenance costs according to ISOcomprises the maintenance management costs, and cost involves in modification or renovation of the green building structural or nonstructural elements. Moreover, it also includes the slight repair and replacement cost, majorcomponents replacement cost that is taken to modify the building. Moreover, cost of dusting & cleaning, ground maintenance& all renovation government tax on maintenance goods and services are also included in this section. ISO defines the buildings maintaining costs consists of cleaning cost, repair cost, repeated monitoring and renovation cost, structures improvement cost, government taxes, and other modification costs that is required for all other purposes.In many countries life cycle costing is not a common practice, but now this analysis is carried out in Europe Regional Network (ERN) and followed by the World Green Building Council (WGBC). Estimated maintenance cost in Euros for Ish Profarma building for the 1st operational year of 2021 is shown in table 3.5. This is calculated based on the average maintenance and consumption charges of 6green buildings in Albania and take the average of all these costs. For example, the maintenance and management team costsare calculated as 3722 Euros / year, this is determined from the previous data and bills of 6 green buildings in Albania that are currently in operation, and then take the average of all these 6 buildings, this gave the value of 3722 €/year. In the same way all the other costs, i.e., "Maintenance service budget costs, security services costs, building cleaning cost, landscaping costs and health care and sanitary products cost etc." are calculated based on the average values of 6 green buildings that are currently in operation in Albania. At the end sum up all these cost gives the total estimated maintenance cost of Ish Profarma building, that is 9807 Euros per year. This is the total cost that this green building takes per year for its complete maintenance operations.

Table 3.5 Estimated Maintenance cost for 1st year of the case study

ESTIMATED MAINTENANCE COST FOR ISH PROFARMA BUILDING		
Sr #	**Description of Works**	**Costs (€/year)**
1	Maintenance & Management Team Cost	3722
2	Maintenance service budget cost including lightening, firefighting, air conditioning etc.	3210
3	Security services	1198
4	General cleaning of building	780
5	Landscaping and gardening	657
6	Healthcare and sanitary products	240
	Total Estimated Cost	**9807**

It is shown in the table 3.5 that estimated cost for the 1st operational year of building is 9807 Euros, which includes all the cost from maintenance team to the cleaning services. Moreover, the average inflation rate in Albania is 3.2% for future life cycle cost analysis, and this will be taken for calculating the maintenance cost of Ish Profarma building for the next 40 years from 2022 to 2060 shown in table 3.6. Using the inflation rate, the maintenance total life cycle cost for the case study was projected over the period of analysis.

Table 3.6 Estimated Maintenance cost for 40 yearsof the case study

Estimated Annual Maintenance Cost in (€/Year) for 40 Years					
Year	**Annual Cost**	**Year**	**Annual Cost**	**Year**	**Annual Cost**

2021	9807	2035	15242	2049	23690
2022	10121	2036	15730	2050	24448
2023	10445	2037	16233	2051	25231
2024	10779	2038	16753	2052	26038
2025	11124	2039	17289	2053	26871
2026	11480	2040	17842	2054	27731
2027	11847	2041	18413	2055	28618
2028	12226	2042	19002	2056	29534
2029	12618	2043	19611	2057	30479
2030	13021	2044	20238	2058	31455
2031	13438	2045	20886	2059	32461
2032	13868	2046	21554	2060	33500
2033	14312	2047	22244	**Total**	**773,905**
2034	14770	2048	22956		

It is estimated from the inflation rate of 3.2% that the total maintenance cost from 2021 to 2060 is 773905 Euros. It increases with the rise of inflation rate and this estimation will be used for life cycle cost analysis for next 40 years period. For example, for 2021 it was 9807 Euros and for the next year 9807 x 0.032 = 313.82 Euros, so in this way for the next year this value becomes 9807 + 313.82 = 10121 Euros. In the same way it is calculated for rest of the years.The total estimated maintenance cost is 773,905 Euros, this is the total amount of maintenance cost that the building will consume for all purposes from 2021 to 2060.

3.11 End of Life Cost:

The end-of-life cost is defined as the cost associated with demolishing, deconstruction of building at the end of service life of project. It is an essential cost element of building life cycle cost that need to be find out for future consideration analysis [12]. Deconstruction or demolishing is done when the service life of structures gets completed or there is need to build new and modern structure for improved serviceability. There are certain costs which are included in this analysis, costs of inspections, deconstruction, demolition,disposing of damp material, or any other costs associated with the disposal operations. There are various techniques and methods which are mostly utilizedfor building demolition, the most important and fast methods used for high rise buildings are mechanical demolition, ballast demolition, deconstruction,and hybrid demolition techniques [21]. In mechanical demolition methods there are heavily machinery and equipment are utilized to dismantle a building, also in ballast demolition techniques a small ballasts or bombs are installed in the basement of the building where the main structural resisting elements get destroyed to collapse the structure. This method is fast and less time consuming and less labor-intensive [22]. Deconstruction is a labor-intensive method which need time and allows carefullydismantling of buildingto save the recyclable and reusable materials for next construction or other purposes. This method is best method if considered as economically and environmentally which leads to sustainable development. While the hybrid demolition consists of both the mechanical and deconstruction methods which are done simultaneously to dismantle the building.

The dismantling of high-rise buildings usually generates large amount of waste which need to be disposed-off to protect the sustainability of environment. Research has proposed in which researchers recommended a factor for calculating the building waste by the area of building, that is 1.2676 m^3 per m^2 of area building. In that research labor required pre meter square of building to demolish the building is also defined which is 0.6 hours/m^2[23]. According to this criterion for Ish Profarma case study having 9100 m^2 total floor area, the total building waste is equals to 11,535 m^3, and labor hours are equal to 5460 hours. According to Albanian government the rate of building waste and material transport is equals to 15.26 Euros/m^3 and labor cost is 2.12 Euros/hours[23].

- Total cost of Site clearing and waste transport = 11,535 x 15.26 = 176024 Euros
- Total cost of labor = 5460 x 2.12 = 11575 Euros
- Total cost of inspection and supervisions = 10% of overall cost = 18760 Euros
- Total end life cost for Demolishing = 206,359 Euros

It is estimated that if demolishing is done in 2021 than total cost will be consumed as 206,359 Euros. It is projected from the inflation rate of 3.2% that the total end life cost after 40 years will be 704,906 Euros. It increases with the rise of inflation rate and this estimation will be used for life cycle cost analysis for next 40 years period. It is the total end life cost that the building will consume for all purposes in 2060.

CHAPTER 4

RESULTS AND DISCUSSIONS

In this chapter the total life cycle cost analysis of Ish Profarma Building will be discussed from construction to end life cost. Total life cycle cost analysis is carried out to study the whole life of structure from cradle to grave. All the costs that are calculated in chapter 3 for construction, operation, maintenance, demolition, and end life cost will be added to obtain the whole life cycle cost. The whole life cycle cost is then will be discussed and results will be concluded for Ish Profarma building and feasibility of project for future will be predicted from this LCCA.

4.1 Total Life Cycle Budget:

The prior life cycle cost analysis components and budget that are calculated in chapter 3 may be utilized as a life cycle cost baseline for Ish Profarma Green Building. LCCA baseline is demarcated as time-based life cycle budget that comprises the LCC elements that relate towards the complete building life cycle from cradle to grave. To track the actual construction cost of green building, the LCC criterion established during construction phase of buildings which is equivalent to cost performance baseline of whole building.

For total life cycle budget firstly the complete life cycle cost components from construction to demolition should be recognized, estimated, and calculated separately and thenit is projected throughout the complete building life. After calculating each component of costs, the annually projected LCC budget is generated, and collected to define the yearly rate, the rate at which the total LCC is fluctuating and varying for whole life of building. The design and construction budget will be applied to 1st two years 2019 and 2020 that is the construction period of building. The total design and construction cost for this building is 3,239,344 Euros and it will be divided equally between construction periods. The total budget is summed up for next 40 years from 2021 to 2060 for future LCCA of Ish Profarma Building, and it is shown in below table 4.1. The below table generates the total cost of building from design and construction, operating, maintenance to end life of structure. The cost of each year is summed up individually of each year and cumulative cost is generated yearly. The fluctuation in the various cost is based on the inflation rate of 3.2 % in Albania. This total life cycle cost is then added with the end life of structure after the completion of its complete service life in 2060, which is 2,71,477 Euros, and then it's given the total LCC of complete building which is 7,368,431 Euros. This total life cycle budget of the Ish Profarma building evaluates the economic performance of building over the entire life from 2021 to 2060.

Table 4.1 Total Estimated Life Cycle Cost for The Case Study

Sr #	Year	Design and Construction Cost (€)	Building Operating Cost (€)	Maintenance Cost (€)	Total Annual LCC (€)	Cumulative LCC (€)
1	2019	1,619,672	0	0	1,619,672	1,619,672
2	2020	1,619,672	0	0	1,619,672	3,239,344
3	2021	0	39,077	9807	48,884	3,288,228
4	2022	0	40,327	10121	50,448	3,338,676
5	2023	0	41,618	10445	52,063	3,390,739
6	2024	0	42,950	10779	53,729	3,444,468
7	2025	0	44,324	11124	55,448	3,499,916
8	2026	0	45,742	11480	57,222	3,557,138
9	2027	0	47,206	11847	59,053	3,616,191
10	2028	0	48,717	12226	60,943	3,677,134
11	2029	0	50,276	12618	62,893	3,740,028
12	2030	0	51,885	13021	64,906	3,804,933
13	2031	0	53,545	13438	66,983	3,871,916
14	2032	0	55,258	13868	69,126	3,941,043
15	2033	0	57,027	14312	71,338	4,012,381
16	2034	0	58,851	14770	73,621	4,086,002
17	2035	0	60,735	15242	75,977	4,161,979
18	2036	0	62,678	15730	78,408	4,240,388
19	2037	0	64,684	16233	80,917	4,321,305

20	2038	0	66,754	16753	83,507	4,404,812
21	2039	0	68,890	17289	86,179	4,490,991
22	2040	0	71,094	17842	88,937	4,579,927
23	2041	0	73,369	18413	91,783	4,671,710
24	2042	0	75,717	19002	94,720	4,766,430
25	2043	0	78,140	19611	97,751	4,864,181
26	2044	0	80,641	20238	100,879	4,965,059
27	2045	0	83,221	20886	104,107	5,069,166
28	2046	0	85,884	21554	107,438	5,176,604
29	2047	0	88,633	22244	110,876	5,287,481
30	2048	0	91,469	22956	114,424	5,401,905
31	2049	0	94,396	23690	118,086	5,519,991
32	2050	0	97,416	24448	121,865	5,641,856
33	2051	0	100,534	25231	125,764	5,767,620
34	2052	0	103,751	26038	129,789	5,897,409
35	2053	0	107,071	26871	133,942	6,031,351
36	2054	0	110,497	27731	138,228	6,169,579
37	2055	0	114,033	28618	142,652	6,312,231
38	2056	0	117,682	29534	147,216	6,459,447
39	2057	0	121,448	30479	151,927	6,611,375
40	2058	0	125,334	31455	156,789	6,768,164
41	2059	0	129,345	32461	161,806	6,929,970
42	2060	0	133,484	33500	166,984	7,096,954
43	End of Life Cost after service life, in 2060				704906	7,8018,60
	Total LCC Budget of Ish Profarma Building				**7,801,860**	

In this table years are mentioned in 2nd column from 2019 to 2060 and 3rd column represented the building design and construction cost that consumed during the construction phase of Ish Profarma Building. 3rd column represented the building operating cost that is calculated by adding energy, water, sewerage cost etc. 5th column represented the building maintenance cost. While the 6th column represented the total LCC cost by adding all the costs mentioned prior. The last column represented the cumulative LCC of Ish Profarma Building.Moreover, the Life cycle cost baseline graph is shown in figure 4.1, showing the life cycle cost in millions from 2019 to 2060. The structure of the graph curvature is concluded from the amount of accumulated life cycle cost which changes the shape of graph from straight slope to sudden upward gradient. The curvature in the curve is explained by the exponential effect of price inflation on the life cycle cost.

From this graph it is clearly visible that during start in the year of 2019, graph has sudden upward gradient due to the design and construction of building which consumes high amount during the initial periods. Then after the construction the graph gets smooth due to constant average inflation rate of 3.2 % in Albania. After the end of service life of Ish Profarma Building in 2060 the graph rises slightly due to involving of high-end life or demolition of structure cost. This graph represents the variation of life cycle cost or economic performance of building during its complete life cycle from 2019 to 2060.

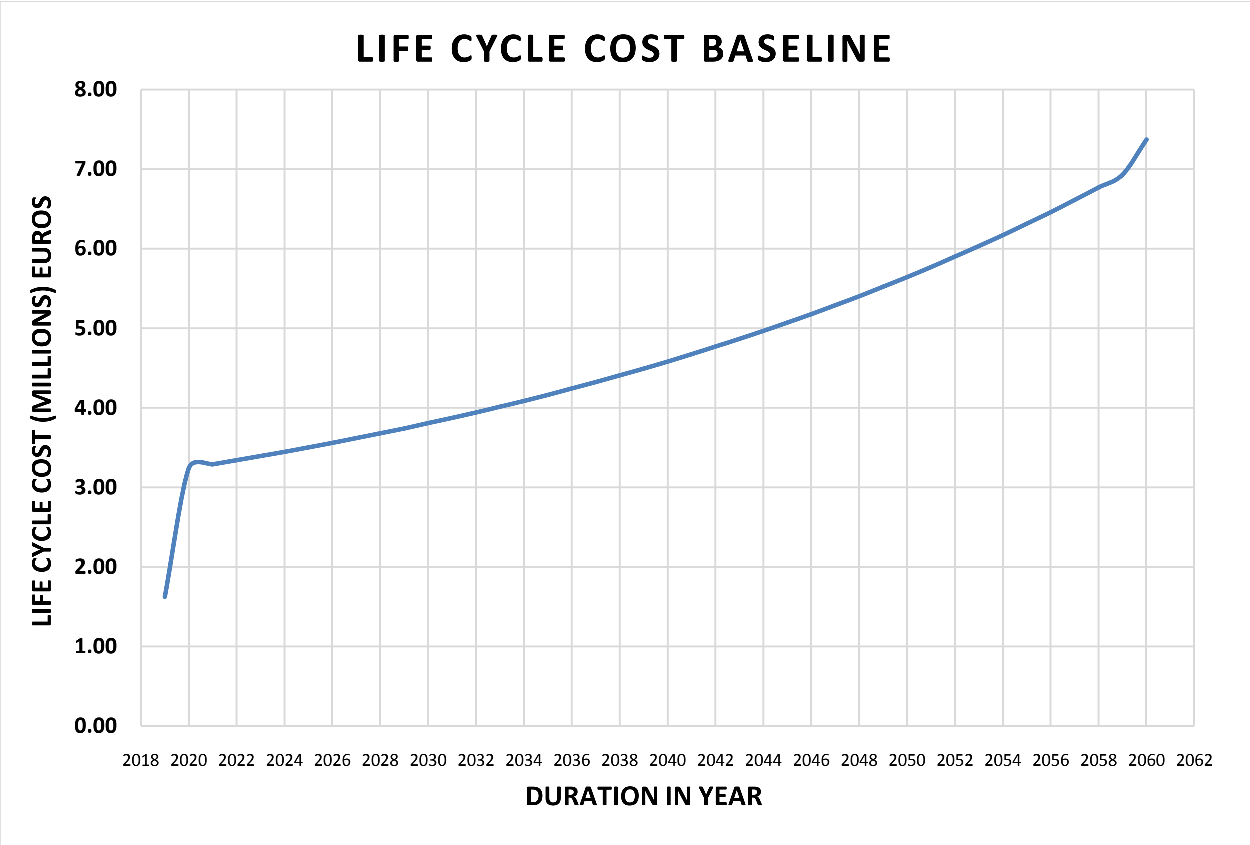


Figure 4.1 Life Cycle Cost Baseline

4.2 RESULTS AND DISCUSSIONS:

From the total life cycle cost analysis, it is estimated that the total LCC of Ish Profarma building is € 7,368,431. This cost includes all the cost of building that involves during the entire life of structure from construction to demolishing. This building has 8 stories and total floor area of 9100 m^2, the average total lifecycle cost is809.7€/m2 (7,368,431/ 9100 m2). This is the cost that will cover the period of 40 years from 2021 to 2060, which is the complete life cycle of building from construction, operation, maintenance & demolishing.

This total life cycle cost can be divided into all the phases of building life cycle that is shown in table 4.2. From this table it is estimated that the total design and construction cost of building is 3,239,343 Euros which constitutes the 44% of overall cost of building. While the building energy cost is 2,074,005 Euros which consists of the 28% overall cost. The total amount of water required, and sewerage produced for its complete service life of 40 years is worth 1,009,699 Euros which almost equals to 14% of overall cost. But the overall building maintenance cost constitutes 10% of overall cost and end life cost is only 4%. A pie chart is shown in figure 4.2 that shows the overall percentage in proper sequence from 1 to 5. It is clearly visible from chart that design and construction constitute the overall weight of total life cycle cost. On the other hand, the energy cost is 2 times higher than water and sewerage treatment cost. Building maintenance and demolishing cost overall contain the 14%, which is less as compared to energy and sewerage.

Table 4.2Total life cycle budget summary for the case study

Sr. #	**Description**	**Total LCC in €**	**Weight**
1	Design and Construction Cost	3,239,343	41.5 %
2	Building Energy Cost	2,074,005	26.5 %
3	Water and Sewerage Cost	1,009,699	13 %
4	Building Maintenance Cost	773,905	10 %
5	End of Life Cost	704,906	9 %
	Total LCC of Building	**7,801,860**	

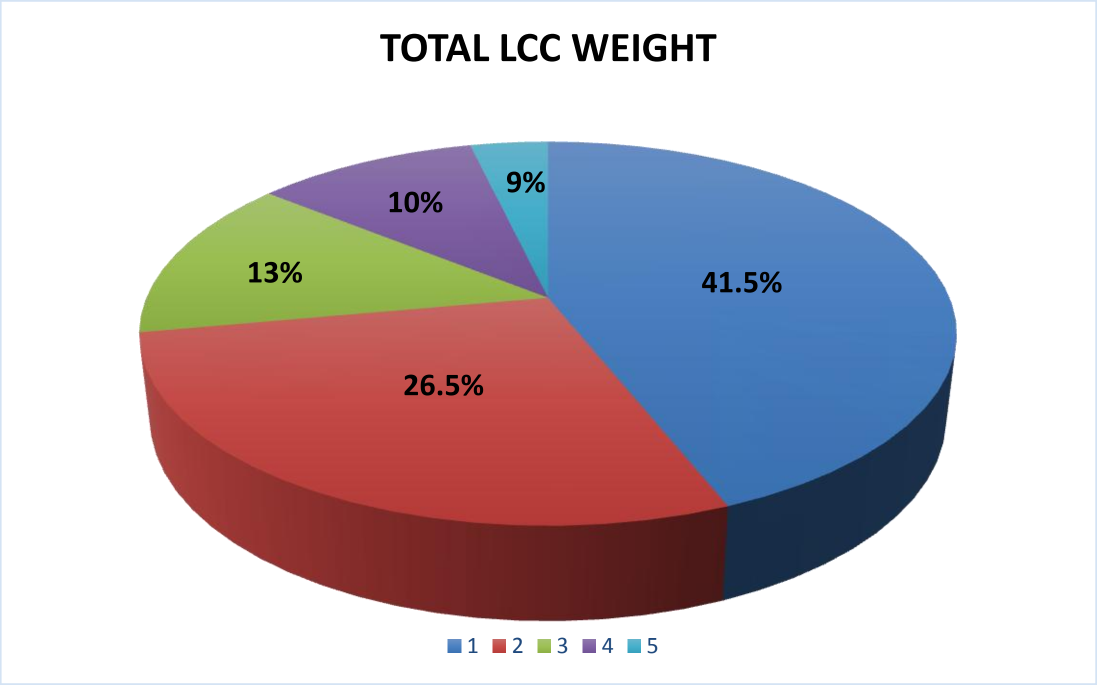


Figure 4.2 Total life cycle cost weight summary pie chart

The construction cost is 41.5% as it is shown in pie chart. This high cost is due to the latest design and construction techniques that are involved in green structures like Double façade skin external wall, Rain harvesting system, gray water treatment structures etc. High construction cost looks like a big budget at the start of project but if we talk about the serviceability and future benefits of green structures, then this cost is not burden for sustainable construction. In pie chart the cost of energy is 26.5% and cost of all other resources and demolishing is also summed up to 26.5%. This is the cost that building will consume for next 40 years up to its end of service life. This life cycle budget is showing the overall performance of green structures, this shows that the green building may be adopted for next generation of infrastructures to reduce the consumption of natural resources. So, this cost analysis may be presented to all stakeholders or governments to make the awareness and acknowledge the green structures for future construction and development.

CHAPTER 5

CONCLUSIONS

Life Cycle Cost Analysis is a technique that measures the sustainability and serviceability of structures for the whole life of structures by considering all the shortcomings, rise and fall and inflation changes that vary with time. This inflation rates and rise and fall in the prices of goods and services changes from place to place, so LCCA is also fluctuates with the variation of inflation rate. So, this is applicable to a certain region and may not be used for different countries. Every country has its own variation and LCCA, but a rough idea may be made to check the feasibility of project or structures. In other words, this research explains and demonstrates, how the LCCA is done for the complete life cycle of building to check the performance and appropriateness of green structures.The cradle to grave approachis used in this research estimates the future cost for construction to demolishing of building.Furthermore, in Europe there is growing market of green buildings, which are increasing day by day, so proper life cycle costing is required concern for further awareness of green buildings. Green buildings are environment friendly but careful considerations are required to operate and maintain its different components that cost more as compared to conventional buildings.

The main objective of this research was to find out the life cycle cost of green building by a case study and make it effective for use in future analysis by giving sustainable, efficient, and economical solution. By this case study it is obvious that the use of green buildings is efficient and economical solution for next generation of infrastructures. The initial construction cost of green building is high but there are certain benefits of using the green structures.Carefully considerations are required during the construction phase of the building because during this there are different risks and problems that we must face, which effect the timeline and budget of project. These risks include the safety problems, variation orders, incomplete or mixing drawings, unknown site weather conditions, labor shortage and unanticipated increase of material cost etc. There are different ways to mitigate the risks and hazards by using latest construction management software and tools, which is now becoming trending and has wide applications in the construction industry. These tools are utilizing to manage and schedule the construction project by considering and mitigating all the risks.

- Review of Green Building concept and its applications in the specific case study.
- Application of LCC Analysis on Green Buildings.
- Identifying the Life Cycle cost variables used for budget development purposes.
- Identifying the Life Cycle Impacts of each phase.

It is concluded from this whole research that the LCCA of green building has positive impacts on environment.Moreover, from the pie chart and results it is concluded that:

- It is estimated that the total design and construction cost of building is 41.5% of overall cost of building.While the building energy cost is 26.5% of overall cost.This is the cost that building will consume for next 40 years up to its end of service life. The total amount of water required, and sewerage generatesin its complete service lifeis13% of overall cost.But the overall building maintenance cost constitutes 10%and end life cost is only 9% of overall life cycle cost.
- It is concluded from this research that design and construction constitute the overall weight of total life cycle cost. This is due to latest design and construction techniques that has been used in Green Buildings. On the other hand, the energy cost is 2 times higher than water and sewerage treatment cost. Building maintenance and demolishingis less as compared to energy and sewerage.The onlyproblems that industry may face is energy consumption, which is nearly equals to all the other costs, i.e., water, sewerage, maintenance, and demolishing.Therefore, reducing energy consumption was found to be the most influential factor to reduce the total life cycle cost of the investigated green building.
- If comparison has been made between conventional buildings and green buildings still green structures has less energy consumption as compared to it. This is due to latest and efficient design of green buildings which involves certain elements like Double façade skin external wall, Rain harvesting system, pressure relives valve, solar energy, triplex glass.

- Therefore, it is concluded that in Green Buildings, lowering energy utilization was found to be the most impactful & significant factor to decrease the total LCC of the examined case study of green building.There are certain techniques like double façade skin external wall that directly entered the sunlight into building that reduce the light expenses during daytime. This also reduce the overall energy consumption of green building. Moreover, cooling towers also installed in green building which sprinkles the drops of water around the building which overall reduce the air conditioning cost, this also reduce the electricity consumption.
- This life cycle budget is showing the overall performance of greenstructurestherefore, the green building may be adopted for next generation of infrastructures to reduce the consumption of natural resources. So, this cost analysis may be presented to all stakeholders or governments to make the awareness and acknowledge the green structures for future construction and development. The developed life cycle budget can be used as a life cycle cost performance baseline against which the actual life cycle cost spending can be tracked and compared. This life cycle budget is demonstrating the complete performance of green structures, this illustrating that the green building may be implemented for next generation of infrastructures to reduce the utilization of natural reserves.
- From this research thesis we have learned that how the LCCA of a green buildingisanalysed and estimated for a period of 40 years. The life cycle budget has indicated the overall performance of GB, also these buildings may be adopted for next generation of infrastructures to reduce the consumption of natural resources.This research is very useful because it may be offered to all governments or private clients to make the clear understanding and importance of GB and this knowledge can be accepted and recognize for future construction and development in Albania.

In this research we have created the new and effective way to analyze the life cycle cost analysis of GBin step by step by usingcradle to grave approach. From this research thesis we have learnedthat the future costs of theGB are high as its initial design and construction costs. It is also examined that the energy cost constitutes a weight of almost more than 26.5% of the total life cycle budget. It is also found that reduced energy consumption in the GB is the most influential factor to reduce its total life cycle cost. It is noted that the natural resources that we use in the GB reduced the electricity consumption and reduced energy consumption which has positive impacts on environment.No doubt the design and construction costs ofgreen building is more but still it may be adopted to save the consumption of natural resources for the sustainable development.

RECOMMENDATION

- So I recommendate the follow step to continue this research is to make a copmerative Life Cycle cost study of green building and traditional building.

REFRENCES

[1] Ahn, Y. H., Pearce, A. R., and Ku, K. H. (2009). "Green Construction: U.S. Contractors' Status and Perception." Proceedings of International Conference on Construction Engineering andManagement (ICCEM), Jeju, Republic of Korea.

[2] Aïtcin, P.-C., Mindess, S., 2011. Sustainability of Concrete. Spon Press. Al-Ghamdi, S.G., Bilec, M.M., 2016. Green building rating systems and whole building life cycle assessment: comparative study of the existing assessment tools. J. Archit. Eng. 23 (1), 04016015.

[3] Ramesh, T., Prakash, R., Shukla, K.K., 2010. Life cycle energy analysis of buildings: an overview. Energy Build. 42 (10), 1592e1600.

[4] Dong, Y. H., & Ng, S. T. (2016). A modeling framework to evaluate sustainability of building construction based on LCSA. The International Journal of Life Cycle Assessment, 21(4), 555-568. doi:10.1007/s11367-016-1044-6

[5] Finnveden, G., Hauschild, M. Z., Ekvall, T., Guinée, J., Heijungs, R., Hellweg, S. Suh S. (2009). Recent developments in life cycle assessment. Journal of environmental management, 91(1), 1-21.

[6] Hass, R., Tighe, S. L., & Falls, L. C. (2005). Beyond conventional LCCA: long term return onpavement investments. Paper presented at the 2005 Annual Conference of the Transportation Association of Canada. Calgary.

[7] ISO, Buildings, and constructed assets - Service-life planning - Part 5: Life-cycle costing (ISO 15686- 5:2008), 1st ed., International Organization for Standardization, Geneva, Switzerland, 2008.

[8] NIST. (1995). NIST Handbook - 135. Retrieved from https://www.wbdg.org/ffc/nist/criteria/nist-handbook-135

[9]http://www.cce.ufl.edu/projects/deconstruction/implementingdeconstruction-inflorida/final-report/#deconCosts (accessed August 21, 2015).

[10] M. Kishk, A. Al-Hajj, R. Pollock, G. Aouad, N. Bakis, M. Sun, Whole life costing in construction-A state ofthe art review, RICS Found. Res. Pap. 4 (2003) 1–39.

[11] Armstrong, J., and Walker, A. (2002). "Health, Comfort & Productivity." Green Building:
Project Planning & Cost Estimating, Reed Construction Data, Kingston, MA.

[12] S.J. Kirk, A.J. Dell'isola, Life Cycle Costing for Design Professionals, 2nd ed., McGraw-Hill, Inc, UnitedStates of America, 1995.

[13] T.E. Swarr, D. Hunkeler, W. Klöpffer, H.-L. Pesonen, A. Ciroth, A.C. Brent, et al., Environmental life-cyclecosting: a code of practice, Int. J. Life Cycle Assess. 16 (2011) 389–391. doi:10.1007/s11367-011-0287-5.

[14] J.W. Bull, Life Cycle Costing for Construction, Taylor & Francis, London, United Kingdom, 2003.doi:10.4324/9780203487723.

[15] http/.fred.stlouished.org/tag/series. Energy Information Administration and Federal Reserve Economic Data.

[16] <ahref='https://www.macrotrends.net/countries/EUU/european-union/inflation-rate-cpi'>European Union Inflation Rate 1960-2022

[17] L. Blank, A. Tarquin, Engineering Economy, 7th ed., McGraw-Hill, Inc, New York, NY, 2012.

[18] http://www.kesh.al/en/

[19] National Water Commission, Sewerage Charge, Seweragre Stat. 2013. (2015). http://www.span.gov.my/(accessed June 3, 2015).

[20] A.L. Olanrewaju, A.-R. Abdul-Aziz, Building Maintenance Processes and Practices: The case of a Fast-Developing Country, 1st ed., Springer-Verlag, Singapore, 2015. doi:DOI 10.1007/978-981-287-263-0.

[21] S.K. Pun, C. Liu, C. Langston, Case Study of Demolition Costs of Residential Buildings, Constr. Manag.Econ. 24 (2006) 967–976. doi:10.1080/01446190500512024.

[22] C.J. Kibert, J.L. Languell, Implementing Deconstruction in Florida: Materials Reuse Issues, Disassembly Techniques, Economics and Policy, 2000.

[23] R. Flanagan, C. Jewell, G. Norman, Whole Life Appraisal for Construction, Blackwell Publishing Ltd,Oxford, UK, 2005.

[24] Chau, C.K., Leung, T.M., Ng, W.Y., 2015. A review on life cycle assessment, life cycle
energy assessment and life cycle carbon emissions assessment on buildings. Appl. Energy 143 (Suppl. C), 395e413.

ISO, I. (2006). 14040: Environmental management–life cycle assessment–principles and framework. London: British Standards Institution

[26] Joshi, S. (1999). Product environmental life-cycle assessment using input-output techniques.Journal of industrial ecology, 3(2-3), 95-120.

APPENDIX 1

WORK PREVENTIVE

OBJECT :HOUSING AND SERVICE STRUCTURE 8 FLOOR WITH 1 FLOOR UNDERGROUND PARKING ON THE ROAD " NIKOLLA ZORAQI " , TIRANE.

NR		DESCRIPTION OF WORKS	UNIT	VALUE
I		***CONSTRUCTION SITE***		
1		Construction site fencing works	m^2	1,272,000
2		Assembly of the construction site sign	m^2	26,250
3		Installation of signboards with the respective signage	m^2	35,000
4		Construction of toilets on the construction site	m^2	166,667
5		Installation of electrical and hydraulic line for the construction site	lek	1,181,667
		SUM I	**ALL**	**2,681,583**
II		***EARTH WORKS***		
6		Demolition of buildings and transport of aggregates up to 15 km	m^3	733,333
7		Excavation of foundations for plinths b> 2 m, excavator with chain, buckets 1m3, car unloading	m^3	3,625,000
8		Soil transport up to 15 km	m^3	3,020,833
		SUM II	**ALL**	**7,379,167**
III		***PILOT WORKS***		
9		Drilling pilots	ml	1,411,938
10		Pilot iron and pilot beam	kg	1,098,636
11		Pilot concrete	m^3	1,352,488
12		Armature druri	m^2	44,588
		SUM III	**ALL**	**3,907,649**

IV		***CONCRETE AND IRON WORKS***		
13		Gravel substrate	m^3	514,267
14		Concrete layer C 10/15	m^3	1,469,333
15		Foundation tiles b / a C 25/30	m^3	11,444,125
16		Slab b / a monolith t = 25 cm C 28/35 quota ± 0.00	m^3	3,362,260
17		Slab b / a monolith t = 15 cm C 28/35 quota ± 0.00	m^3	605,375
18		Column b / a monolith C 28/35 h ~ 4m	m^3	8,382,813
19		Beam, architectural belt b / a C 28/35 h ~ 4m	m^3	8,700,000
20		Walls b / a with t = 21-30 cm h ~ 4m C 28/35 (basement walls)	m^3	1,288,083
21		Solete b / a with brick traverses with 6 holes thickness 30 cm C 28/35	m^3	15,647,917
22		Periodic reinforced concrete 6-10 mm	ton	5,100,810
23		Periodic reinforced concrete> 10 mm	ton	39,415,350
		SUM IV	**ALL**	**95,930,333**
V		***MASONRY WORKS***		
24		Brick wall, thermal brick with intermediate mortar t = 20 cm	m^3	3,948,833
25		Brick wall, thermal brick with intermediate mortar t = 12 cm	m^3	7,443,333
26		Belt b/a for brick masonry C 20/25	m^3	3,443,750
27		Cassettes for doors and windows on the outer facade	piece	1,523,708
		Assembly of stone wool between the partition walls of the apartments from each other.	m^2	1,508,000
		SUM V	**ALL**	**17,867,625**
VI		***TERRACE AND INSULATION WORKS***		
28		Thermal slab insulation layer with polystyrene t = 8 cm	m^3	510,180
29		Concrete layer C 6/10 leveling with t average = 3 cm	m^2	336,038
30		Leveling cement luster layer with tmes = 6 cm	m^2	485,388
31		Antivapore barrier layer	m^2	205,356
32		Aerator	piece	47,500
33		Waterproofing of the terrace with two layers of karama paper	m^2	1,344,150

34		River granule layer to protect the insulation on tar paper with t = 6 cm	m^3	112,013
35		Insulation of toilets and balconies with 2 hands with bicomponent material	m^2	1,334,000
36		F.V.Insulation of the floor on the floor ± 0.00 with two layers of parchment paper (part of the parking lot)	m^2	1,276,798
		SUM VI	**ALL**	**5,651,421**
VII		***EXTERNAL WORKS***		
38		Leveling cement chandelier layer for apartments, shop in internal scale with t = 8 cm	m^2	4,517,658
39		Slayer with stoneware tiles porcelain in apartments and shops	m^2	9,813,238
40		F.V.Slayer with porcelain tiles in apartments and shops	m^2	1,087,500
41		Cliding tiles in the toilets and at the entrances of the stairs of each object	m^2	5,020,021
42		Marble t = 3 cm for stairs, doors and facade windows	m^2	2,529,042
43		Marble t = 2 cm for stair treads, apartment doors, etc.	m^2	1,096,563
44		Plindus marble t = 2 cm for stairs	ml	192,729
		SUM VII	**ALL**	**24,256,749**
VIII		***PLASTERING WORKS AND FACADE CLOTHING***		
45		Interior plastering of walls, ceilings in apartments and shops	m^2	15,763,856
46		External plastering of balconies and ceilings with thermal system	m^2	2,591,875
47		Facade cladding with thermal system and cladding with decorative brick according to the technical detail	m^2	32,538,773
		SUM VIII	**ALL**	**50,894,505**
IX		***INTERIOR AND EXTERIOR PAINTING WORKS ON THE FACADE***		
49		Inner painting with plastic paint	m^2	4,537,473

50		Exterior painting of the facade with acrylic paint	m^2	471,250
		SUM IX	**ALL**	**5,008,723**
X		***DURALUMIN DOORS AND WINDOWS WORKS, ARMORED AND DRUM***		
51		Thermal duralumin doors and windows with tdouble glass	m^2	22,026,225
52		Duralumin glass for shops	m^2	6,420,600
53		Duralumin grille	m^2	18,976,440
54		Parapet balcony with tempered glass t = 10	m^2	2,318,550
55		Duralumin railings for interior stairs	ml	903,229
56		Interior doors drums	cope	5,437,500
57		Interior doors drums	cope	2,098,875
		SUM X	**ALL**	**58,181,419**
XI		***ELEVATOR ASSEMBLY WORKS***		
58		Assignment of the elevator object 1,2,3	cope	-
		SUM XI	**ALL**	**-**
XII		***PARKING WORKS***		
59		Industrial concrete works Treated on the surface with quartz micelles	m^2	1,833,814
60		Connection of pins	ml	207,833
61		Thermal brick wall t = 20 cm for warehouses and technical premises	m^3	245,654
62		Internal plastering of walls for warehouses and technical premises	m^2	77,575
63		Insulation of water storage	m^2	108,750
64		Signalistics on the floor, walls and columns	m^2	679,068
65		Painting walls, columns and diaphragms with stone varnish	m^2	184,029
66		Electrical installation in the basement	m^2	1,776,782
67		Hydrotechnical installations, water pumps, submersible pumps and basement fire hydrant pumps	m^2	2,244,356

68		Industrial concrete works treated on the surface with quartz michelle pandusi of the building	m^2	97,353
69		Mounting of the beam for the entrance to the parking lot	lek	410,000
70		Place the glass in the basement windows for ventilation and lighting	m^2	525,631
71		Interior painting of basement walls	m^2	25,858
		SUM XII	**ALL**	**8,416,704**
A	AMOUNT OF CONSTRUCTION WORKS CARBINES		ALL	*109,898,731*
B	AMOUNT OF CONSTRUCTION WORKS REFINED		ALL	*161,860,442*
C	AMOUNT OF PARKING CONSTRUCTION WORKS		ALL	*8,416,704*
D	AMOUNT OF ELECTRICAL WORKS		ALL	*11,330,231*
E	AMOUNT OF HYDRAULIC + HYDRO-SANITARY WORKS		ALL	*24,279,066*
F	LOT OF WORKS FIRE PROTECTION		ALL	*4,855,813*
	AMOUNT OF WORKS A + B + C + D + E + F		ALL	*320,640,988*
	T.V.SH		20%	*64,128,198*
	TOTAL AMOUNT OF WORKS IN OBJECT		ALL	*384,769,185*