An-Najah National University

Faculty of Graduate Studies

Developing Non-Industrial Buildings Energy Performance Indicators in Nablus city

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Dedication

To my father PROF. ABED ASSAF who taught me how to never stop asking for knowledge and to be always ambitious. To my beloved mother the one she never gave up on my ability, she was always there for me.

To my brother eng. Basel Assaf (May his soul rest in peace) the only one encourage me to continue

All my family, my brothers, my husband and my friends thank you for everything

Acknowledgment

The first and final gratitude is to Allah who gave me the strength and determination to continue this work, who gave me the ability to endure all the difficulties and challenges to successfully complete this work.

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Finally, I would like to thank my mother, the greatest mother on earth, my father, who never spares me any of expertise and help. Thank you to my brothers for their effort, support, and standing by my side. Thanks to my husband and daughter for their patience and support.

الإقرار

انا الموقعة أدناه مقدمة الرسالة تحت عنوان:

Developing Non-Industrial Buildings Energy Performance Indicators in Nablus city

أقر بأن ما اشتملت عليه هذه الرسالة هو نتاج جهدي الخاص، باستثناء ما تمت الإشارة إليه حيثما ورد، وأن هذه الرسالة لم تقدم من قبل لنيل أي درجة علمية، أو أي بحث علمي أو بحثي لأي مؤسسة تعليمية أو بحثية أخرى.

Declaration

The work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree of qualification.

اسم الطالب: **Student's Name:**

التوقيع: **Signature:**

التاريخ: **Date:**

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List of Abbreviations

CCBFC	Canadian Commission on Building and Fire Codes
CI	Confidence Interval
CT	Computerized Tomography
ECI	Energy Cost Index
EIM	Energy Institutions Managements
EM	Energy Management
EUI	Energy Utilization Index
GDP	Gross Domestic Product
MRI	Magnetic Resonance Imaging
PI	Probability Interval
OECD	Organisation for Economic Co-operation and Development
SDPD	Seattle Department of Planning and Development
TI	Tolerance Interval
US	United State

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Abstract

Scientific evidence indicates the seriousness of energy loss. Given the importance of energy, the global direction is toward energy conservation. Studies showed the amount of energy loss and big energy consumption in Palestine. From that point, this study was conducted, in order to adapt and develop energy performance indicators, study the main variables affecting those indicators. The study was conducted in the city of Nablus because it is the economic capital of Palestine.

Energy performance indicators, ECI and EUI were calculated. ECI is the average annual consumption of energy divided by conditioned area, while EUI is the average annual payment divided by size. After calculating both indicators, variables affecting those indicators were studied with special focus on size multiplied by occupancy rare, which was termed conditioned area.

The methodology for this study was to collect data through questionnaires and interviews; the sample was 78 facilities, distributed into categories including companies, hospitals, hotels, restaurants, and schools. After data collection, statistical analysis including descriptive and differential analysis was conducted, descriptive statistics of the questionnaire showed that multiple variables could affect energy indicators, which should be studied

in the future, those variables include an age of the facility and used equipment.

Results indicated a direct relation between conditioned area and energy (Hotels p=.005, schools p=.008, companies p=.0005) this relationship between energy and conditioned area reflect the relation with energy indicators. The researcher mainly recommends studying every category separately taking into consideration all variables affecting energy indicators, and the extent of their effect on both ECI and EUI. As a secondary recommendation, the researcher encourages facilities to register and save their energy data, and following energy conservation strategies.

Chapter One
Introduction

1.1 Chapter overview

This chapter gives a general idea about this research; it includes an introduction, definition and objectives, the hypothesis and research questions, the importance of the study and finally the research structure.

In order to deal with Global Energy challenges and its corresponding negative environmental impacts, so what is energy. Simply, energy can be defined as the ability to do work. According to the Organisation for Economic Co-operation and Development (OECD)) 2012), as an economy grows, demands for energy increases rapidly, thus energy consumption increases. Forecasts show that by 2050 the world economy will become four times larger than today and it is projected to use 80% more energy (OECD, 2012). So we need a good quality of statistics to understand the underlying trends in energy consumption.

Since energy use has a big impact on our environment, which can be negative or positive, many civilized governments support sustainable development in their societies which will benefit current and future generations.

One of the most basic steps to counter this situation is to start developing, monitoring, and improving energy performance indicators. energy indicator such as energy utilization index (EUI) and energy cost index (ECI), the first one talks about energy used per one unit of area. Energy index will help to further study many parameters like energy used per worker; energy used occupancy energy effect by age buildings, the used equipment and the type of used equipment's. The second type is energy cost; here will talk about the cost aspect of energy

An accurate and a holistic understanding of Energy Indicators (EnPIs), which are easily understood, quantitative measure of performance will increase efficiency, decrease intensity, increase understanding of improvement, define abnormal situations, implement projects that reduce energy consumption, increase production output, and capture cumulative impact of all projects by statistically isolating various influences on energy use.

The proposed research aims to develop Palestinian local community energy consumption as Energy Utilization Index (EUI) and Energy Cost Index (ECI) and its direct and indirect effects on their local environment and economy. Moreover, aims to calculate and analyse the average of EUI and ECI for Nablus city, in such a way, these indicators could be assumed as a baseline for determining potential energy savings opportunities for various buildings types, which could help experts, engineers, accountants, and policy makers in defining better solutions and developing appropriate plans.

1.2 Nablus and non-industrial buildings

Nablus is a Palestinian city, with an area of 12700 acres, it is considered one of the economically active cities, it plays an important role in the economy despite occupation and siege. In fact, despite those challenges the city of Nablus is considered the economical capital of Palestine, it was a center for Arab and Palestinian banks in the west bank before most of them were transferred to Ramallah with the establishment of the Palestinian Authority there, Nablus is also famous for the construction of its markets, especially in the Kasbah district of the Old City. It is also famous for its sweets.

The City of Nablus occupies the first place among Palestinian cities in terms of non-industrial facility population According to 2016 statistics; Nablus had a population of 153,061 people with a population density of 540 per Km2. (Nablus Chamber of Commerce, 2011).

According to the 2009 records of the Palestinian Central Bureau of Statistics, the number of industrial and commercial facilities in Nablus District was about 13,742 distributed among different sectors (private, public and civil as shown in (Table 1) (Figure 1).

Nablus Chamber of Industry and Trade

Table 1: Classification of members of the general authority by sector

Sectors	Number of members
Commercial sector	3621
Industrial sector	969
Services	383
Careers	151
Construction	183

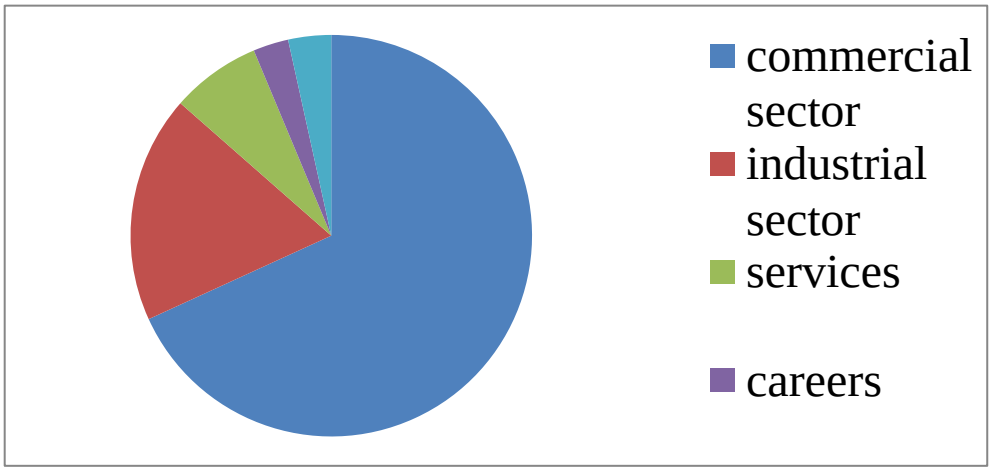


Figure 1: Classification of member of general authority by sector**.**

In addition, the overall number of workers reached 38,542 between employers and workers. Recently, a new sector emerged in Nablus pertained to services including hotels, restaurants, stock-exchange, and communications, being managed with total of 4000 workers distributed among 900 services' utilities. (Nablus Chamber of Commerce, 2011)

Table 2: Number of establishment of different sectors in the city of Nablus

ISIC	Economic Activity	No. of Employed Persons		عدد المشتغلين	عدد المنشآت	النشاط الاقتصادي
		إناث Females	ذكور Males	المجموع Total	No. of Establishments	
A	Agriculture (raising of cattle &other animals)	762	1,650	**2,412**	**973**	الزراعة (تربية الماشية والحيوانات الأخرى)
C	Mining & quarrying	3	318	**321**	**67**	التعدين واستغلال المحاجر
D	Manufacturing	1,220	8,173	**9,393**	**2,278**	الصناعة التحويلية
E	Electricity and water supply	8	16	**24**	**7**	إمدادات الكهرباء والمياه
F	Construction	53	755	**808**	**73**	الإنشاءات
G	Wholesale, retail trade & repairs	1,336	11,899	**13,235**	**7,239**	تجارة الجملة والتجزئة وإصلاح المركبات والدراجات
H	Hotels & restaurants	150	1,189	**1,339**	**681**	الفنادق والمطاعم
I	Transport, storage & communications	289	2,037	**2,326**	**103**	النقل والتخزين والاتصالات
J	Financial intermediation	235	624	**859**	**125**	الوساطة المالية
K	Real estate, renting & business activities	276	877	**1,153**	**484**	الأنشطة العقارية والايجارية
M	Education	1,536	1,532	**3,068**	**235**	التعليم
N	Health & social work	813	793	**1,606**	**490**	الصحة والعمل الاجتماعي
O	Other community, social & personal services	718	1,262	**1,980**	**987**	أنشطه الخدمة الاجتماعية والشخصيه الأخرى
	Total	**7,399**	**31,125**	**38,524**	**13,742**	المجموع

Economic indicators showed a daily loss of Nablus District during 2002-2008 estimated at $ 1.2 million per year of which industrial sector share was 42%, services sector was 30%, the agriculture sector was 20%, and tourism sector was 2% (Nablus Chamber of Commerce, 2011).

Today, and upon the reinforcement of the security, it was clearly noticed that a number of new service facilities were opened including restaurants, public parks, and different commercial centres. Nablus enjoys the high potential for being the leader of Palestinian industry and commercial activities even in the hardship and worst situations. It is, with no doubts, the business incubator and the economic capital of Palestine.

All this data indicates the importance of this study especially in Nablus, given that it is a non-industrial city with a large number of non-industrial buildings. Also, the importance of energy conservation in Nablus which is essential for the provision of environmental conservation and development

in the future. This study is concerned specifically with the city of Nablus hoping it might have a clear, positive and useful impact on its economy, given the financial and economic deficits the city has been suffering from in the last few years, hopefully, the conservation of energy and finding the causes of energy loss will have a role in improving the economy in the future.

1.3 Research problem

In the field of energy, the Palestinian economy and especially energy situation is a bit more complicated because Local environmental legislation is limited and the lack of real data describing the current situation. Thus, Palestinian decision-makers do not have a clear vision regarding the performance of their energy consuming systems. Having a clear and controllable vision regarding energy consumption will enhance and improve the economy which will benefit the environment which will also benefit the society as it removes obstacles and maintains sustainability

Palestinian decision-makers do not have a reference point to know how much they consume and how their lifestyle sustainability and its consequences on their environment and local economy. In addition, the proposed project aims to facilitate business owners' energy conservation decisions. However, an effective energy conservation and management program should begin from understanding current energy consumption situation. Based on that, comparison with average indicators gives a good understanding regarding the current situation and potential saving that

could be achieved. In this context, EUI is one of the most powerful indicators. It sums up that all building energy consumption per year (electrical, gas, oil fuel …etc.) then dividing over conditioned space area, in such a way, a kJ/m2 or kWh/m2 indicator then be calculated. In addition, the ECI which is the same as EUI except that its numerator contains the annual energy cost, thus, the indicator will have the unit $/m2. Both indicators will be calculated based on the better comparison between buildings, assessing energy management programs and estimating possible saving opportunities.

In order to do so, a statistical survey is conducted. An interview-based Questionnaire is used, which aims to accomplish the main objectives of the study which is targeting different building structures to calculate its EUI and ECI. To do it effectively, the US building in the same context classification which includes at least the following subdivisions: all buildings, education buildings, food sales, food services, health, lodging, retail, office, assembly, safety, mosques and churches, service, warehouse, and others will be used as a guide to establish our targeted building subdivisions

1.4 Research objective and outcome

The main objectives of this research proposal are:

1. Calculating the average value for EUI and ECI for Nablus city
2. Define general trends building energy consumption in Nablus.

3. Establishing a reliable data base of information to be used by buildings owners as a reference point to estimate possible savings

4. Identifying factors that have a direct effect on energy indicators

This research has been started so as to reach the following outcomes:

1. Estimated EUI ECI for non-industrial building in Nablus

2. Estimated CI and TI with 95% level of significance

3. Description of the energy consumption trends and behaviour for non-industrial building.

4. Energy indicators with tables and figures displaying the variations in order to use it in the future

1.5 Research questions

To reach the research outcome, the researcher needs to find answers for the following questions:

1. How much energy consumption in EUI and ECI?

2. How much the variance between non-industrial buildings with respect to the two indicators?

3. What are the significant difference between categories? or can we sum it in under one category called building

4. How can we define a specific relationship between energy indicators, area, size, occupancy rate and number of employee?

1.6 Significance of the study

Through the development of energy indicators, energy will be conserved and opportunities to decrease cost will be available, thus increasing competition and profits of the company. Also, energy audit plays a key role for the benefit of a company, because it provides opportunities to learn what needs to be done to develop and improve energy conservation rates. The first step for any company in energy auditing is to calculate basic indicators that will be studied here such as EUI and ECI. The outcome of these indicators includes tables and statistical values that would be a reference for any company or organization in order to know their place in terms of energy conservation. doing useful and is there any way to increase energy conservation.

1.7 Thesis structure

This thesis consists of five chapters. An outline of each chapter is given:

Chapter 1 gives a general idea about this research; includes an overview of Palestinian situation and particular focus on energy use in Palestine, and the encompass of Nablus and non-industrial buildings as the main problem and objectives, and research questions, the importance of the study and finally the research structure.

chapter 2 represents, previous research work including an overview of previous studies about energy indicators. This chapter covers various aspects of building energy performance and defines the two indicators EUI and ECI, from the relationships of energy use and different building characteristics, also focused on the energy audit and energy levels to energy conservation and retrofitting in building finally talked about the sector that we will talk about

Chapter 3describes the research type by defining population of sample size which would be 78 and data analysis approach by using conducting quantitative interviews and questionnaire for data collection to get the average for ECI and EUI for non-industrial building.

Chapter 4 presents and discusses our results; each result is presented separately with a comprehensive discussion.

Chapter 5 talks about the conclusions and recommendations and some of the limitations by defining difficulties from gathering data and information

Chapter Two
Literature Review

This chapter reviews the previous studies regarding energy saving in buildings, energy management and energy audit and how can we develop indicators to control the energy consumption by benchmarking between each categories in the non-industrial buildings

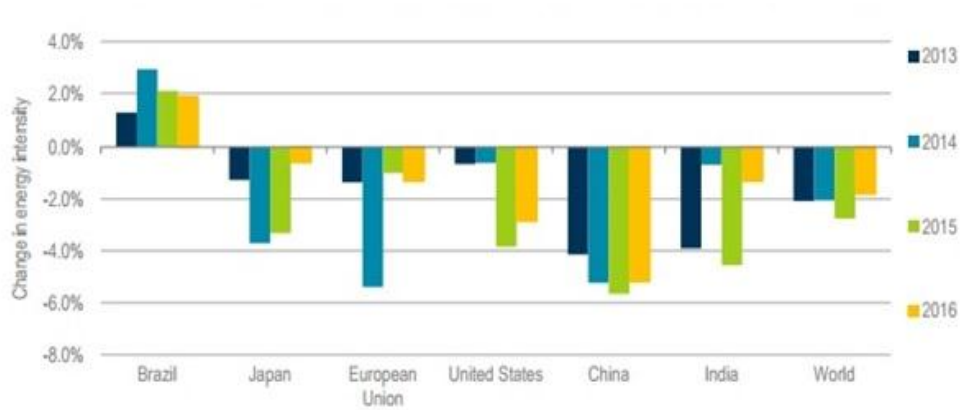
2.1 Chapter overview

This chapter reviews the previous studies regarding energy consumption and their analysis of empirical and theoretical data in order to demonstrate the importance of energy saving in nonindustrial buildings. Also, by studying two indicators the EUI and ECI we can know if we want to reduce energy consumption which leads to the first step in an energy audit, how much we consume, are we above average and out of limit energy.

Many authors discussed the positive relationship between the management and efficiency of energy consumption. Bloom et al. (2010) were able to find a positive relationship between good management practices and productivity/energy efficiency which was later defined as the positive impact in EM (Energy Management), suggesting that well-run firms use energy more efficiently. Also, Cowan et al. (2010) further noted that especially energy consumption and conservation qualifies for setting measurable targets which are the basic line for energy management practice. Thus, good management results in more efficient energy

conservation. One of the first steps of good management is calculating quantities and comparing them with indicators that we will study and know what can be done, developed and adjusted for proper conservation, which is within the levels of energy.

This was also noticed later on the global report (energy efficiency services limited, 2017) which reported an improvement in energy efficiency by 13% between 2000 and 2016. Changes in the global primary energy intensity are influenced by improvements in energy efficiency as well as changes in economic structure, such as the movement of economic activity away from energy-intensive industry towards less intensive service sectors Thus can be noted that countries that have developed the proper management of energy conservation have achieved a significant increase in energy efficiency and this shows that countries adopt energy management to improve the efficiency of consumption, as shown in (Figure 2)



Sources: Adapted from IEA (2016a) *World Energy Outlook 2016*; and IEA (2017a), *World Energy Statistics and Balances 2017* (database), www.iea.org/statistics.

Figure 2: Change in primary energy intensity in selected countries and regions.

2.2 Energy indicator EUI and ECI and their importance

The indicator called Energy Utilization Index (EUI) is one of the most powerful indicators. sums up all building energy consumption per year (electrical, gas, oil fuel …etc.) then dividing over conditioned space area, in such a way, a kJ/m2 or kWh/m2 indicator will be calculated. In addition, the Energy Cost Index (ECI) which is the same as EUI except that its numerator contains the annual energy costs, the benefits from the two indicators are to know how much we consume, is there a lot of energy loss in buildings, what is the solution and hopefully working on raising awareness of global environmental challenges in the future by developing and adopting a number of environmental legislation.

However, local environmental legislation is limited, and environmental problems are not assumed with high priority in comparison with any political issue either internally or externally. In addition, there is a lack of real data describing the current situation. Thus, Palestinian decision-makers do not have a clear vision regarding their lifestyle sustainability, and its consequences on their environment and the local economy.

EUI is a very important energy performance indicator, many studies discussed the effects of establishing the EUI in buildings and how after knowing the average EUI for each commercial building can save energy

2.3 Overview of two energy management indicators:

There are several studies connecting EUI with saving environment energy performance and ECI with economic performance (Allcott and Greenstone, 2012; Bloom et al., 2010; Cetindamar and Husoy, 2007; Cowan et al., 2010; Enderle and Tavis, 1998; Porter and Linde, 1995).

In their paper, Enderle and Tavis (1998) suggested a balanced concept for organizations, combining economic, social and environmental responsibilities. Savings in energy consumptions, in particular, are found to make both economic and environmental sense. They further argued that environmental and economic responsibilities partly overlap when comes to the use of energy, since energy savings can be justified from a purely economic as well as a noneconomic point of view. While Enderle and Tavis (1998) remained cautious and reported the overlap being only partial, other authors such as Porter, and Lindeand Cetindam (1995) argued more strongly and suggested a ‘win-win’ situation, They suggested that well placed environmental standards and goals in organizations will trigger innovations that will subsequently lower overall costs. Similarly, Cetindamar and Husoy (2007) noted that environmentally sound measures are often at the same time economically sound and have the potential to result in higher profits in the long run. This theoretical assumption has been tested and confirmed by Al-Tuwaijri et al. (2004) who found a significant positive relationship between environmental and economic performance.

Al-Tuwaijri et al. (2004) further suggest the environmental performance and economic performance are closely linked to management quality in energy management. Indeed, management seems to have realized the importance of tackling energy usage and energy efficiency. Bloom et al. (2010) were able to find a positive relationship between good management practices and productivity/energy efficiency which later defined as the positive impact in EM, suggesting that well-run firms use energy more efficiently. Similarly, Montabon et al. (2007) argued that environmental management practices are positively related to firm performance. In order to reach environmental and other organizational goals, Waggoner et al. (1999) and Caldelli and Parmigiani (2004) perceived exclusively financial performance measures as not sufficient. by supporting the inclusion of ECI performance indicators in organizational performance measurement energy systems. Authors have found support for the notion that environmental accounting can positively influence an organization's ability to estimate and control environmental costs (Buhr, 1998; Caldelli and Parmigiani, 2004; Li and McConomy, 1999).

Dingwerth and Eichinger (2010) argued that collecting data will raise awareness and could set internal processes within the organization in motion. Caldelli and Parmigiani (2004) likewise suggested that the inclusion of environmental goals in a performance measurement system will help manage these as well as to report on transition. They stated that environmental accounting is used to improve the organizational oversight

over impact and effects the organization's activities have on the environment and with respect to energy.

Cowan et al. (2010) further noted, that especially energy consumption and conservation qualifies for setting measurable targets which are the basic line for energy management and it is practice, on the other hand, EUI is very important performance energy indicator, lots of studies talked about it after establishing the EUI in building and how after knowing the average EUI for each commercial building thought that now we can save energy by knowing the EUI for each commercial building and compared with control chart to be in a control limit so can control the use of energy, but In theory, the approach has merit, but most previous attempts to use simple targets for commercial buildings have failed (Goldstein and Eley 2014). Two major drawbacks to an EUI target approach are difficulty in setting an appropriate and fair target and difficulty in having a reliable prediction of building energy use. Setting fair and appropriate targets can be a substantial challenge. EUI targets can be developed based on the actual energy use of typical existing buildings or by using prototype building models normalized for the climate. Unfortunately, few buildings are typical. Even simple buildings vary in function, number, and frequency of occupants, plug and process loads, hours of operations, and other energy services. That makes fixed targets either too easy or too difficult to meet (Goldstein and Eley 2014)

2.4 Energy intensive is a good indicator for non-industrial building

Commercial consumers are defined to be all non-residential consumers, with the exception of users classified as a large industry. Studies in many countries revealed that non industrial buildings are one of the most energy-intensive building categories as mentioned in (global energy efficiency 2017) the movement of economic activity away from energy-intensive industry towards less intensive service sectors, Changes in global primary energy intensity are influenced by improvements in energy efficiency as well as changes in economic structure

Energy efficiency indicators, or more generally energy performance indicators, give the links between energy use and some relevant monetary or physical indicators measuring the demand for energy services.

Generally, energy efficiency indicators are intensities, presented as a ratio between energy consumption (measured in energy units) and activity data (measured in physical units) (IEA, 2014), as shown in the following equation:

$$Energyefficiency Indicator = Energyconsumption / Activitydata$$

Through this study, we will find the correlation between variables like the number of workers and occupancy rate with EUI, which will provide the opportunity to develop energy indicators to calculate the national GDP and to develop further indicators

2.5 Energy audit and energy management

The main point of choosing a level of an energy audit is the right level from the first time to reduce effort and cost. Based on the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) (ASHRAE, 2015)) defines three levels of audits. Each audit level builds on the previous level. As audit complexity increases, so do thoroughness of the site assessment, the amount of data collected and the details provided in the final audit report. This effort can translate into higher energy savings.

Each level depends on the next; some companies cannot identify its place between levels of an energy audit, despite the availability of money, time and resources. In this study we will attempt to identify those levels by defining them according to the American society of energy engineers, and identifying energy indicators which will make it easier for business owner to find out if there is an excessive use of energy, why there is an excess and what is the easiest and comprehensible plan for energy audit. Those levels are:

Level I: Site Assessment or Preliminary Audits identify no-cost and low-cost energy saving opportunities (ASHRAE,2015), only a month to month comparison of the general energy use will be done including electric bills and gas bills, in order to know a general energy, use of the company, gives a general view of potential capital improvements. Activities include an assessment of energy bills and a brief site inspection of your building. Is there a reasonable reason for energy loss in a specific month, which is an

easy and inexpensive process? Through this study, by identifying the energy indicators (EUI, ECI) we can compare a company general energy use with other companies from the same field which in turn gives us a broader indicator for energy consumption and if we have energy loss or not.

Level II: Energy Engineering Analysis Audits identify energy lost cost and low-cost opportunities, and also provide EEM table and what are the recommendations in line with financial plans and potential capital-intensive energy savings opportunities based on (ASHRAE,2015). Level II audits include an in-depth analysis of energy costs, energy usage and building characteristics and a more refined survey of how energy is used in a building. This process is very important but also very expensive, where an external team would be assigned to do the audit, yet it is a big step in the right direction for big companies.

Level III: Detailed Analysis of Capital-Intensive Modification Audits provides solid recommendations and financial analysis for major capital investments(ASHRAE,2015). In addition to Level, I and Level II activities, Level III audits include monitoring, data collection, and engineering analysis. It is a very expensive process that could last for months. It is very comprehensible, it takes a detailed look at the company energy loss plans, and it looks for every reason for energy loss and what can be done to conserve energy. Engineers will help in setting the appropriate budget and levels of energy.

By identifying energy audit levels, we should note that the development of performance indicators which is the main purpose of this study will serve the interest of auditing. The first level of auditing depends mainly on consumption and comparison, and through this study, we will make it easier and give everyone the opportunity to start the audit process and give them an idea about the amount of consumption

2.6 Some of non-industrial building in Nablus and their Energy Profile

by chose a classification according to the US classification, did not take it fully but relied on the same basis for the selection process

Restaurant's: According to data available from the U.S. Department of Energy (DOE), food service buildings are the most energy-intensive of all commercial buildings Estimates of energy consumption attribute 50% of an average restaurant's energy use to the preparation and storage of food (Clark Energy Cooperative, 2002). Both full service and fast food restaurants pose significant challenges to HVAC systems because the presence of people and the activities of food preparation and presentation creates high heat gain; ventilation air requirements are high; kitchen doors must be isolated; and there are typically a large influxes of outdoor air through entrances during peak hours Therefore, considered to include restaurants and hotels with conditioning and heating systems and refrigerators. The sample was taken from the city of Nablus randomly and here is worth mentioning that the hotels have been added because the hotels

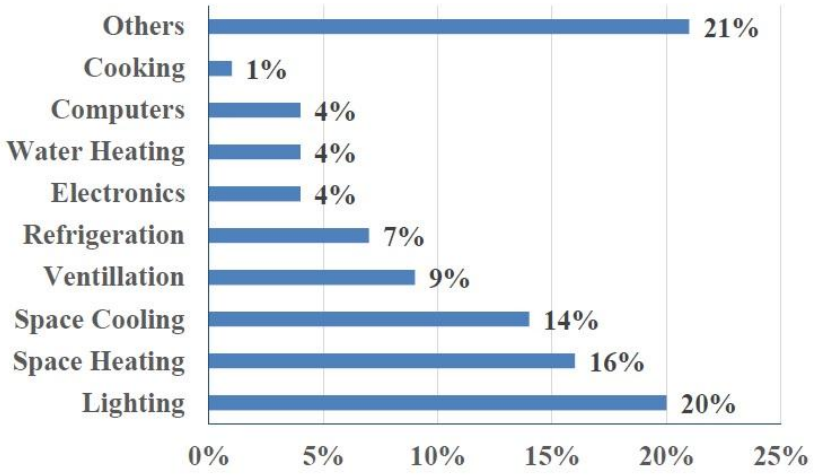
here are only for accommodation not for entertainment, hotels include rooms and restaurants.

Hospitals: The electric loads of hospitals are largely lighting, HVAC, elevators, medical equipment (such as CT scan and MRI), computers, copiers and other office equipment. Also, gas and diesel use in the hospital is higher compared with other establishments, thus, the sample collected from hospitals is higher and more holistic. Hospitals also include health centers like eye centers, dialysis centers, fertility centres, and outpatient clinics. Taking into consideration that hospitals as a building and equipment's are the same; the sample was taken from hospitals in Nablus.

Office Buildings (Schools, Universities, office, company,)

In the U.S., commercial buildings share 19% of the primary energy use among all sectors in 2010 (U.S. Energy Information Administration, 2011; 2012). Figure (3) below shows the breakdown of primary energy use in commercial buildings by end-use services. The figure demonstrates that five energy services accounted for 79% of primary energy use in buildings in 2010. These are thermal comfort space conditioning that includes space heating, cooling and ventilation (39%), illumination (20%), sanitation and hygiene, including water heating (4%), communication and entertainment electronics including televisions, computers, and office equipment (8%), and provision of food, refrigeration and cooking (8%) (U.S. Department of Energy, 2008). The remaining 21% includes service station equipment, telecommunications

Figure 8. Primary energy use in U.S. commercial buildings in 2010



Source: (Urge-Vorsatz, 2013)

Figure 3: Primary energy use in U.S. commercial building in 2010.

By studying the establishments in Nablus city the following took in the inclusion criteria: The fact that the commercial sector represents the economy of the city, a great deal of attention was on including companies from the city taking into account the higher percentage of energy use among non-industrial buildings in Nablus.

But in our case divide the schools alone because of the number of schools in the city. The rest of the classification was according to the USA classification which includes buildings of university, companies and others, some buildings were not included like banks because Nablus does not have main bank only branches.

2.7 Analysis background

An analysis was carried out to suit the required data. Using Minitab analysis is done and created descriptive data and the analysis was

conducted. Tolerance intervals are very useful when predict has wanted a range of likely outcomes based on sampled data, on the other hand, the confidence interval is an interval estimate for a parameter value. constructed in a way so that, in the long run, a given proportion of these intervals will include the unknown true parameter value. The proportion is given by the "level of confidence". For instance, you can expect that at least 90% of (a large series of) 90% confidence intervals will include the unknown true values of the parameters.

The differences between CI &TI

The width of a confidence interval depends entirely on sampling error. The closer the sample comes to including the entire population, the smaller the width of the confidence interval, until it approaches zero, but a tolerance interval's width is based not only on sampling error but also variance in the population. As the sample size approaches the entire population, the sampling error diminishes and the estimated percentiles approach the true population percentiles.

According to (Gelo,2014) confidence interval is an Interval that we are (1-α)% confident covers μ, gets smaller as n increases, Provides a range for the practical interpretation of the mean and Tells us nothing about individuals in the population

According to Olsson, (2013) tolerance interval like a confidence interval for individuals can cover a certain proportion of the population with a

certain degree of confidence, for example, a 99%/95% tolerance interval will include 99% of the population with 95% confidence.

The prediction interval will always be longer than the confidence interval for because there is more variability associated with the prediction error than with the error of estimation. This is easy to see because the prediction error is the difference between two random variables, and the estimation error in the CI is the difference between one random variable and a constant. As n gets larger, the length of the CI decreases to zero So as n increases, the uncertainty in estimating goes to zero, although there will always be uncertainty about the future value even when there is no need to estimate any of the distribution parameters. Practical Interpretation: Notice that the prediction interval is considerably longer than the CI. This is because of the CI an estimate of a parameter, while the PI is an interval estimate of a single future observation

Chapter Three
Research Methodology

3.1 Introduction

In this chapter will describe the research type and the sector that want to study by defining population of sample size and data analysis approach

3.2 Research type

Depending on the research goals, a researcher can find the type of the research (Bhattacherjee:2012) and this research is calculating the indicators of energy in order to explain the relationship between variables which is consumption in energy number of worker so, in this study quantitative method approach was used to collect quantitative data. The main point from quantitative data to find the average of EUI and ECI and after that to investigate the coloration between variables which is represented by the figures and charts (Creswell,2012) and to explore and understand the circumstances caused the calculated EUI & ECI, although the data must be understandable and give a solution to the research problem (Creswell,2014)

3.3 Research methodology steps

First, have been developed a strategy for the study methodology. have enumerated the number of non-industrial commercial buildings located in the city of Nablus according to the 2015 statistics of the Palestinian Central Bureau of Statistics.

Second, chose a suitable classification of buildings according to the Palestinian needs, the availability of information and the nature of the Palestinian environment itself. The classification includes schools, hospitals, restaurants, hotels, and companies. The sample was chosen based on a planned strategy. From the non-industrial buildings, we chose our sample based on size and occupancy rate, also, first began to do a pre studying in hospitals in order to find the variables that could affect this study, based on these criteria collected our sample from hospitals, restaurants, hotels, universities, schools, supermarkets, and shopping malls. For example, schools were chosen based on size, number of laboratories and the existent of energy saving programs. Hotels were chosen based on the number of rooms and occupancy rate. Nablus is a small city but it has a great economic status and lots of landmarks which makes small hotels compete with big hotels that why included hotels with more than 15 rooms in this study. Restaurants were also chosen based on size, occupancy rate and available equipment’s

Third, the sample size was calculated based on a specific mechanism. The number of total operating establishments and the area of the same establishment were taken into account. Based on those criteria the establishments with small areas have been cancelled and the large ones with high occupancy rate were included

Fourth, by designed a questionnaire and distributed it, the quantitative questionnaire was designed based on a previous study with the same scientific purpose, the questionnaire was presented and checked by a panel of experts, and then the questionnaire was distributed to the targeted sample. Data were collected through a questionnaire (shown in appendix 1) distributed and collected by the researcher. An also quantitative interview was also conducted to collect more data

Fifth: Purification and filtering the data; after data collection, the data was purified for information, knowing what will be the benefits from this study, and pointing to some important things for this study and other studies that might build on our results

Sixth: Statistical analysis: a Minitab analysis program was used, based on descriptive analysis of data

3.4 Sample size

Nablus is the economic capital of Palestine. In 2009, the number of economic facilities in the city of Nablus was 13742(Nablus Chamber of Commerce, 2009) as shown in Table 2. facilities belong to social services with 980, facility 235 were educational facilities, 490 health, and social work, 484 were real state and commercial, 103 Transport, storage, and communications, 681 restaurants and hotels and 125Financial intermediations(Nablus Chamber of Commerce, 2011). According to the Industrial Analysis Report from the Chamber of Commerce and Industry,

Nablus has a 56.3% share in the economic facilities which makes the number of facilities in Nablus 1748, by using the following equation:

$$n = \frac{N \times p(1-p)}{\left[\left[N-1\times\left(d^2 \div z^2\right)\right]+ p(1-p)\right]}$$

N=1748 *P*=.5 *D*=.05 *Z*=1.96

Based on the previous equation the desired sample would be 315, however, in this study only want to include large facilities, given that 25%of them are considered large facilities (Chamber of Commerce and Industry, Nablus). the sample size would be 78. Table (3) shows the distribution of the sample among different categories

Table 3: Distribution of the sample among different categories

Category	Number of establishments	Percentage	Desired sample	Collected sample
Restaurants and hotels	681	22%	16	6 restaurants and 6 hotels
Transport, storage and communications	103	3.3%	3	3
Financial intermediation	125	4.1%	No main banks in Nablus	-------- Not applicable
social services	987	31%	24	------not applicable
health and social work	490	16%	12	4
Education	235	7.5%	6	22 schools and 2universities
real state, renting, and business activities	484	15.5%	12	30 companies

Based on the Central Statistical Book of Palestinian Cities, relied on the number of establishments located in Palestine as in the table (2) to determine the classification of establishments and their number

3.5 Research sample size

The purpose of a survey is to capture the main characteristics of the population at any instant or monitor changes over time (Tan. 2004). Hence, proper design of the sampling process is very important to make the resulting sample representative of the population. According to Tan (2004), the trade-off between cost and precision in determining sample size may be derived using the Central Limit Theorem (The central limit theorem (CLT) The central limit theorem states that if you have a population with mean μ and standard deviation σ and take sufficiently large random samples from the population with replacement, then the distribution of the sample means will be approximately normally distributed, this theory could be applied in this study, were the sample taken from the population would represent the same data, with the same mean and standard deviation as the entire population of commercial facilities in Nablus (Chamber of Commerce and Industry, Nablus), but later noticed that data come from nonparametric and that because the sample was small and a Small sample simply don't contain enough information to let you make reliable inferences about the shape of the distribution in the entire population (Motulsky,2013)

3.6 Questionnaire

The distributed questionnaire designed to get all the data needed for this research, it is designed by reviewing past studies with similar objectives based on ‘ENERGY PERFORMANCE OF HOTEL BUILDINGS questioner. It was acknowledged that a very long questionnaire with many details is likely to deter some building from being included in the survey. a very short one will inevitably fail to collect the necessary data. Therefore, the principle is to keep it succinct but still able to grasp the essentials. Ultimately, the questionnaire was finalized as a result of careful evaluation of these factors. The questionnaire was distributed manually by the researcher; extra questions were added based on the type of the facility (Appendix I)

The questionnaire was divided to many sections which were: general information section which was designed in order to collect information about the establishment including its type, if there were any factors which increase energy use and bills for calculating energy use which will be used to calculate energy indicators ECI and EUI.

The second section is the physical characteristics of the establishments which include information about the establishment itself in terms of size, number of workers, year of the establishment, number and type of equipment’s and period of use, taking into consideration the establishment type which has a great impact on those answers, this section also asks if an energy audit had been performed previously or not.

The last section was designed to collect information about the Operational characteristics of the facility including operating period, nature of work and occupancy rate

3.7 Preliminary study

A Preliminary testing is very important because by conducting a Preliminary study a lot of problem could be detected and what might face the respondent (bhattacherjee,2012) and then obtain validity and sustainability of the question (bhattacherjee,2012). A sample of hospitals were chosen; only private hospitals were included because governmental hospitals declined giving the data.

then examined the questions in the questionnaire and a group of experts and arbitrator saw the questionnaire to be easy to answer. (Table 4)

Table 4: Expert and arbitrator who reviewed the questionnaire

Number	Position
4	Teaching staff at Al- Najah university
2	Auditing of energy ISO

3.8 Data analysis approach

By using Conducting Quantitative Interviews for data collection. An average for ECI and EUI for non-industrial building will be calculated. An important step in conducting a survey is to check for data integrity. In the current study, this step was taken through site visit and conducting interview with the establishment engineers and accountants.

Through site visits and questionnaire filling, the researcher focused on specific questions in order to collect correct information and clarify the differences between the chosen categories. For example, when collecting data from hotels, number of rooms was taken into consideration. However, when data were collected from schools, numbers of teachers, students and labs were taken into consideration because these factors affect energy use. In restaurants, asked about refrigeration rooms, fridges and stores. As for companies, asked about number of branches, stores, and warehouses, these questions were asked to explain expected results variability during data analysis.

Conducting Quantitative Interviews

Quantitative interviews are sometimes referred to as survey interviews because they resemble survey-style question-and-answer formats. They might also be called standardized interviews. The difference between surveys and standardized interviews is that questions and answer options are read to respondents rather than having respondents complete a questionnaire on their own. As with questionnaires, the questions posed in

a standardized interview tend to be closed ended. There are instances in which a quantitative interviewer might pose a few open-ended questions as well. This approach was adopted in order to be more clear and to find any other indicators (Rubin & Rubin. 1995).

In quantitative interviews, an interview schedule is used to guide the researcher as he or she poses questions and answer options to respondents. An interview schedule is usually more rigid than an interview guide. It contains the list of questions and answer options that the researcher will read to respondents(Creswell, 1998)

Table 5: Questions for each category

Name of the establishment	Specific questions
Schools	Number of teachers Number of students Is there summer school Number of floors Number of scientific labs
Companies	Number of stores Number of branches Numbers of reserved staff
Hotels	Number of single bed rooms and suites Number of floors Accessories from a wedding hall or conference room

Chapter four will present data analysis and results and discussion, which includes the effect of variables on energy indicators and we will talk CI &TI and t test and ANOVA test

3.9 T test & ANOVA test

Some conditions before performing the two tests are needed to be accomplished. For the T-test, population data should be normally distributed, and are comparing equal variances of the population. While for ANOVA tests, samples that are to be used are selected independently and randomly. should also assume that the population are taking the samples from is normal and have equal standard deviations.

Chapter four
Results and discussion

4.1 Introduction

The questionnaire had been explained, data were analysed using SPSS programme. In order to spot the difference, the questionnaire part and the interview part were presented as followed

4.2 Questionnaire analysis

First section: general information

In the first section we were only interested in the general information regarding the establishment including its type, nature of work, type of fuel used, electric and fuel bills. As seem in table 6 this information was used to calculate energy indicators (EUI, ECI).

Table 6: ECU and EUI for all categories

No	Name	No Employee	Size (m^2)	EUI Kj/ m^2	ECI Nis/ m^2	Occupancy rate %	energy kj
1	عالم التيشيرت	7	633	31.27326	6.129542	40.00%	19795.9732
2	awad center	3	500	48.70872	10.08	50.00%	24354.3624
3	مدرسة الامهات	3	850	52.13107	10.78824	50.00%	44311.4094
4	البيت السعيد	8	640	54.30201	10.6875	65.00%	34753.2886
5	المركز الصيني	4	150	65.68591	13.59333	20.00%	9852.88591
6	صيدلية صبري	5	550	68.49445	13.85455	55.00%	37671.9463
7	الحطاب للموبيليا	4	270	71.54064	14.37037	25.00%	19315.9732
8	شركة هضبة الجنيدي	33	7250	98.47226	16.00441	60.00%	713923.862
9	شركة البيت العصري	2	300	106.1799	21	40.00%	31853.9597
10	دريم مول2	5	120	110.9799	21.5	35.00%	13317.5839
11	شركة طوقان	3	320	112.1527	19.70313	35.00%	35888.8591
12	صيدلية الانوار		120	114.2013	22.16667	60.00%	13704.1611
13	اسواق الصوالحي	9	1000	121.7332	24.84	55.00%	121733.154
14	جامعة القدس		10000	127.5705	26.4	70.00%	1275704.7
15	دريم سوبر ستور	10	850	136.8452	27.26706	50.00%	116318.4
16	اركاد للعقار	7	150	143.5705	28.73333	40.00%	21535.5705
17	نضالكو للطباعه	15	200	231.7894	47.015	20.00%	46357.878
18	شركة السلطان	3	150	247.0792	37.52	30.00%	37061.8792
19	Dand	4	100	296.3114	61.32	20.00%	29631.1409
20	مجموعة شركات سامر شبيطه	6	250	729.1889	150.62	40.00%	182297.235
21	شركة فيروزي	5	100	794.4	161.9	25.00%	79440
22	شركةbci	5	220	824.1123	170.5455	40.00%	181304.698

23	بال عقار	44	6500	983.071	202.7754	75.00%	6389961.34
24	شركة نقليات القواسمي	4	100	1014.965	150.9	25.00%	101496.483
25	اسواق ابو بكر التجاريه	10	600	1032.071	168.0083	30.00%	619242.462
26	سوب ستور	16	800	2010.338	181.525	40.00%	1608270.46
27	شركة بسطامي للادويه	15	420	48323.75	25.62791	50.00%	20295974.6
28	شركة الحج علي	4	400	137.6215	27.6	60.00%	55048.5906
36	مستشفى الانجيلي	153	3500	1285.081	219.7119	89%	4497784
37	مستشفى النجاح	450	10000	965.859	190.9574	90%	9658590.32
38	مستشفى نابلس	207	4000	937.8115	173.5757	75%	3751246
39	مستشفى العربي	230	3600	1865.827	303.1691	80%	6716975.6
41	الاماكن	22	1200	335.7731	59.77673	30%	402927.709
42	ورد	30	350	5245.171	684.6069	60%	1835809.92
43	زادونا	10	400	506.944	98.84533	20%	202777.6
44	دومينوز بيتزا	9	267	6461.249	934.1	70%	1725153.54
45	الف ليله وليله	70	1000	2286.178	337.2421	80%	2286177.73
46	تشليو	26	700	519.1553	103.4057	60%	363408.738
47	القصر	32	3000	467.7405	271.0555	35.00%	1403221.39
48	سليم افندي	12	2500	177.5712	35.866	70.00%	443928
49	عساف	2	480	164.4	34.25	85.00%	78912
50	القلعه	15	2500	480	82.5	70.00%	1200000
51	الاسراء	6	850	85.9	17.14	50.00%	73015
52	فندق الياسمينه	16	1000	459.7632	88.3392	75.00%	459763.2
53	عراق التايه الثانوية	23.50	2070.	16.67768	2.79686	75%	34522.8
54	اليرموك الثانوبة	26.00	4177	12.61537	2.130242	70%	52694.4
55	مدرسة العائشية الثانوية	25.50	4050	8.701926	1.443647	75%	35242.8
56	سمير سعد الدين الثانوية	35.50	4091	12.68404	2.14747	70%	51890.4
57	كمال جنبلاط الثانوية	30.00	4270	9.850398	1.656419	80%	42061.2

58	الفاطمية الثانوية	23.50	3060	12.75843	2.162663	80%	39040.8
59	جمال عبد الناصر الثانوية	27.50	6445	10.00068	1.676631	85%	64454.4
60	الصلاحية الثانوية للبنين	28.00	7430	18.2463	3.09776	75%	135570
61	الصلاحية الثانوية للبنات	26.00	3700	8.808324	1.469959	70%	32590.8
62	عمرو بن العاص الثانوية	18.00	3900	10.24892	1.730638	70%	39970.8
63	سعد صايل الاساسية	24.50	3400	15.83224	2.651459	60%	53829.6
64	جميلة بو حيرد الاساسية	10.50	1000	17.2872	2.88761	65%	17287.2
65	فهمي الصيفي	26.50	1140	29.70842	5.029491	70%	33867.6
66	النظامية الاساسية للبنات	10.50	1100	15.48218	3.510245	70%	17030.4
67	بلال بن رباح	19.00	1509	16.24891	2.731206	70%	24519.6
68	الخنساء الاساسية	13.00	1528	11.18325	1.879568	75%	17088
69	ابن سينا	16.00	5000	3.62376	0.60598	75%	18118.8
70	فدوى طوقان	21.50	2000	11.9052	1.99854	70%	23810.4
71	طارق بن زياد	12.00	667.00	13.09745	2.086897	75%	8736
72	عادل زعيتر الاساسية	16.50	2200.00	17.17364	2.900482	70%	37782
73	عمر المختار الاساسية	18.50	1577.00	13.86278	2.337514	75%	21861.6

After data collection, out of 78 questionnaires, 73 were collected and completed, 5 were not completed.

Here, was noticeable the big variability in the data. So, after several trials including classifying by size, the results were not understandable yet, when was classified by category there was a big variability, this could be related to the wide differences even in the same category. For example, companies had big differences in a number of employee, branches, age equipment, and heating and conditioning system which gave the great variability. In the second section, the energy performance indicators were calculated.

In the case of hospitals, the sample was small, but was noticeable that the nature of hospitals was the same, same equipment; same heating and conditioning system, all used the same energy sources (Gas, diesel, electricity). That's why other factors like size and occupancy rate were obvious, and their effects on the energy indicators were clear which was seen in the statistical analysis.

In cases of restaurant and hotels, clear differences were spotted, which is related to the differences in the same category, for example, some hotels target college students only for sleeping, like in Israa and Assaf hotels. However, AlQasr hotel despite its big size, other factors affected the hotel, like its old establishment, and the shortage of its visitors. As for restaurants, the nature of the work used equipment and the age of the building had an effect on the results. In cases of schools, only

governmental schools were selected, which makes it easier to compare and it would be difficult to get data from private schools.

After data analysis noticed that the analysis should be based on the Conditioned Area (size*Occupancy rate). New EUI and New ECI were calculated based on the conditioned Area. We also took into consideration the effect of other factors on New EUI and New ECI.

Second section: Physical characteristics of the establishment

In the second section, we were focusing on questions like the age of the facility, size, number of employees, type of glass, number of equipment, number of work hours, and questions regarding energy conservation.

Through these questions, it was expected what the factors and how they affected the energy performance indicators. But, the differences were clear, for example, hotels had big halls and equipment, restaurants had different working hours, type of glass, energy saving strategies, which gave very important results.

Schools had a big size, applied many strategies to decrease its energy consumption according to the ministry of education plans, which also included changing the lighting to LED, and future plans for applying sun cells on the school's roof. As for companies, it was noticed that some companies had the greatest number of employee, greatest size, but, their consumption was less which is related to their nature of work and applying strategies for reducing energy consumption.

Third section: Operational characteristics of the facility

In the third section asked regarding the occupancy rate and number of workers in the first shift which is a very important for this study.

4.3 Interview analysis

Upon finishing the data collection and interview process, data analysis was performed in order to answer the research questions. To collect more data and to obtain more information about the research problem, by using a semi-structured interview analysis. In the first step, data were taken from people in charge; the questionnaire was analysed using a strategic process in which every category was analysed separately including related questions and output (Table 7) in order to reach our objectives. (See Appendix III)

By correlating the interview questions with the overall energy consumption, data were analysed using SPSS. The analysis was separate for each category, with regards to the factors affecting their energy consumption. As seen in table (7). For example, a number of students, size and number of laboratory had a role in increasing energy consumption in schools. But, in companies, a number of branches and number of stores questions indicated high energy consumption. As for hotels, a number of rooms, accessory conference rooms, and halls had a roll in increasing energy consumption.

Table 7: Questions related to each category

Name establishment	Specific questions	Affect Significance α
Schools	Number of teachers Number of students Is there summer school Number of floors Number of scientific labs	No Effect.767 No Effect.644 No Effect.9 Effect.022 Effect .032
Companies	Number of stores Number of branches Numbers of reserved staff	Effect .014 Effect .031 No Effect.184
Hotels	Number of single bed rooms and suites Number of floors Accessories from a wedding hall or conference room	Effect.042 Effect .030 Effect.019

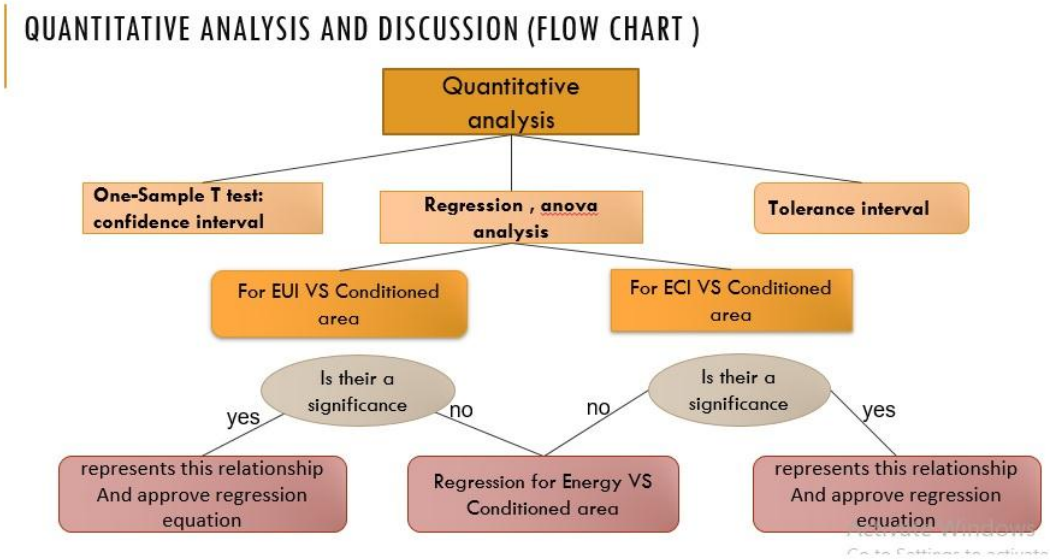
4.4 Quantitative analysis and discussion

Introduction

By calculating the energy indicators (EUI) which is energy consumption divided by the area of the establishment (condition area = actual area*average occupancy rate).

Using Mini tab programme, T-test analysis was performed; confidence interval and descriptive statistics were found. Regression analysis was also used but did not give satisfactory for some of the equations, this might have related to the high variability between variables. ANOVA test was performed to identify significance relationship. Finally, by calculated Tolerance Interval (TI) in order to identify the highest and the lowest values. Data were found to be not normally distributed

As shown below in the flow chart, the analysis process was as follows: using Minitab to analyzes and find the prediction equation for indicators, in case the equation failed we went to energy as a primary variable for the indicators, which can use to find the correlation between actual area and energy (actual area is the of area multiplied by occupancy rate), can also prove that actual area has an impact on energy indicators.



EUI for companies

Normal probability plot shows high variability which indicates that other immeasurable variables like nature of work and type of equipment could have an effect on EUI

One-Sample T test: new EUI

A confidence interval for companies EUI mean value was calculated using a t-test, the test assumes unknown variance and data not in normal distribution. Results are presented in table 8. It is shown that the average

EUI value equals to 1086 kJ/m^2, with a 95% confidence interval varies between 506 to1630 kJ/m^2. This value is equivalent to 30.2 litres of diesel per m2. But it should be kept on mind that the original consumption will exceed 90 Litre of diesel per m^2since the efficiency of electricity generation is about 35%.

Table 8: descriptive statistics for Companies EUI

Variable	N	Mean	SD	SE Mean	95% CI
EUI new	26	1068	1391	273	(506, 1630)

Tolerance interval

As shown in the normal probability plot figure (4), all values are confined between the highest and lowest value by a 95% ratio so the tolerance interval between (78.18, 5025.84) (Table 9) Upper tolerance interval and lower tolerance interval so far between each other

Upper tolerance interval and lower tolerance interval so far between each other, which is related to the differences in the nature of work for each establishment, more specific, detailed and precise classification are needed for future study. That’s why the data shown in the graph was nonparametric

Normality Probability Plot with Nonparametric data:

Nonparametric tests have less power than parametric tests, and the difference is noticeable with tiny samples. Unfortunately, normality tests have little power to detect whether or not a sample comes from a Gaussian population when the sample is tiny. Small samples simply don't contain enough information to let you make reliable inferences about the shape of

the distribution in the entire population (Motulsky,2013). Normality tests work well with large samples, but here we have a small sample which didn't contain enough data to let us make reliable inferences about the shape of the distribution of the population from which the data were drawn. So normality tests don't answer the question. Normality tests ask the question of whether there is evidence that the distribution differs from Gaussian. But with huge samples, normality testing will detect tiny deviations from Gaussian, differences small enough so they shouldn't sway the decision about parametric vs. nonparametric testing(Motulsky,2013). That's why the sample was distributed as shown in (Figure 4)

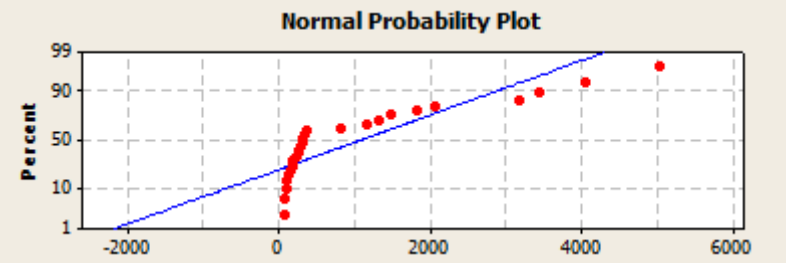


Figure 4: Normal probability plot for Companies EUI

Table 9: Tolerance interval for Companies EUI

N	Mean	SD	Lower	Upper
26	1067.61	1391.45	78.18	5025.84

Regression for EUI V.S Conditioned Area for company

Assumed the relationship to be linear and calculated the regression equation, the values were R square =.022 and P value =.4, the significance was higher than .05 which means that cannot consider conditioned area as a predictor for EUI, as shown in (Table 10)

Table 10: Regression for EUI vs. Conditioned area

Multiple R	0.151649
R Square	0.022997
Adjusted R Square	-0.01608
Standard Error	1381.444
Observations	27

One-way ANOVA: New EUI versus condition area

After using ANOVA test to prove the effect of condition area which is all area multiplied by occupancy rate, p value was .4 which is more than p value in the regression and there is no significant relationship between conditioned area and EUI, as shown in (Tables11 and 12)

Table 11: one way ANOVA EUI for Company

ANOVA				
	SS	*MS*	*F*	*Significance F*
Regression	1123030	112303	0.5884	0.450196
Residual	4770971	19083		
Total	4883274			

Table 12: Standard Error

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	1133.435	290.8873	3.896476	0.000646	534.3418	1732.529
conditioned area	-0.12026	0.156766	-0.76712	0.450196	-0.44312	0.202608

After applying the regression equation, the percentage of error was very high which means that the linearity assumption is not valid. This indicates that the relationship was not linear and the equation is not useful. So, by drawing a graph (Figure 5) representing only the relationship between EUI

and conditioned area, the graph was binomial and we can use to predict future energy consumption.

Variables other than conditioned area and occupancy rate which could have an impact, such as, number of employee load factor, working hours, building age, applying energy conservation measures caused variation and deviation from linearity assumption; table 13 shows the differences between the actual EUI and the predicted one.

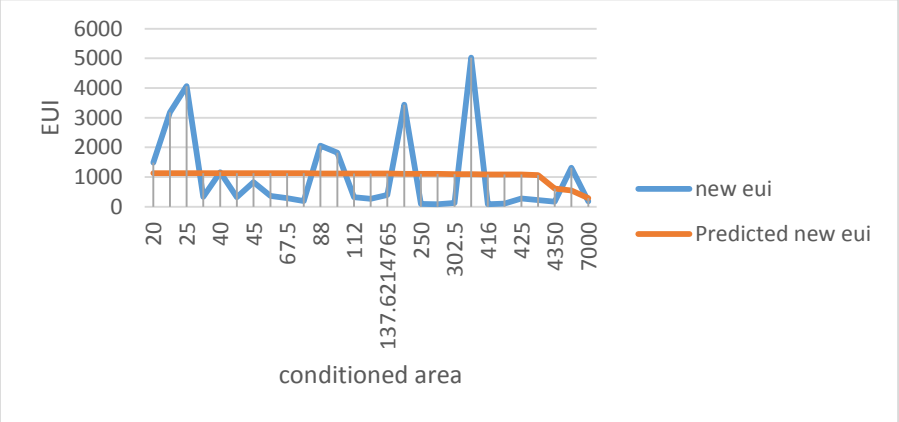


Figure 5: EUI kj/m^2 and conditioned area m^2

Table 13: Predicted EUI VS Real measures

Observation	Predicted new euikj/m^2	Residuals	new eui (kj/m^2
1	1131.030164	350.5268833	1481.557047
2	1130.428873	2047.171127	3177.6
3	1130.428873	2929.430456	4059.859329
4	1129.827583	-801.3980526	328.4295302
5	1128.625002	30.32194765	1158.94695
6	1128.384486	-811.299155	317.0853308
7	1128.023712	-304.4263961	823.5973154
8	1126.21984	-767.2936657	358.9261745
9	1125.317905	-839.1553393	286.1625652
10	1124.776743	-934.4411727	190.3355705
11	1122.852614	937.4280452	2060.280659

12	1121.409517	701.5628323	1822.972349
13	1119.96642	-799.5301781	320.4362416
14	1119.004355	-853.5546906	265.4496644
15	1116.88523	-716.8852299	400
16	1111.78887	2328.447028	3440.235897
17	1103.370804	-1005.953354	97.41744966
18	1102.985978	-1024.80283	78.18314832
19	1097.057254	-972.5218944	124.5353597
20	1094.952738	3930.892455	5025.845192
21	1083.407961	-999.8664022	83.54155911
22	1082.325638	-978.0634987	104.2621398
23	1082.325638	-808.6352855	273.6903529
24	1067.293378	-845.9603697	221.3330079
25	610.3126474	-446.1922194	164.120428
26	547.1771518	763.5841492	1310.761301
27	291.6287171	-109.3851888	182.2435283

As mentioned in EUI for companies the t-test shows confidence interval between (78.18, 5025.84). In the regression model here noticed the weakness of the linear assumption between conditioned area and EUI. Also, performed one-way ANOVA to prove that there is a direct effect between Conditioned Area and EUI, we found no significant result (p=.4), so the size has no effect on EUI which should be taken in consideration as shown above

After establishing the relationship between conditioned area and EUI, figure 6 present a graph that represents this relationship, the graph presents a polynomial shape, the equation is: Y = 2.8093x2 - 123.77x + 2054.7 The percentage of R^2 was 8%. Thus, we cannot predict the future EUI based on the conditioned area

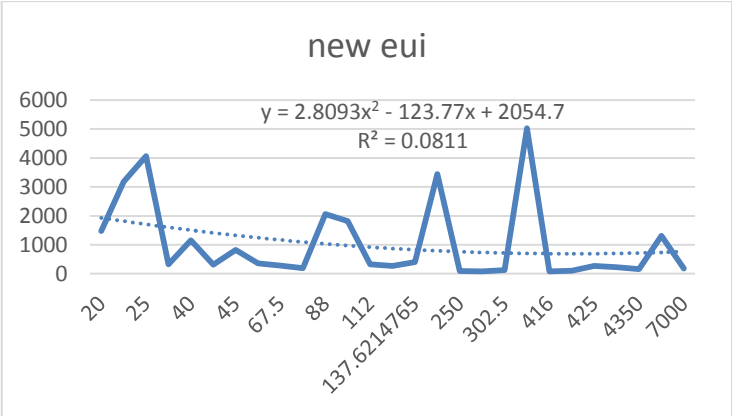


Figure 6: New EUI and conditioned area in companies

ECI (Energy Cost Index)

The factor affecting this indicator were studies, which is related to the energy price for every square meter, big variability was found, which indicates that some factors had a main effect and some do not, which will be seen later in this chapter.

One-Sample T: ECI new

Confidence interval for companies ECI mean value was calculated using t-test, the test assumes unknown variance and data normal distribution. Results are presented in table (14). It is shown that the average ECI value equals to 179.7 Nis/m^2.year, with a 95% confidence interval varies between 96.6 to 262.8 Nis/m^2.year

Table 14: Descriptive statistics for Companies ECI

Variable	N	Mean	SD	SE Mean	95% CI
ECI new	26	179.7	205.8	40.4	(96.6, 262.8)

Tolerance Interval: NEW ECI

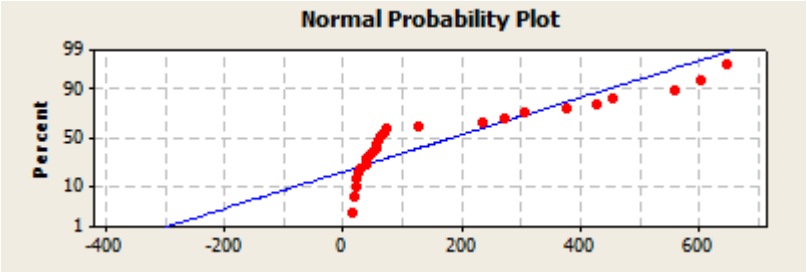


Figure 7: Normal Probability plot for Companies ECI

all values are confined between the highest and lowest value by a 95% ratio. (Table 15)

Table 15: Tolerance probability for Companies ECI

N	Mean	SD	Lower	Upper
26	179.70	205.772	15.324	647.6

ECI Regression Analysis (Conditioned Area V.S ECI)

Assuming a linear relationship, the regression equation presented in results (Table 16, 17, and 18), $r^2 = .02$ it is shown that the values is low and the modelled equation does not explain the data variability.

Table 16: Regression ECI and Conditioned area

Multiple R	0.152321
R Square	0.023202
Adjusted R Square	-0.01587
Standard Error	204.2845
Observations	27

Table 17: ANOVA for Companies ECI

ANOVA				
	SS	*MS*	*F*	*Significance F*
Regression	24781.28	24781.28	0.593817	0.448168
Residual	1043304	41732.17		
Total	1068085			

Table 18: Standard error

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	189.4704	43.01568	4.404684	0.000174	100.878	278.0629
conditioned area	-0.01786	0.023182	-0.7706	0.448168	-0.06561	0.029881

Figure 8 represent the relationship between the predicted and actual ECI in order to show the difference and the percentage of error (Table 19). The assumption of a linear relationship between conditioned area and occupancy rate also failed.

Table 19: Actual ECI VS predicted ECI

Observation	*Predicted new eci nis/*m^2	*Residuals*	*Standard Residuals*	new eci nis/m^2
1	184.9473	-169.623	-0.846	15.32
2	185.0044	-164.844	-0.822	20.16
3	181.8782	-160.302	-0.800	21.56
4	182.039	-165.597	-0.826	16.44
5	188.9345	-120.968	-0.603	67.966
6	184.0666	-158.876	-0.793	25.190
7	188.2646	-130.783	-0.652	57.481
8	111.7617	-85.0877	-0.424	26.674
9	187.3268	-134.827	-0.673	52.5
10	188.7202	-127.292	-0.635	61.42
11	187.4697	-131.175	-0.654	56.29
12	188.1842	-151.24	-0.755	36.944
13	179.6452	-134.482	-0.671	45.16
14	64.42191	-26.7076	-0.133	37.714
15	181.8782	-127.344	-0.635	54.534
16	188.3986	-116.565	-0.5819	71.83

17	188.7559	46.31912	0.2312	235.07
18	188.6666	-63.5999	-0.3175	125.06
19	189.1132	117.4868	0.5865	306.6
20	187.684	188.866	0.9428	376.55
21	189.0238	458.5762	2.2892	647.6
22	187.8984	238.4652	1.1904	426.36
23	102.3831	167.9841	0.8385	270.36
24	189.0238	414.5762	2.0695	603.6
25	186.2549	373.7729	1.8659	560.02
26	183.7539	270.0586	1.3481	453.81
27	187.012	-106.792	-0.533	80.220

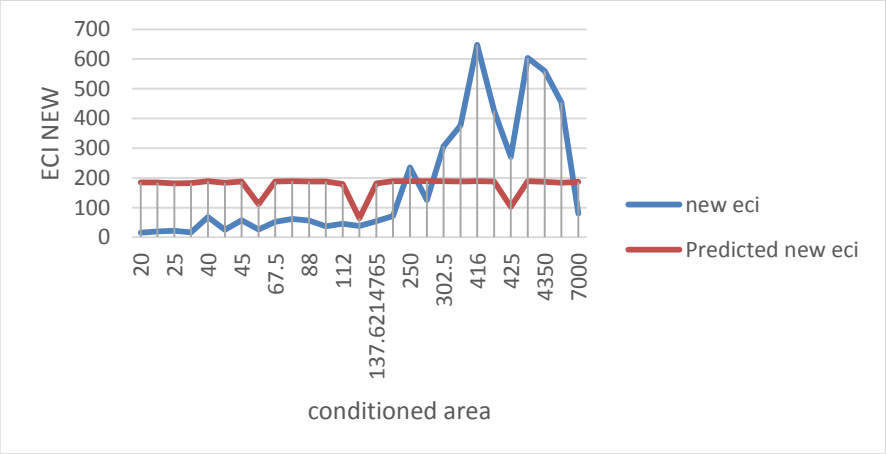


Figure 8: Actual ECI VS predicted ECI

After establishing the relationship between conditioned area and ECI, figure 9 shows a graph that represents this relationship, the graph presents a polynomial shape, and the equation is:

$$Y = 0.6955X^2 - 29.295x + 407.62$$

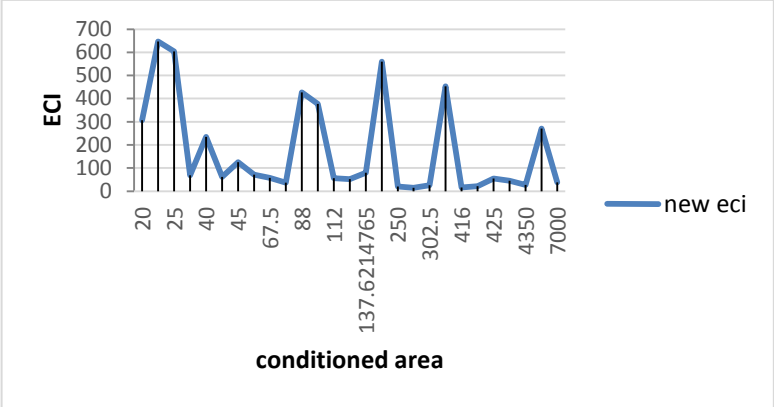


Figure 9: new ECI VS conditioned area

The percentage of R^2 was 18.3%. Thus, cannot predict the future ECI based on the conditioned area. After failed to prove that conditioned area has a direct effect on both energy indicators, connected conditioned area with energy, where energy is the main factor in both indicators and any change to energy can affect energy indicators. So, study will define the relationship between energy and conditioned area and find the regression equation.

Regression for Energy V.S Conditioned Area for company

Regression analysis was done between energy level and conditioned area; after find that conditioned area affect energy using a regression equation and by calculating the standard error (Table 20-23). R^2 equals 0.38 and adjusted R square equals 0.36. a significant relationship was found (p=0.0005). the conditioned area lies between the values (218.5855 and 685.7852)m^2.

Table 20: Energy VS condition area

Regression Statistics	
Multiple R	0.623426
R Square	0.38866
Adjusted R Square	0.364207
Standard Error	999502.5
Observations	27

Table 21: ANOVA Energy for company

	SS	*MS*	*F*	*Significance*
Regression	1.59E+13	1.59E+13	15.8938	0.000513
2.5E+13	9.99E+11			
Total	4.09E+13			

Table 22: Standard error

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	98920.32	210462.7	0.470013	0.64242	-334536	532376.4
conditioned area	452.1853	113.4234	3.986703	0.000513	218.5855	685.7852

Equation *Y=98920+452x*

Table 23: Predicted and actual energy

RESIDUAL OUTPUT				
Observation	*Predicted energy KJ*	*Residuals*	*Standard Residuals*	Calculated energy KJ
1	213413.7	-193618	-0.19755	19795.9732
2	211966.7	-187612	-0.19142	24354.3624
3	291099.1	-246788	-0.2518	44311.4094
4	287029.4	-252276	-0.2574	34753.2886
5	112485.9	-102633	-0.10472	9852.88591
6	235706.4	-198034	-0.20206	37671.9463
7	129442.8	-110127	-0.11236	19315.9732
8	2065927	-1352003	-1.37946	713923.862
9	153182.6	-121329	-0.12379	31853.9597
10	117912.1	-104595	-0.10672	13317.5839
11	149565.1	-113676	-0.11599	35888.8591
12	131477.7	-117774	-0.12017	13704.1611
13	347622.3	-225889	-0.23048	121733.154
14	3264218	-1988513	-2.0289	1275704.7

15	291099.1	-174781	-0.17833	116318.4
16	126051.4	-104516	-0.10664	21535.5705
17	117007.7	-70649.9	-0.07208	46357.878
18	119268.7	-82206.8	-0.08388	37061.8792
19	107964	-78332.9	-0.07992	29631.1409
20	144138.9	38158.38	0.038933	182297.235
21	110225	-30785	-0.03141	79440
22	138712.6	42592.06	0.043457	181304.698
23	2303324	4086637	4.169643	6389961.34
24	110225	-8728.47	-0.00891	101496.483
25	180313.7	438928.8	0.447844	619242.462
26	243619.6	1364651	1.392369	1608270.46
27	161150.7	-106102	-0.10826	55048.5906

Figure9 shows that the actual and predicted energy almost match. However, after studying the differences can see that the reason was related to the nature of the company, number of employee and the system that the company follows.

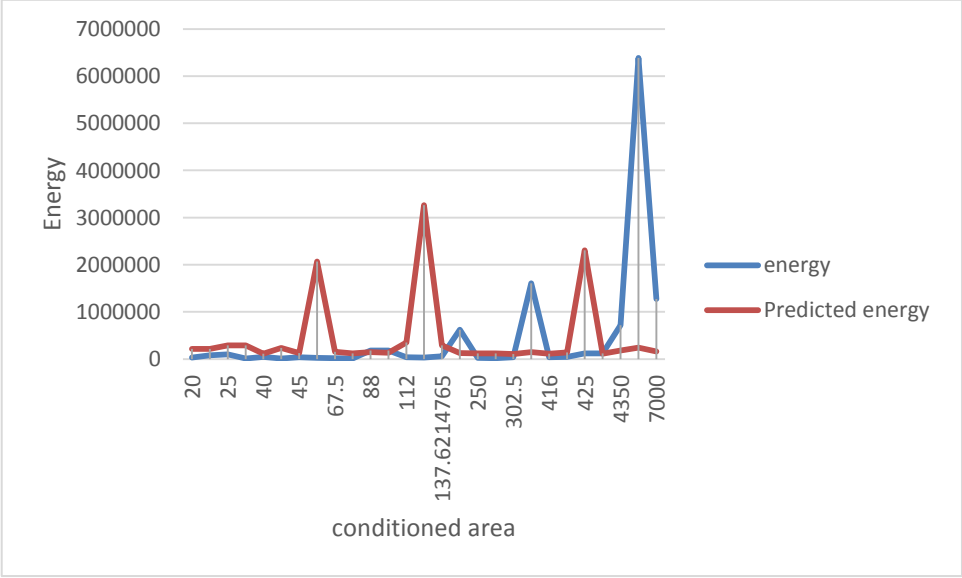


Figure 9: The relationship between actual energy kj and the predicted energy kj.

EUI for Hospitals

One sample T test:

Number of hospitals in this sample was 6, only 4 answered the questionnaire, as presented in table (24), it is shown that the average EUI value equals 559 kJ/m^2, with a 95% confidence interval varies between 635 to 2415 kJ/m^2 average confidence interval.

Table 24: Descriptive Statistics for Hospitals EUI

Variable	N	Mean	SD	95%CI
New EUI	4	559	280	(635,2415)

Tolerance Interval: new EUI

As shown in Table 25, all values are confined between the highest and lowest value by a 95% ratio, also here we note due to lack of sample number of hospital there is no figure for tolerance interval

Table 25: Probability for Hospital EUI

N	Mean	SD	Lower	Upper
4	1524.94	559.11	1073.17	2332.28

The P value was much higher than .05, which indicates high variance, differences in conditioned area and differences in energy indicators. (Table 26-29) show an r^2=.31 which is a very low value.

Regression for EUI V.S Conditioned Area for Hospital

Table 26: Regression Statistics

Regression Statistics	
Multiple R	0.559338
R Square	0.312859
Adjusted R Square	-0.03071
Standard Error	567.6339
Observations	4

Table 27: ANOVA EUI for Hospital

ANOVA				
	SS	*MS*	*F*	*Significance F*
Regression	293406.1	293406.1	0.91061	0.44066208
Residual	644416.4	322208.2		
Total	937822.5			

Table 28: Standard errors

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	1993.546	567.1802	3.514838	0.072279	-446.83282	4433.926
conditioned area	-0.10416	0.109155	-0.95426	0.440662	-0.5738186	0.365494

Table 29: Residual Output

RESIDUAL OUTPUT				
Observation	*Predicted new eui*	*Residuals*	*Standard Residuals*	new eui
1	1669.081	-225.17	-0.48583	2332.283
2	1056.086	17.09023	0.036874	1250.415
3	1681.06	-430.644	-0.92917	1443.911
4	1693.559	638.7239	1.378131	1073.177

Figure 10 shows a high variance and high percentage of error between calculated and actual EUI .

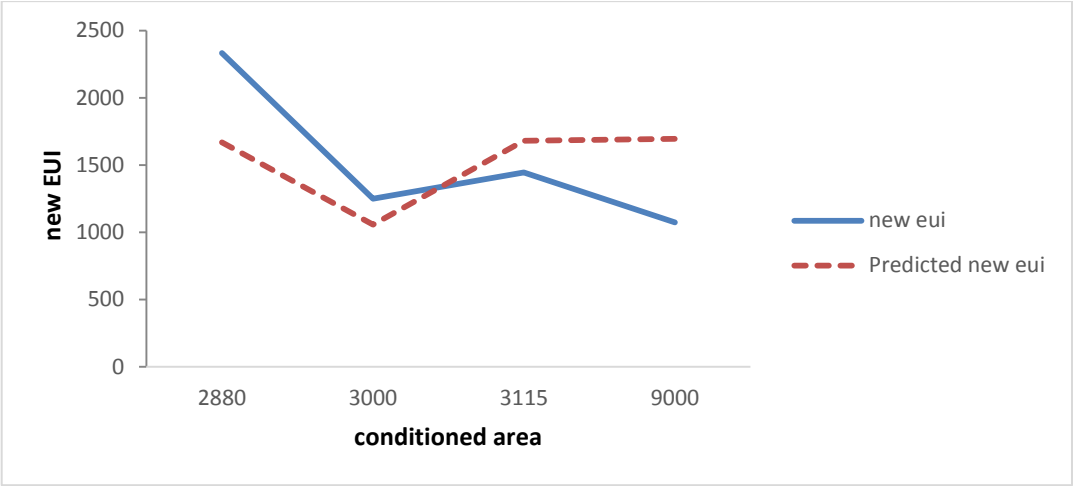


Figure 10: Predicted EUI kj/ m^2 VS Real measures.

After establishing the relationship between conditioned area and hospital EUI, figure 11 present a graph that represent this relationship, the graph presents a polynomial shape, the equation is:

$$y = 177.78\mathbf{X}^2 - 1247.3x + 3309.8$$

The percentage of R^2 was 81.9%. Thus, we can predict the future EUI based on the conditioned area.

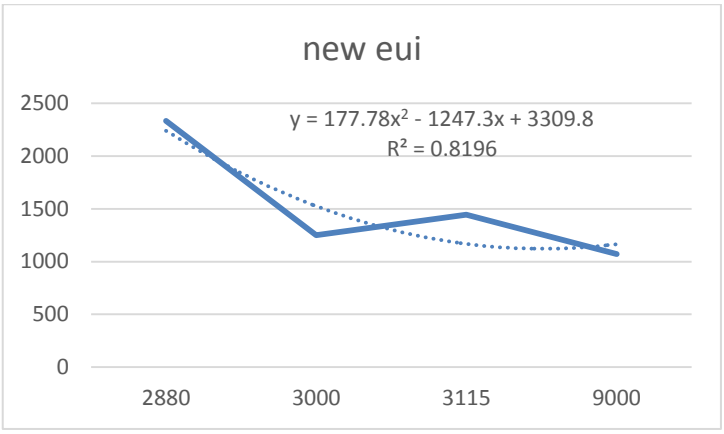


Figure 11: new EUI VS conditioned area in Hospitals.

ECI FOR HOSPITAL

One-Sample T Test

Confidence interval for hospitals ECI mean value was calculated using t-test; the test assumes unknown variance and data normal distribution. Results are presented in table (30). It is shown that the average ECI value equals to 267.4 kJ/m^2, with a 95% confidence interval varies between 146.8 to 387.9kJ/m^2.

Table 30: Descriptive Statistics for Hospitals ECI

Variable	N	Mean	SD	SE Mean	95% CI
ECI new	4	267.4	75.7	37.9	(146.8, 387.9)

Tolerance Interval: ECI NEW

As shown in the normal probability plot (Figure 12), all values are confined between the highest and lowest value by a 95% ratio.

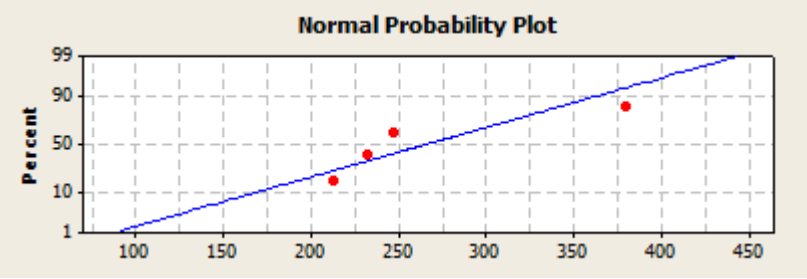


Figure 12: Normal Probability plot for Hospitals.

After assumed a linear relationship and applied the regression equation the result shown in Table (31-34) r^2=.83 (p=.08) which is slightly higher than .05. The equation was:

Table 31: Regression for ECI V.S Conditioned Area for hospitals

Multiple R	0.913229
R Square	0.833988
Adjusted R Square	0.750981
Standard Error	76.66505
Observations	4

Table 32: ANOVA ECI for hospital

ANOVA				
	SS	*MS*	*F*	*Significance F*
Regression	59053.23	59053.23	10.04729	0.086771
Residual	11755.06	5877.53		
Total	70808.29			

Table 33: Standard Error

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	426.6649	76.60378	5.569763	0.030756	97.06545	756.2643
conditioned area	-0.04673	0.014743	-3.16975	0.086771	-0.11016	0.016702

Table 34: RESIDUAL OUTPUT

Observation	*Predicted new eci*	*Residuals*	*Standard Residuals*	new eci
1	292.082	86.87936	1.387921	378.9613
2	286.4744	-55.04	-0.87928	231.4343
3	281.1004	-34.233	-0.54688	246.8673
4	6.093276	2.393721	0.03824	8.486997

Figure 13 represent the relationship between the actual and the predicted ECI

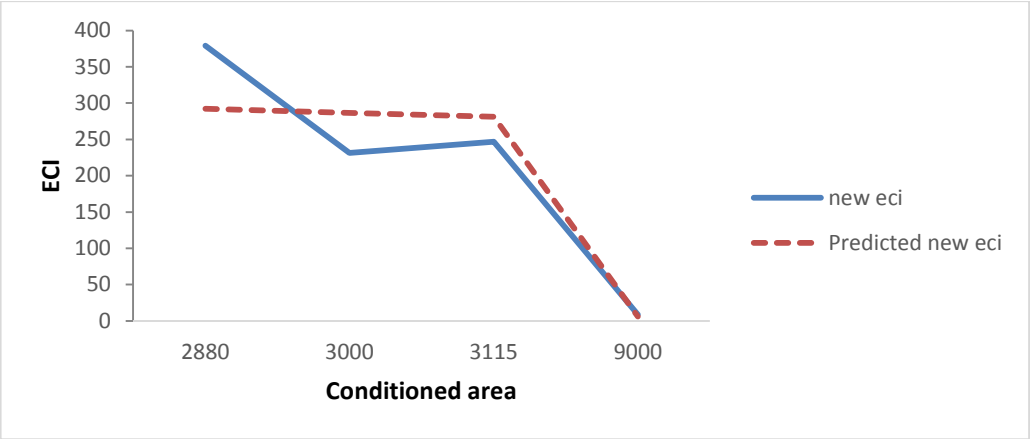


Figure 13: The relationship Predicted ECI VS Real measures.

After establishing the relationship between conditioned area and hospitals ECI, figure 14 present a graph that represent this relationship, the graph presents a linear shape, the equation is:

$y = -0.0467x + 426.66$

The percentage of R^2 was 83.3%. Thus, can predict the future ECI based on the conditioned area or based regression equation because R^2 Values are close together.

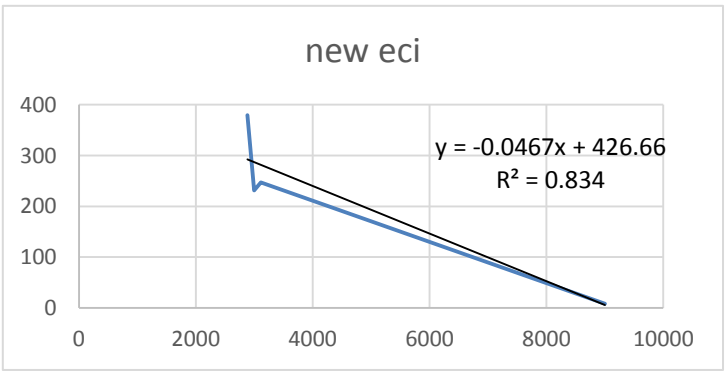


Figure 14: New ECI and energy in Hospitals

Regression for Energy vs. conditioned area

Regression analysis was done between energy level and conditioned area; did find that conditioned area affects energy using a regression equation and find the regression equation. R^2 equals 0.75 and adjusted R square equals 0.36. (Table 35)

Table 35: Regression Statistics

Regression Statistics			
Multiple R		0.868627	
R Square		0.754513	
Adjusted R Square		0.63177	
Standard Error		1609898	
Observations		4	
ANOVA			
	MS	*F*	*Significance F*
Regression	1.59318E+13	6.14707808	0.131372798
Residual	2.59177E+12		
Total			

The sample size here is 4, a small sample size will give us huge variability in data and large margin of error because of that regression equation is week but R^2 is high= 63%so the model fits the data. The higher the R^2 value, the better the model fits the data. The p value (.13) was higher than .05 which indicates that conditioned area does not affect energy (Tables 35 and 37).

Table 37 shows the residual error. Energy = 2703121+767.55*conditioned area

Table 36: Standard error

	Coefficients	*Standard Error*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	2703121	1608610.816	0.23489455	-4218172.75	9624415
conditioned area	767.5528	309.5806998	0.1313728	-564.465474	2099.571

Table 37: RESIDUAL OUTPUT

Observation	*Predicted energy*	*Residuals*	*Standard Residuals*
1	5094047.837	-596263.8375	-0.453613373
2	9611095.88	47494.44348	0.036131849
3	5005779.269	-1254533.269	-0.954398091
4	4913672.937	1803302.663	1.371879616

Figure 15 represents the relationship between predicted energy and actual energy; it is noticeable that the two lines almost match with slight differences, which indicates that the nature of hospitals in the city is the same in terms of consumptions. The high error indicates that the sample does not take energy indicators in consideration.

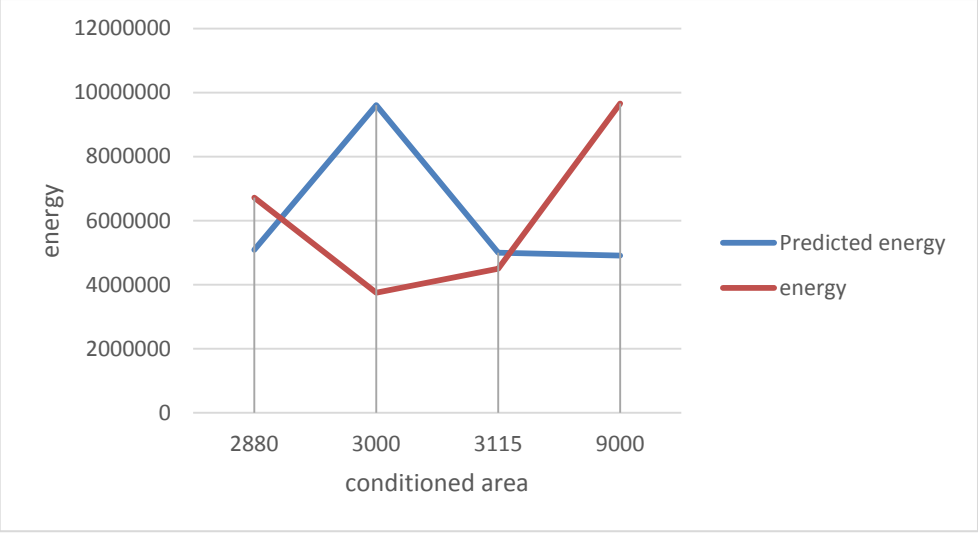


Figure 15: Predicted Energy kj VS Real measures kj.

EUI for restaurants &hotels

One-Sample T test: new EUI

Confidence interval for restaurants and hotels EUI mean value was calculated using t-test; the test assumes unknown variance and data normal distribution. As presented in table (38), the average EUI value equals to 1053kJ/m^2, with a 95% confidence interval varies between 366 to 1740 kJ/m^2.

Table 38: Descriptive statistics for Restaurants and Hotels EUI

Variable	N	Mean	SD	95%CI
condition EUI	12	1053	1082	(366,1740)

Tolerance Interval: new EUI

As shown in the normal probability plot (Figure 16), all values are confined between the highest and lowest value by a 95% ratio. (Table 39)

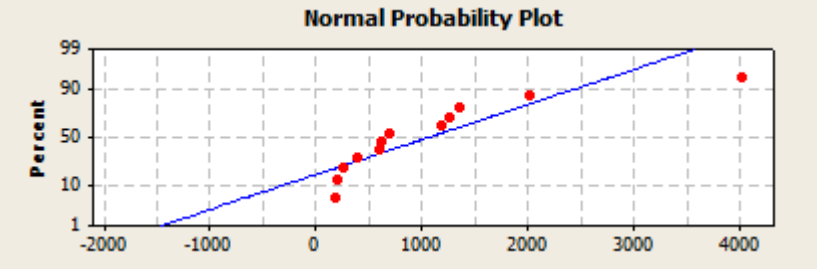


Figure 16: Normal Probability plot for Restaurants and Hotels EUI.

Here as shown in (figure 16) Upper tolerance interval and lower tolerance interval so far between each other, which is related to the differences in the nature of work for each establishment, more specific, detailed and precise

classification are needed for future study. That's why the data shown in the graph was nonparametric

Table 39: Probability Restaurants and Hotels EUI

N	Mean	SD	Lower	Upper
12	1052.95	1081.58	171.8	4000

Regression Restaurants and Hotels EUI VS conditioned area

Assuming a linear relationship, the results were (r^2=.079, p=.19) which is higher than .05 (Table 40). The regression equation was Y= 1486.7-.322X

Table 40: Regression

Regression Statistics	
Multiple R	0.404369
R Square	0.163514
Adjusted R Square	0.079865
Standard Error	1037.495
Observations	12

Table 41: ANOVA EUI for Restaurants and Hotels

ANOVA				
	SS	*MS*	*F*	*Significance F*
Regression	2104110	2104110	1.954773	0.192309
Residual	10763961	1076396		
Total	12868070			

Table 42: Standard error

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	1486.796	431.2617	3.44755	0.006252	525.8853	2447.707
conditioned area	-0.32245	0.230628	-1.39813	0.192309	-0.83632	0.191423

We drew a graph (Figure 17) representing the relationship between the actual and the predicted EUI. The results were shown in table (43), noticed that high percentage of error, the results were much different than the actual values.

Table 43: Predicted EUI VS Real measures

Observation	*Predicted new eui kj/m*^{2}	*Residuals*	*Standard Residuals*	new eui kj/m^2
1	1454.315	2545.685	2.573445	4000
2	472.0167	111.3166	0.11253	583.3333
3	1454.103	545.8965	0.551849	2000
4	28.40082	353.0277	0.356877	381.4286
5	897.056	352.944	0.356793	1250
6	1386.356	-219.689	-0.22208	1166.667
7	1148.225	188.1764	0.190228	1336.401
8	922.5108	-668.838	-0.67613	253.6731
9	1355.237	-1161.83	-1.17449	193.4118
10	922.5108	-236.797	-0.23938	685.7143
11	1349.755	-1177.96	-1.1908	171.8
12	1244.96	-631.942	-0.63883	613.0176

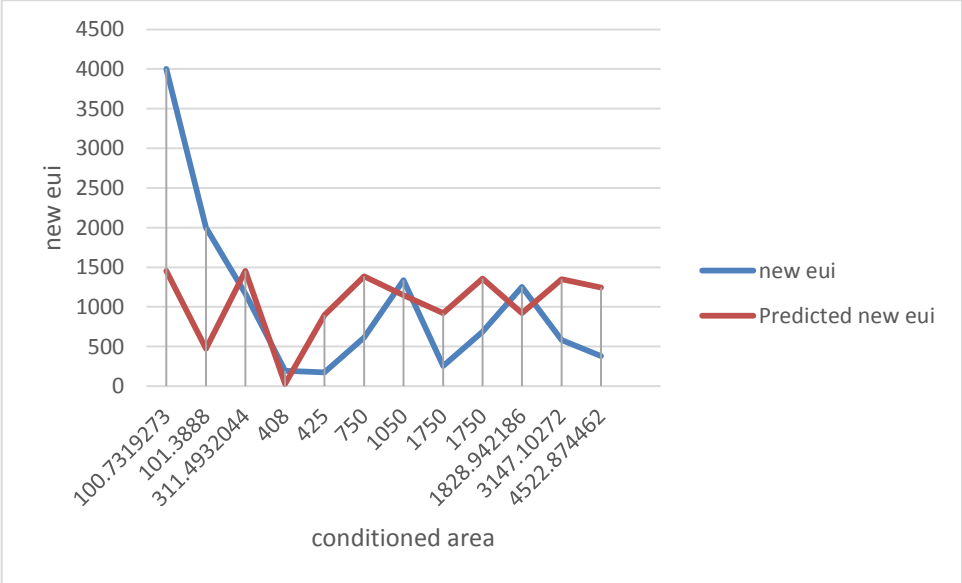


Figure 17: Predicted EUI kj/m^2 VS Real measures kj/m^2

After establishing the relationship between conditioned area and EUI, figure 18 present a graph that represent this relationship, the graph presents a linear shape, the equation is:

Y=-0.3224x + 1486.8 The percentage of R^2 was 16.35%. Thus, we cannot predict the future EUI based on the conditioned area.

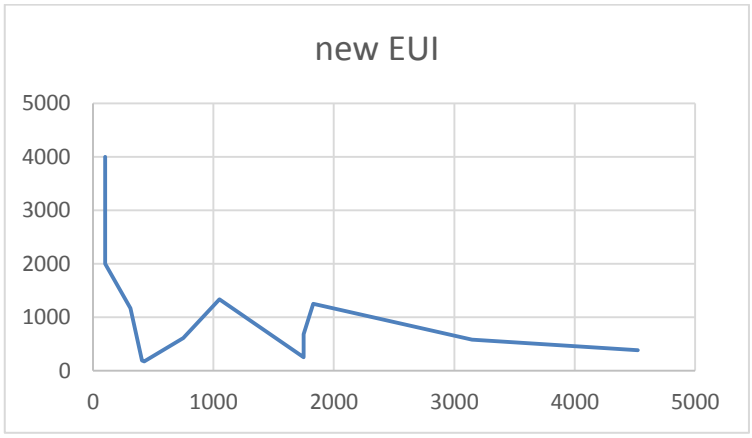


Figure 18: New EUI and Energy

Sample size here was 14, 12 answered the questioner. After analysing the data, noticed that confidence interval is good and regression equation is not good for to predict in the future trend of EUI and energy consuming in hotel and restaurants. Also, R^2 here 16.35%. Also, type of the hotel and restaurant play a role in energy consuming and other building follow the main play a role.

ECI for RESTURANTCE &HOTEL

One-Sample T: new ECI

Confidence interval for restaurants and hotels ECI mean value was calculated using t-test; the test assumes unknown variance and data normal distribution. Results are presented in table (44). It is shown that the average ECI value equals to 232 kJ/m^2, with a 95% confidence interval varies between 67.1 to 397.2 kJ/m^2.

Table 44: Descriptive Statistics for Restaurants and Hotels ECI

Variable	N	Mean	SD	SE Mean	95% CI
ECI new	12	232.2	259.7	75.0	(67.1,397.2)

Tolerance Interval: New ECI

As shown in the normal probability plot (Figure 19), all values are confined between the highest and lowest value by a 95% ratio. (Table 45)

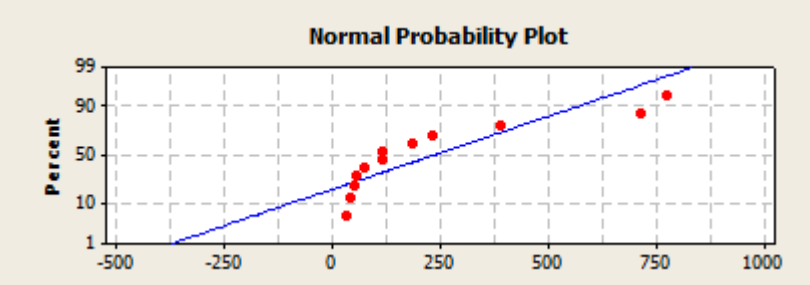


Figure 19: Normal probability plot for Restaurants and Hotels

Also here the data shown in the graph was nonparametric in (Figure 19) Upper tolerance interval and lower tolerance interval so far between each other, which is related to the differences in the nature of work for each

establishment, more specific, detailed and precise classification are needed for future study.

Table 45: Probability for Restaurants and Hotels

N	Mean	SD	Lower	Upper
12	232.169	295.744	34.28	774.44

Regression ECI for RESTURANTCE &HOTEL vs conditioned Area

Table 46 shows the regression statistics (r^2=.09)

Table 46: Regression Statistics

Multiple R	0.301399
R Square	0.090841
Adjusted R Square	-7.5E-05
Standard Error	214.9157
Observations	12

One-way ANOVA: new ECI versus condition area

By used ANOVA test to prove the effect of condition area which is the size multiplied by occupancy rate, p value was more than .05, which indicate no significant effect on energy consumption as shown in table (47-48)

Table 47: ANOVAECI for Restaurants and Hotels

	SS	*MS*	*F*	*Significance F*
Regression	46150.84	46150.84	0.999179	0.341082
Residual	461887.6	46188.76		
Total	508038.4			

Table 48: Standard error

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	247.0798	89.33528	2.765759	0.019932	48.02842	446.1312
conditioned area	-0.04775	0.047774	-0.99959	0.341082	-0.1542	0.058693

Table 49: RESIDUAL OUTPUT

Observation	*Predicted new eci*	*Residuals*	*Standard Residuals*	new eci
1	242.2694	-4.89986	-0.02391	237.3695
2	96.79079	-20.6533	-0.10079	76.13746
3	242.238	147.7275	0.720924	389.9655
4	31.09118	24.05178	0.117375	55.14296
5	159.7392	-85.9824	-0.4196	73.75675
6	232.2045	0.172913	0.000844	232.3775
7	196.9374	577.507	2.818288	774.4443
8	163.509	-112.272	-0.5479	51.23714
9	227.5959	-194.017	-0.94682	33.57843
10	163.509	-45.6519	-0.22279	117.8571
11	226.7841	-192.504	-0.93944	34.28
12	211.2638	-93.4782	-0.45618	117.7856

Figure 20 represent the relationship between actual and predicted ECI

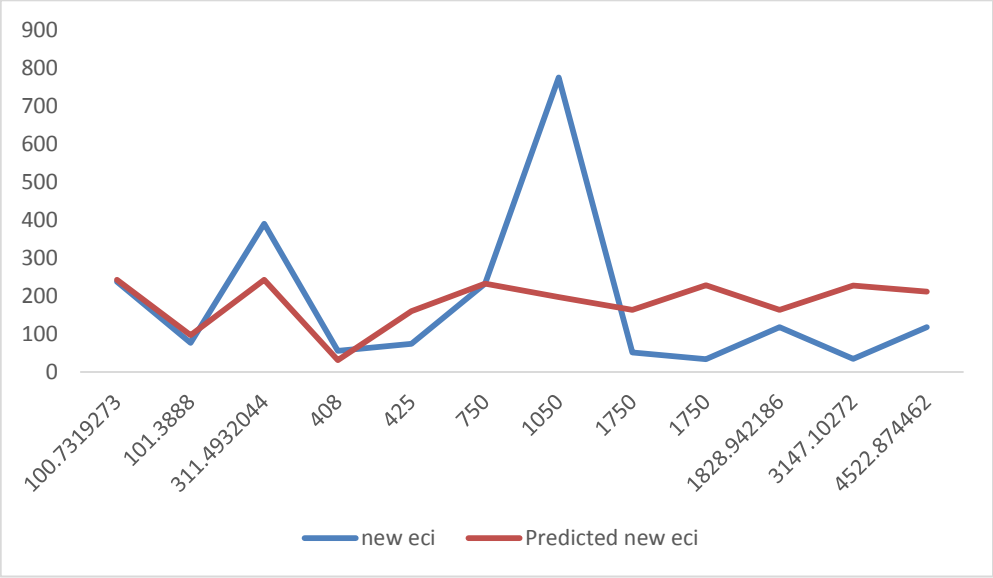


Figure 20: Predicted ECI nis/ m^2 VS Real measures nis/ m^2

After establishing the relationship between conditioned area and EUI, figure 21 present a graph that represent this relationship, the graph presents a polynomial shape

The percentage of R^2 was 9%. Which indicate that the equation could not be used, and the results can't be adopted. This might be related to the other underestimated factors, like wedding halls in Hotels, meeting rooms, swimming pools and number of rooms. Thus, can predict the future ECI based on the conditioned area.

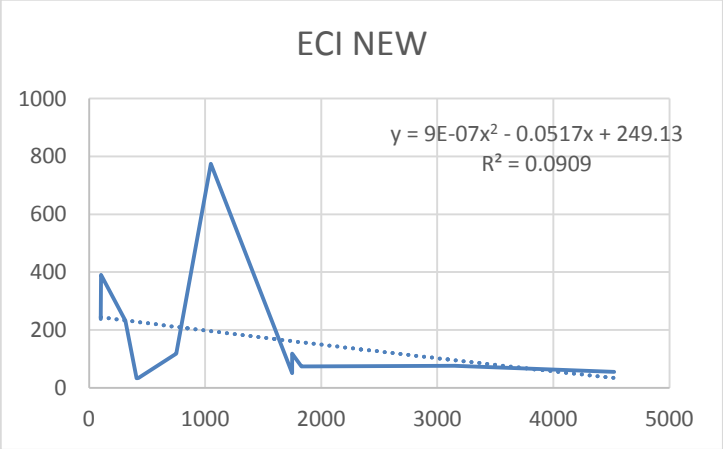


Figure 21: New ECI nis/ m^2 and conditioned area m^2

We considered energy a main factor affecting both energy indicators, that's why considered a linear relationship and can apply regression statistics in order to get a relationship between energy and conditioned area.

Regression for Energy V.S Conditioned Area

Regression analysis was done between energy level and conditioned area; find that conditioned area affect energy using a regression equation and by calculating the standard error. R^2 equals 0.55 and adjusted R^2 equals 0.50 (Table 50-52)

P value .005 is smaller than .05 and equation for regression is Y=301136.6825+424.9754109X

Table 50: Regression statistics

Regression Statistics	
Multiple R	0.744520852
R Square	0.554311299
Adjusted R Square	0.509742429
Standard Error	542095.9833
Observations	12

Table 51: ANOVA Energy for Restaurants and Hotels

	SS	*MS*	*F*	*Significance F*
Regression	3.65E+12	3.65489E+12	12.43719	0.005477
Residual	2.94E+12	2.93868E+11		
Total	6.59E+12			

Table 52: Standard error

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	301136.6825	225336.2	1.336388246	0.211033	-200944	803217.1
conditioned area	424.9754109	120.5044	3.52663939	0.005477	156.475	693.4758

Y=424.9x+301136

The data were represented in Table (53) and figure (22). It's noticeable that the standard residual decreases and the data are proximal which proves our theory that conditioned area is a predictor for energy.

Table 53: RESIDUAL OUTPUT

Observation	*Predicted energy kj*	*Residuals*	*Standard Residuals kj*
1	343945.2747	58982.43	0.114115029
2	1638577.954	197232	0.381590415
3	344224.4295	-141447	-0.27366129
4	2223247.115	-498094	-0.9636761
5	1078392.139	1207786	2.336737876
6	433513.635	-70104.9	-0.13563398
7	747360.8639	655860.5	1.26891242
8	1044843.652	-600916	-1.16260897
9	474526.6502	-395615	-0.76540716
10	1044843.652	155156.3	0.300185495
11	481751.2321	-408736	-0.79079386
12	619868.2407	-160105	-0.30975987

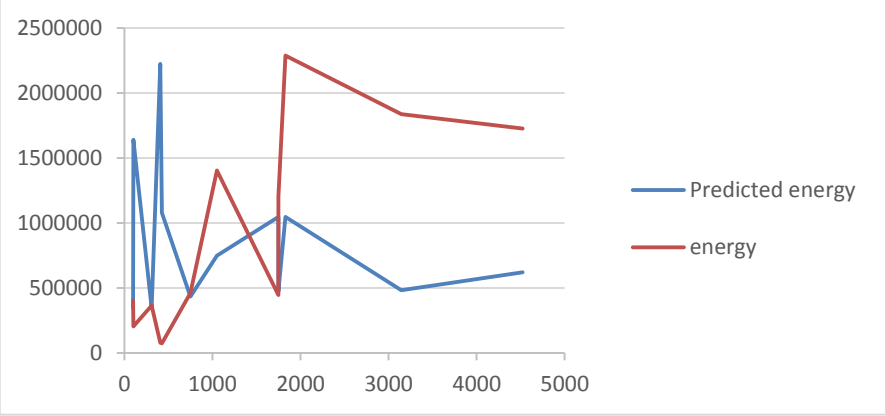


Figure 22: The relationship between: Predicted Energy kj VS Real measures kj

For schools

One-Sample T: new EUI

Confidence interval for schools EUI mean value was calculated using t-test; the test assumes unknown variance and data normal distribution. Results are presented in table (54). It's shown that the average EUI value equals 19.03 with a 95% confidence interval varies between 15.49 to 22.56 kJ/m^2

Table 54: Descriptive statistics for Schools EUI

Variable	N	Mean	SD	95%CI
New EUI	21	19.03	7.76	(15.49,22.56)

Tolerance Interval: new EUI

As shown in the normal probability plot (Figure 23), all values are confined between the highest and lowest value by a 95% ratio. (Table 55)

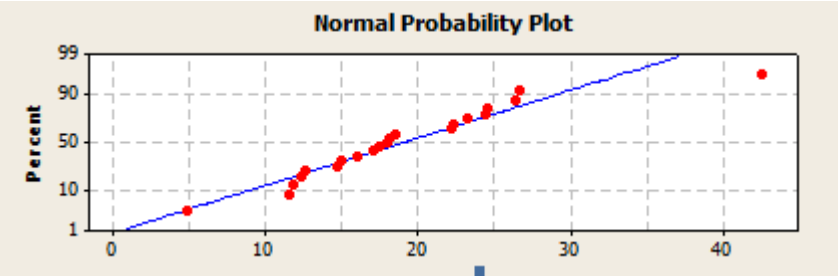


Figure 23: Normal Probability Plot for Schools EUI

Table 55: Probability for Schools EUI

N	Mean	SD	Lower	Upper
21	19.02	7.76	4.83	42.44

Regression for EUI V.S Conditioned Area for school

Assumed a linear relationship between conditioned area and EUI, using regression R^2=.19 which is very low, p=.04 which is less than .05 which indicates that conditioned area affect EUI for schools (Table 56-58)

Table 56: Regression Statistics

Multiple R	0.44569
R Square	0.19864
Adjusted R Square	0.156463
Standard Error	7.131166
Observations	21

Table 57: ANOVA EUI For School

ANOVA				
	SS	*MS*	*F*	*Significance F*
Regression	239.5039	239.5039	4.709682	0.042877
Residual	966.2169	50.85352		
Total	1205.721			

Table 58: Standard Error

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	24.39791	2.923853	8.344438	8.91E-08	18.27822	30.5176
conditioned area	-0.00238	0.001096	-2.17018	0.042877	-0.00467	-8.5E-05

The regression equation is *Y= 24.3 - .00238X*

after applying the regression equation, drew the relationship between actual EUI and predicted EUI in order to examine the residual output. (Table 59) (Figure 24). see through the graph that there is a slight variation between data which indicates that the regression equation and the results could predict EUI. However, R^2 is low, which means that the data does not fit the graph

Table 59: RESIDUAL OUTPUT

Observation	*Predicted new eui* *kj*/m^2	*Residuals*	*Standard Residuals*	new eui kj/m^2
1	20.70656	1.530351	0.220175	22.23691
2	17.4458	0.576154	0.082893	18.02196
3	17.1757	-5.57313	-0.80182	11.60257
4	17.58894	0.531115	0.076413	18.12005
5	16.27574	-3.96275	-0.57013	12.313
6	18.57734	-2.6293	-0.37828	15.94804
7	11.37237	0.39314	0.056562	11.76551
8	11.14827	13.18013	1.896257	24.3284
9	18.23971	-5.65639	-0.8138	12.58332
10	17.90684	-3.26552	-0.46982	14.64132
11	19.54744	6.839622	0.984033	26.38706
12	22.85242	3.743277	0.538554	26.59569
13	22.50052	19.94008	2.868829	42.4406
14	22.56709	-0.44969	-0.0647	22.1174
15	21.88636	1.326361	0.190827	23.21272
16	21.67308	-6.76209	-0.97288	14.91099
17	15.4816	-10.6499	-1.53223	4.83168
18	21.06915	-4.06172	-0.58437	17.00743
19	23.20847	-5.74521	-0.82658	17.46327
20	20.73628	3.797488	0.546354	24.53377
21	21.58571	-3.102	-0.44629	18.4837

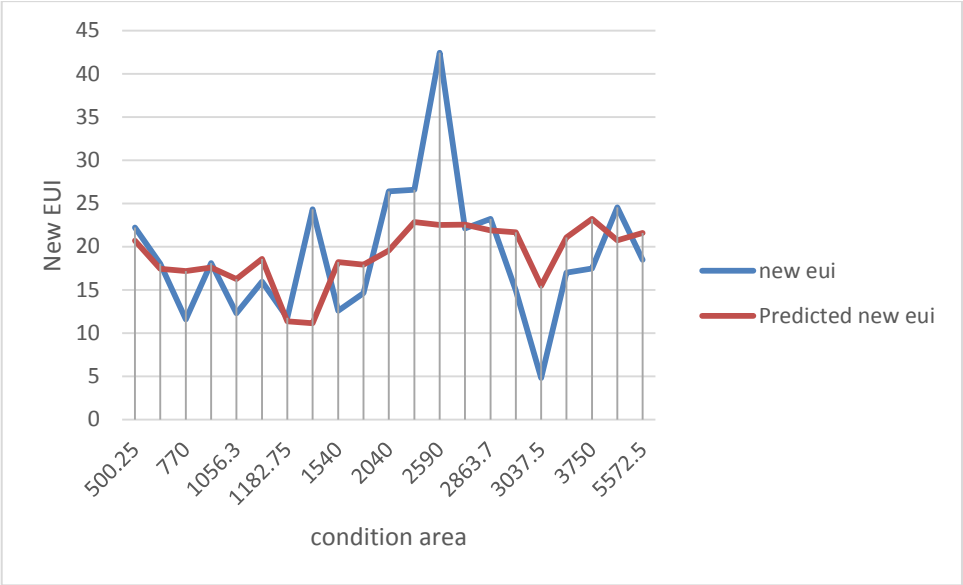


Figure 24: Predicted EUI VS Real measures

After establishing the relationship between conditioned area and EUI, figure 25shows a graph that represent this relationship, the graph presents a polynomial shape, the equation is:

$y = 0.0079x^2 - 0.8327x + 26.936$ The percentage of R^2 was 27%. Thus, we cannot predict the future EUI based on the conditioned area.

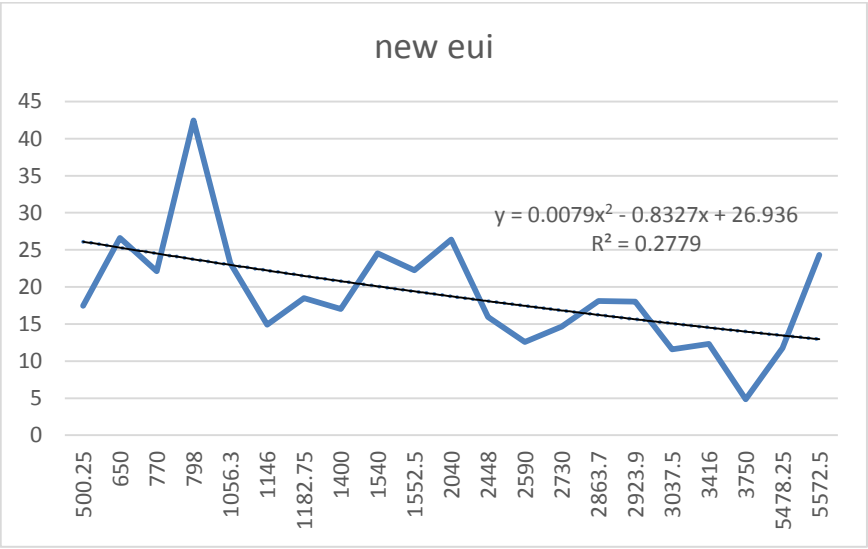


Figure 25: New EUI kj/ m^2 and conditioned area m^2

We could not identify trending for the data, thus, cannot consider the graph binomial. Also, r was very low (27%) which means we cannot use it as a predictor

The school's data were proximal to each other; all schools were applying energy saving systems for light, in which they all used led light, also, there is high percentage of green areas in schools. noticed variation in energy between high schools and other schools which might be related to using laboratory which in turn consume gas. The number of students and teachers was constant in all schools which is a percentage adopted by the ministry of education, this proves that conditioned area, which is the only variable her, could be considered a major influential on EUI in schools.

ECI for School

One-Sample T: New ECI

Confidence interval for schools ECI mean value was calculated using t-test; the test assumes unknown variance and data normal distribution. Results are presented in table (60). It is shown that the average ECI value equals to 3.25 kJ/m^2, with a 95% confidence interval varies between 2.63 to 3.88 kJ/m^2.

Table 60: Descriptive Statistics for Schools ECI nis/ m^2

Variable	N	Mean	SD	SE Mean	95% CI
New ECI	21	3.25	1.37	0.299	(2.63, 3.88)

Tolerance Interval: new ECI

As shown in the normal probability plot (Figure 26), all values are confined between the highest and lowest value by a 95% ratio. (Table 61)

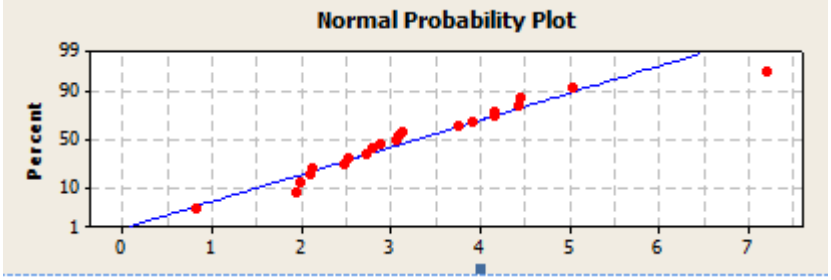


Figure 26: Normal probability plot for Schools ECI

Table 61: Probability for Schools ECI

N	Mean	SD	Lower	Upper
21	3.257	1.371	0.808	7.185

Assuming a linear relationship and tried to apply regression but values were very low. So, could not find a relationship between conditioned area and ECI (r^2=.06, p=.27). (Table 62-64)

The regression equation was, y=3.15-.00026x

Table 62: Regression

Regression Statistics	
Multiple R	0.25118
R Square	0.063091
Adjusted R Square	0.01378
Standard Error	1.489454
Observations	21

Table 63: ANOVA ECI for School

ANOVA				
	SS	*MS*	*F*	*Significance F*
Regression	2.83844	2.83844	1.2794	0.2720
Residual	42.150	2.2184		
Total	44.989			

Table 64: Standard Error

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	3.151351	0.610692	5.160299	5.56E-05	1.873159	4.429543
conditioned area	-0.00026	0.000229	-1.13113	0.272076	-0.00074	0.00022

Using the regression equation, we drew the actual and the predicted value for ECI (Table 65) (Figure 27)

Table 65: Predicted ECI VS Real measures

Observation	*Predicted new eci nis/*m^2	*Residuals*	*Standard Residuals*	new eci nis/m^2
1	2.749496	-2.02889	-1.39756	0.720608
2	2.394518	0.648684	0.446832	3.043203
3	2.365114	-0.44025	-0.30326	1.924863
4	2.410101	0.657714	0.453052	3.067814
5	2.267141	-2.07318	-1.42807	0.19396
6	2.517702	0.185627	0.127865	2.703329
7	1.733341	0.239167	0.164745	1.972508
8	1.708945	2.421402	1.667931	4.130347
9	2.480946	-2.25393	-1.55257	0.227021
10	2.444708	0.027633	0.019034	2.472341
11	2.62331	1.795788	1.23699	4.419098
12	2.983103	1.459374	1.005259	4.442477
13	2.944794	-0.42375	-0.29189	2.521048
14	2.952042	2.062595	1.420774	5.014636
15	2.877935	1.023788	0.705215	3.901723
16	2.854716	-0.34863	-0.24014	2.506091
17	2.180688	-2.11605	-1.4576	0.064638
18	2.78897	0.066087	0.045523	2.855057
19	3.021865	-0.23934	-0.16486	2.782529
20	2.752732	1.390813	0.958032	4.143545
21	2.845204	-2.05467	-1.41531	0.790535

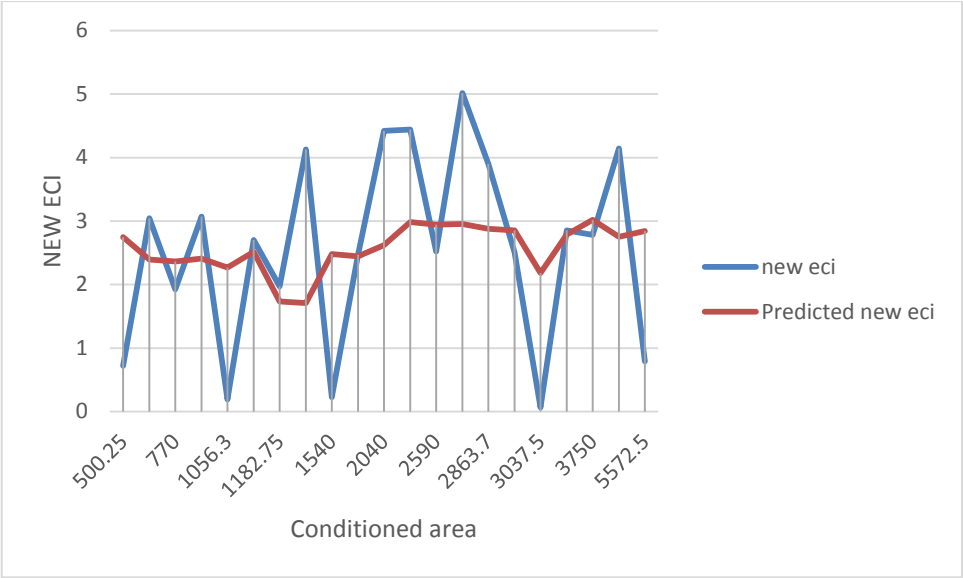


Figure 27: Predicted ECI nis/m^2 VS Real measures

The percentage of error was high, with high variation between data, which means that can't assume a linear relationship.

After establishing the relationship between conditioned area and ECI, figure 28 present a graph that represent this relationship, the graph presents a pronominal shape, the equation is:

$Y= -3E-07x^2 + 0.0005x + 3.0456$The percentage of R^2 was 29.4%. Thus, cannot predict the future ECI based on the conditioned area only.

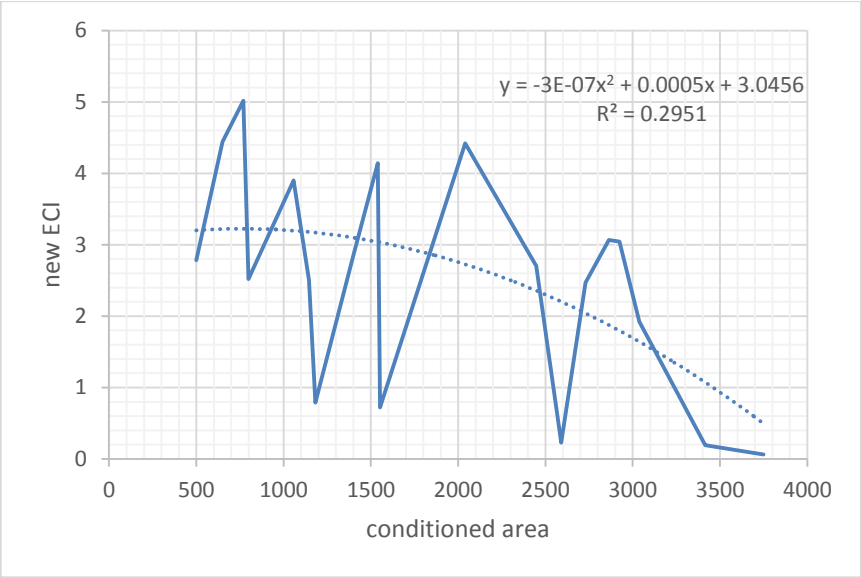


Figure 28: New ECI nis/m^2 and conditioned aream^2

To find a relationship between conditioned area and energy assume a linear relationship in order to perform regression statistics

Regression for Energy V.S Conditioned Area for school

Regression analysis was done between energy level and conditioned area; find that conditioned area affect energy using a regression equation and by calculating the standard error. R^2 equals 0.3 and adjusted R square equals 0.27 (Table 66-69)

P value .008 is smaller than .05 and equation for regression is Equation is:*Y=205.65+.0595X*

Table 66: Regression statistics

Regression Statistics	
Multiple R	0.555932
R Square	0.309061
Adjusted R Square	0.272695
Standard Error	133.187
Observations	21

Table 67: ANOVA Energy for School

ANOVA				
	SS	*MS*	*F*	*Significance F*
Regression	150758.3	150758.3	8.498797	0.008875649
Residual	337036.8	17738.78		
Total	487795.1			

Table 68: Standard Error

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	205.6517	54.60808	3.765958	0.001308	91.35569083	319.9477
conditioned area	0.059654	0.020463	2.91527	0.008876	0.016825231	0.102482

Equation is: $Y=205.65+.0595X$

Table 69: RESIDUAL OUTPUT

Observation	*Predicted energy kj*	*Residuals*	*Standard Residuals*	REAL energy kj
1	298.2643	122.7357	0.945469	421
2	380.0735	-39.0735	-0.30099	341
3	386.8502	48.14982	0.370912	435
4	376.4823	281.5177	2.168612	658
5	409.4291	148.5709	1.144485	558
6	351.6843	-24.6843	-0.19015	327
7	532.4502	-23.4502	-0.18064	509
8	538.0726	-10.0726	-0.07759	528
9	360.1551	18.84491	0.145168	379
10	368.5066	-130.507	-1.00533	238
11	327.3455	63.6545	0.490349	391
12	244.4267	-174.427	-1.34366	70

13	253.2555	208.7445	1.60802	462
14	251.5851	-115.585	-0.89039	136
15	268.664	16.33596	0.125841	285
16	274.015	-124.015	-0.95532	150
17	429.3535	-267.354	-2.0595	162
18	289.1671	117.8329	0.907701	407
19	235.4935	-58.4935	-0.45059	177
20	297.5186	-46.5186	-0.35835	251
21	276.2073	-12.2073	-0.09404	264

Figure 29, shows that actual and predicted data almost match which means that conditioned area is an influence on energy which in turns affects both energy indicators. There are some variations which may be related to the nature of the school and other factors.

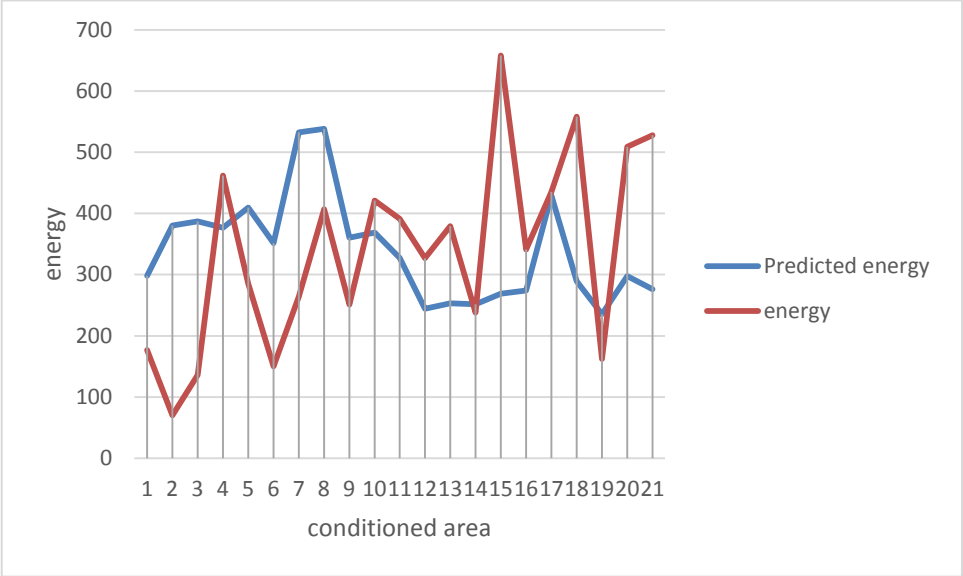


Figure 29: The relationship between Predicted Energy kj VS Real measures kj

Chapter Five
Conclusion and Recommendations

The main aim of this study is to develop energy indicator for non-industrial buildings energy consumption in Nablus city,

5.1 Conclusions

first, EUI and ECI indicators were calculated. Results are presented before and revealed that:

There is a big variability in calculating EUI and ECI, the variance was related to the nature of the building, its occupancy rate, location, inside environment thermal comfort equipment, and number of occupants.

Statistical analysis was performed to understand if there is a significant relationship between conditioned area and annual energy consumption. It was found that there is a significant relationship in restaurants and hotel where P-value was equal to .005, for School the p – value was .008 and for company was .0005

Simple linear regression to estimate EUI and ECI by considering conditioned area as an independent variable and EUI and ECI as dependent variable. However, R^2 values indicated poor performance of the model. The main reason for that is the other hidden independent variables which are not considered in the linear model.

Surveying results show that there is a large diversity between buildings, even if it is categorized in the same cluster. As an example, hospitals energy consumption is close to each other, but, since conditioned area is different. Large differences calculated EUI and ECI were obtained. The main reason for that is hospitals with relatively small conditioned area might have a larger occupancy rate on every working shift, which resulted high energy demand and so larger EUI and ECI.

Surveys revealed that buildings owners, managers, and/or financial representatives suffer from lack of data and awareness related to energy consumption. Most of the energy bills are missing or at least not will document.

With respect to energy conservation and losses reduction. Surveys revealed that buildings owners and managers have very limited knowledge regarding their electrical and mechanical systems performance (efficiency and working conditions). Thus, they were not able to provide reliable data in this context.

Generally, all institutions suffer from lack of suitable documentation, especially the one related to energy consumption and losses.

5.2 Limitations

Researcher may face a difficulties' in gathering data and information. The main limitations in this study were:

1. Some of the non-industrial facilities did not answer the questionnaire, some refused to provide us with information and some of the facilities did not complete the questionnaire

2. Our statistics were based on the 2009 Palestinian Central Bureau of Statistics, which might be missing or outdated

3. There was a big variably in the price of fuels which led to a big individual differences

4. Low awareness in energy consumption

5. The statistics data that was adopted in this study is relatively old, but it was used in calculating sample size thus the sample size will change if the number of facilities increased or decreased

6. The results could not be generalized to the general population. This could be related to the variance between facilities in terms of nature of work, different policies, improper documentation, and lack of coordination with the governmental authority which made it harder to get the necessary information despite obtaining the permission from the authority.

5.3 Recommendations

In light of the results of this research, the researcher recommends the following:

1. Other studies regarding energy indicators should be done taking in consideration more variables. (e.g working condition of buildings)
2. Generalizability is recommended for each category, not for all four categories as in this study
3. data of each facility should be stored for a year prior to the study in order to provide better result with less variability
4. Despite the fact that results could not be generalized, the facilities should still focus on calculating energy indicators (EUI, ECI) in order to compare itself with other facilities
5. Increase owner's awareness regarding energy saving and the importance of following up with energy consumption rather it rising or declining, the purpose of this study was to provide indicators regarding energy status in order to save money, effort and time.
6. some challenges were faced because of the outdated data; the last time data was collected by Chamber of Commerce was in 2009. In fact, in 2018 a new data was collected which could change some of the results and might explain other results. So, new research is recommended in order to provide an up to date data

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- U.S. Department of Energy Commercial Building Partnerships – **information on partnering with DOE representatives, national laboratory staff, and private-sector technical experts to explore energy-saving ideas and strategies in retrofit and new construction projects**

http://www1.eere.energy.gov/buildings/commercial_initiative/building_partnerships.html

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Appendices

Appendix I: Cover page

AL Najah National University

Faculty of Graduate Studies

Engineering Management Program

Dear Mr/Mrs

Please fill in the attached questionnaire which was developed to study indicators of energy performance in nonindustrial buildings in the city of Nablus. The data will be confidential and would be only used for scientific research purposes.

Eng. Razan Assaf

Researcher/ Master Degree

Master Program/ engineering management

Developing Energy Performance Indicators for Non-Industrial Buildings

Appendix II: Questionnaire

First section: general information

1. Name of the establishment: ----------
2. Type of establishment: private public governmental
3. Contact person: ----------
4. Telephone Number: ----------
5. Email----------
6. Classification of the establishment:

✓ Hospitals Schools Banks Malls restaurants Hotels client services centers companies Universities other

7. Please choose the type of energy used and fields of energy used:

a. Electricity

b. Gas

c. Diesel

d. Others

8. Fields of energy use ----------
9. Please fill in the following table with the last 2 years of energy consumption:

<u>In case of providing copies of bills regarding energy use (Electricity, diesel, gas) please fill in the table below</u>

Consumption	**Electricity**		**Diesel**		**Gas**		**Notes**
Month	Amount kWh	Price Nis/kWh	Amount (L)	Price Nis/L	Amount m3	Price Nis/m3	
January							
February							
March							
April							
May							
June							
July							
August							
September							
October							
November							
December							
Second year							
January							
February							
March							
April							
May							
June							
July							
August							
September							
October							
November							
December							

In the absence of detailed information (each month) regarding energy use for the last two years, please provide estimation for that month (months), with referring to that month ----------

Second section: physical characteristics of the establishments

1. Size of the establishment (m^2)----------
2. Age of the establishment in years ----------
3. Number of workers currently working in the establishment ----------
4. Number of glass layers used in windows----------
5. Windows and outdoors are tightly closed: Very good good
   I don't know Accepted
6. Equipment existing inside the establishments:

a. Office electronic devices (computer / printer)

b. Heating system

c. Air conditioning system

d. Fridges

e. Others

7. Number of daily and annual working hours for the equipment using different type of energy:

Classification	**Number of daily working hours**	**Number of annual of working hours**

8. Do you think that the establishment takes energy saving protocols into consideration? ---------- And why ----------
9. Has an energy audit been performed within the facility? Yes NO

If yes please mention the year ----------

10. Is there any system for energy saving (like electronic control sensors for lighting)

Yes no if yes mention it ----------

Third section: Operational characteristics of the facility

1. Is the facility operating all year round yes No
2. if no please specify the time period ----------
3. How many daily work shifts and how long is eachshift ----------
4. Number of workers in first shifts ----------
5. Please fill in the following table of the occupancy rate of the establishment during the month and approximate annual occupancy of the facility

Monthly occupancy rate	**Jan**	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
First year												
Second year												

6. What are the energy consumption problems you face in your organization----------

Note: If the occupancy rate is not specified and the data is not specified, please enter the approximate annual rate and point to it with a star.

Signature ----------

Classification of the facility ----------

Name of the facility ----------

Date ----------

Thanks for your cooperation

Appendix III

Questions from the interviews for each category

Schools

1. How many students are in this school?
2. How many teachers are in this school?
3. How many laboratories in this school?

Hotels

1. How many rooms?
2. Is there any halls?
3. How many sweets?
4. Is it this hotel for sleeping only or are there any other tourist additions?
5. Is there a restaurant?

Restaurants

1. Dose it open 24 hour?
2. Do you have delivery?
3. Does it have a separate kitchen and store?

Companies

1. Is there other branches?
2. Do the company bills include accessories?
3. Is there any stores?

جامعة النجاح الوطنية

كلية الدراسات العليا

تطوير مؤشرات اداء الطاقة للمباني الغير صناعية في مدينة نابلس

إعداد

رزان عساف

إشراف

د. محمد السيد

قدمت هذه الاطروحة استكمالاً لمتطلبات الحصول على درجة الماجستير في الإدارة الهندسية، بكلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس– فلسطين.

2019

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الملخص

تشير الادلة العلمية الى مدى خطورة فقدان الطاقة ونظراً لأهمية الطاقة كان الاتجاه لترشيد استهلاك الطاقة والحفاظ عليها عالمياً، فقد بينت الدراسات مقدار الفقد وكبر الاستهلاك للطاقة في الجانب الفلسطيني ومن هنا جاءت هذه الدراسة لتقوم ببناء وتطوير مؤشرات أداء الطاقة ودراسة اهم العوامل المؤثرة عليها كحالة دراسة في مدينة نابلس وذلك لأنها تشكل العاصمة الاقتصادية للضفة الغربية، حيث قامت الباحثة بحساب مؤشرين عالمين هما ECi , EUI الاول هو معدل الاستهلاك السنوي للطاقة مقسوم على المساحة الكلية واما الثاني فهو معدل الدفع السنوي للمال على المساحة بعدها تم حساب المؤشرين ثم قامت الباحثة بدراسة عوامل تؤثر على المؤشران وركزت على المساحة ونسبة الاشغال وهو ما اطلقت عليه المساحة الفعلية وهو حاصل ضربهما معاً. كانت منهجية عمل الباحثة للحصول على البيانات اللازمة توزيع استبانة وعمل مقابلات مع العينة المختارة حيث كانت عينة الدراسة 78 منشأة موزعة على الفئات التي قمنا بدراستها وهي شركات ومستشفيات ومدارس وفنادق ومطاعم، وبعد عملية جمع البيانات قامت الباحثة بعملية التحليل الوصفي والكمي للبيانات وقد لاحظت كثرة المتغيرات المؤثرة على المؤشرين حيث من خلال التحليل الوصفي للاستبانة تبين ان هناك عوامل اخرى تؤثر على المؤشرات يمكن ايضا دراستها وتفصيلها بالمستقبل وهي لعبت دور في تغيير النتائج نذكر منها عمر المنشأة والمعدات المستخدمة واختلافها، لذلك قمنا بدراسة العوامل مع استهلاك الطاقة ومن هنا توصلنا لمدى تأثير المساحة الفعلية ومدى تأثيرها حيث كانت النتائج الاحصائية تبين وجود تأثير واضح حيث كانت p للفنادق هي .005 وللمدارس هي .008 وللشركات هي .0005 وهذا يدل على التأثير الواضح من المساحة الفعلية على الطاقة وهو ما سينعكس على المؤشرين ايضا وتوصي الباحثة بشكل

رئيسي اجراء هذه الدراسة بشكل مفصل على كل فئه لوحدها مع اخذ بعين الاعتبار دراسة كل العوامل ومدى تأثيرهم على مؤشرات الطاقة وكتوصيات ثانويه يجب تشجيع المؤسسات على تسجيل بيانات الطاقة والاهتمام بترشيد الاستهلاك ايضاً.