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## **Greening Existing Buildings in the United Arab Emirates**

تحويل المباني القائمة إلى مباني خضراء في دولة الإمارات  
العربية المتحدة

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## DISSERTATION RELEASE FORM

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## **ABSTRACT**

It is expected that in the next few decades, CO<sub>2</sub> production in the United Arab Emirates (UAE) will increase up to 138.4 million metric tonnes annually as a result of increasing the consumption of building resources, like energy and water (Radhi. 2009, p.2462). No matter how big or small buildings are, they still contribute to the accumulation of greenhouse gases (GHG) in the atmosphere as well as the consumption of resources. One of the challenges and misconceptions that slow down the spreading of “greening existing buildings” concept is that many, including building professionals, still believe that is it very costly to sustainably renovate buildings (Nelson. 2010).

The UAE has recently started to develop policies and guidelines to encourage the application of green building strategies for new contraction; however, little attention has been given to the existing buildings. That is why this paper focused its research on the concept of greening existing buildings in the UAE. It takes Dubai Chamber of Commerce and Industry’s headquarter building as a case study example of an existing building that turned green. It then explores the applicability of learning from Dubai Chamber’s experience in an aim to green other existing buildings in the UAE.

The research concludes that existing buildings in the UAE can easily be greened as well as save costs and sustain resources at the same. Although buildings are not alike in terms of the systems they use and the ways they operate, understanding what is available and how they function are important to identify improvement opportunities and achieve the their green building goals.

## الملخص

من المتوقع أنه في العقود القليلة القادمة سترتفع نسبة انبعاث غاز ثاني أكسيد الكربون في دولة الإمارات العربية المتحدة إلى 138.4 مليون طنًا كل عام؛ وذلك بسبب زيادة استهلاك المباني للطاقة والماء (Radhi.2009,p.2462). بغض النظر عن حجم تلك المباني القائمة، إلا أنها تسهم في تراكم الغازات الدفيئة المسببة لظاهرة الاحتباس الحراري بالإضافة إلى استهلاكها للمصادر. ومن أحد التحديات والمفاهيم الخاطئة التي تبطئ انتشار مفهوم "تحويل المباني القائمة إلى مباني خضراء" إعتقاد العديد من المهنيين والمتخصصين أن ترميم تلك المباني على نحو مستدام مكلفٌ جداً (Nelson.2010).

لقد بدأت دولة الإمارات العربية المتحدة في الآونة الأخيرة بوضع سياسات ومبادئ توجيهية لتشجيع تطبيق استراتيجية المباني الخضراء للمباني الجديدة، إلى جانب اهتمام بسيط جداً بالمباني القائمة. لذلك تركز ورقة البحث هذه على مفهوم تحويل المباني القائمة إلى مباني خضراء في دولة الإمارات العربية المتحدة، حيث تم اختيار مبنى غرفة تجارة وصناعة دبي كمثال لدراسة حالة مبنى قائم تم تحويله إلى مبنى أخضر مؤخراً والتعرف عن قرب على تجربتهم هذه. ومن ثمّ النظر إلى قابلية تطبيق تجربة غرفة تجارة وصناعة دبي على المباني القائمة في دولة الإمارات العربية المتحدة بهدف تحويلها إلى مباني خضراء.

ويلخص البحث بتأكيد إمكانية تحويل المباني القائمة في دولة الإمارات العربية المتحدة إلى مباني خضراء بسهولة، بالإضافة إلى توفيرها للتكاليف واستدامتها للمصادر. على الرغم من أن المباني لا تشبه بعضها من ناحية النظم المستخدمة والطرق التي تعمل بها، إلا أنه من الضروري معرفة ما هو متاح أمامنا وكيفية عمل النظم لتحديد فرص التحسين وتحقيق أهداف المباني الخضراء الخاصة بالمبنى.

## **DEDICATION**

This book is dedicated with boundless love and gratitude to my parents,  
Mona Sagudang and Mohammad Al Madani.

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# **1 CHAPTER ONE: INTRODUCTION**

## 1.1 The Need for Sustainably Renovating Existing Buildings

In the last few years, a lot of attention has been given to the economic, environmental and social aspects of the built environment in the UAE. Some organizations started using those terminologies as a marketing means to attract more investment opportunities. The fact of the matter is that having buildings built using low energy consuming technologies and low Volatile Organic Compound (VOC) emitting materials could have them function efficiently, and thus, reduce the consumption cost of different resources. Old buildings that were constructed using less environmentally friendly materials and technologies and were not operating efficiently still have a chance to become more environmentally sustainable.

Various components in a building could last for different time spans. For example, building materials and the building's external structure (i.e. *support systems*) could last for more than 50 years, bearing in mind that their internal systems (i.e. technical, electrical and mechanical systems) will encounter regular facility maintenance during that period. When comparing other building types, commercial/business buildings have one of the highest energy consumption rates. On average, energy consumption of buildings in a country could range from 20% to 40% (Juan et al. 2009, p.290) of their total energy consumption depending on the buildings' geographic location, core and shell materials, type of office equipment and the methods their HVAC and lighting systems are used. In the United States and European Union for instance, their buildings consume about 37% of the total energy consumption, and Hong Kong uses about 40% (Juan et al. 2009, p.290).

A lot of countries in the mid-1970s encountered energy crisis which led them to start looking for energy-saving strategies. Their studies resulted in having them create policies and regulations to reduce energy consumption and protect the environment by reducing carbon dioxide (CO<sub>2</sub>) emissions. Even recently, more studies are being conducted as a global response

towards global warming and environmental disasters. The Kyoto Protocol that has been signed by many countries around the world in 1997 to reduce greenhouse-gasses is one of the examples that testify that countries are realizing how much they contribute to damaging the environment (Cakmanus, 2005, p.1348). In spite the awareness, the trend of resource and energy consumption is still increasing due to the growth of global population and building developments for businesses (Juan et al. 2009, p.291). As a result, a lot of carbon emissions and greenhouse gasses (GHG) come from transportation emissions, electricity generation and most dominantly from building operation, based on the Intergovernmental Panel on Climate Change (Radhi. 2009, p.2451).

It was found that more than 40% of GHG produced in the world is caused by our existing buildings (Cook and Khare, 2009, p. 142). There have been a lot of regulations and requirements that impose the construction of more sustainable and/or zero energy buildings, however, less focus is given to the current existing buildings (Cook and Khare, 2009, p. 142). In spite of what is happening around the globe, the area of existing buildings has found various cost-effective renovation strategies that could be applied on buildings to enhance their sustainability effectiveness. In order to improve existing buildings, their current condition first needs to be assessed, and then a plan needs to be developed for the buildings' future upgrade (Juan et al. 2009, p.291).

As discussed earlier, building materials and their operational activities can play a big role towards impacting the environment. Such impacts can also be reflected on the occupant's health depending on the concentration of adverse emissions of buildings, like dust and CO<sub>2</sub>. At the same time, there might be some difficulties in measuring the various effects that might result from being exposed to such buildings, and the severity of each of the effects. Therefore, a specific value cannot be determined to assess the total environmental impact of a building, which is why a number of environmental guidelines could be developed to highlight the different

indicators that can influence buildings and its occupants (Harris, 1999, p.751). There are a lot of such guidelines that have been developed by many organizations in order to evaluate different types of buildings (i.e. new buildings, existing buildings, buildings under construction and building components) based on their environmental, economic and social aspects, as well as the different stages of their life cycle. Though each has a different set of requirements and specifications, they can still help to determine the environmental performance of buildings generally, and existing buildings, more specifically.

Before embarking on the subject of greening existing buildings in the United Arab Emirates (UAE), it is important to understand what the term “green building” means and how existing buildings can be greened. A green building can be defined as “*a structure that is designed, built, renovated, operated, or reused in an ecological and resource-efficient manner*”. Having such buildings can ideally increase the building occupants’ productivity; improve the efficiency of resource, water and energy consumption, cause less harm to the environment and ecosystem as well as enhance the overall quality of life. It can also increase profits and improve the economic performance since resources are being less wasted (Shapiro, 2009, p.258).

There have been a few building examples worldwide that implemented green initiatives to reduce their resource consumption and impact on the environment. For Instance when New Zealand realized the importance of improving building performance to reduce GHG emissions, they started to impose policies and regulations to tackle this issue, including improving their building code. Unfortunately, such an approach gave a lot of focus on improving new buildings although there is many opportunity to reduce GHG emissions in existing buildings. The government believed that reducing GHG emissions might require a lot of cost to be involved, which is a wrong perception. At the same time, they see that New Zealand produces relatively less GHG emissions given it generates a lot of its

electricity through renewable sources. Regardless of this fact, the operation of buildings in New Zealand is found to be the main reason for producing 17% of domestic CO<sub>2</sub> emissions (Garry, 2008, p. 233); hence trying to close this gap will consider being an opportunity for the country to cut its emissions and save resources (Garry, 2008, p. 233).

Another study focused on the link between health and green cleaning products, which revolves around the concept of indoor air quality (IAQ) for indoor environments like offices. OSHA found that about 30% of people (which can constitute to about 1.5 million people) that work in non-industrial buildings work in poor IAQ environments. Working in such environments can adversely affect a country's economy. For instance, the United States loses about USD 168 billion per year due to problems related to poor IAQ, which is reflected in the workers' absenteeism and medical care rates (Sawchuck, 2009, p. 42). Some of the health problems that result from poor IAQ include asthma and sinus infections. Hence, proper measures need to be followed in order to solve these problems such as using environmentally friendly cleaning products, implementing more effective cleaning practices (through producing effective cleaning schedules, etc.) as well as using proper cleaning equipment. Conventional cleaning products are less encouraged to be used compared to the green cleaning products because most of them contain petroleum and many unsustainable ingredients which often are not biodegradable. Green or environmentally friendly cleaning products that are certified and recognized are normally produced from more sustainable and natural ingredients that can easily biodegrade and are not as toxic as the conventional cleaning products. More importantly, green cleaning products usually contain less volatile organic compounds (VOCs), which are known to cause respiratory problems and affect the general health (Sawchuck, 2009, p. 43). It is also important to bear in mind that green cleaning products are not perfect and can continuously be enhanced to work more effectively and sustainably. At the same time, most of the facilities that used green cleaning products and related measures to enhance their IAQ

and work environment found that their workers' productivity and morale increased, and their health problems and absenteeism rates went down (Sawchuck, 2009, p. 45).

Implementing such initiatives usually result in having facilities continuously look for better ways to enhance the work environment and reduce expenditure, such as sourcing sustainable paper and office products, using healthier pest control products, etc. (Sawchuck, 2009, p. 45). Being a responsible consumer is another important aspect that needs to be considered when renovating existing buildings. We have currently reached to a point where over-consumption is part of the culture and purchasing the most expensive products is something a lot of companies aim to look for when renovating or constructing their buildings. Such activities lead to the production of more waste and the emission of carbon gases which affect the environment in the end (Al Gore, 2006).

One of the strategies that can be implemented to reduce existing buildings' carbon emissions is to conduct an energy audit to identify the areas within a building that consume a lot of energy, and hence identifying the areas of focus when implementing energy saving strategies (Al Gore, 2006). Moreover, reports produced by Energy Star identified that lighting contributes to a big percentage of energy consumption in companies. To help reduce that load, companies are encouraged to switch off their lights and electrical appliances when not in use, installing lighting motion sensors if possible and/or replacing the light bulbs with more energy efficient ones. If energy leakages in air vents were insulated and plugged, about 10% of the energy bill will be reduced. It is also recommended to have a proper maintenance system to ensure that air-conditioning ducts and filters are regularly cleaned. Another smart way can be by forming an energy committee that can work together to gather energy improvement ideas and projects. Staff engagement in a company's energy reduction initiatives can contribute to the reduction of energy bills as well, and this can be done by informing them of the progress of the initiatives and



encouraging their involvement in some of the required activities (i.e. staff switching-off lights when leaving their offices) (*Conserve while you work*, 2011, p.1).

A building's energy consumption can also be significantly caused by the effect of Urban Heat Island (UHI), which is considered a "*reflection of the totality of microclimatic changes brought about by man-made alterations of the urban surface*". Buildings and roads usually absorb solar radiation during the day and release the heat at night, which contribute to the increase of temperatures around. Other factors also contribute to the increase in temperatures such as road traffic and air conditioners. Also, the more buildings there are, the more the wind speed gets reduced in the area. The UHI effect can have different intensity levels depending on where it is located within the city, but the denser the built area is the higher the intensity level it would usually be (Priyadarsini, 2009, p. 261). There are various factors that play part in having the phenomenon occur, some of the main factors include the following:

**a. Surface Reflection or Albedo:**

Albedo is defined as the "*fraction of the total light striking a surface that gets reflected from that surface. An object that has a high albedo (near 1) is very bright; an object that has a low albedo (near 0) is dark. The Earth's albedo is about 0.37. The Moon's is about 0.12.*" (Albedo, 2012). Urban albedos are commonly within the range of 0.10 to 0.20, but can also have increased rates in some cities. The higher the albedo materials are (in building envelopes and surfaces), the less solar radiation they absorb and hence maintain a cooler surface temperature compared to lower albedo materials. This therefore can reduce the amount of heat transmitted into the building, which will then require less energy to cool the indoor environment. A simulation study was carried out in Singapore which looked at the impact of surface albedo on the UHI effect. Results of the simulation found that surfaces with low reflecting properties (in low wind speed areas) had a 2.5°C increase in temperatures, which means that the

type of materials used in building envelopes and their colors can significantly affect the temperatures of the areas surrounding the building(s) (Priyadarsini, 2009, p. 262). Therefore, increasing the albedo of surfaces in buildings and its surroundings can increase the percentage of solar radiation being reflected away from them, this can then reduce the amount of heat absorbed through those surfaces (Priyadarsini, 2009, p. 268).

#### **b. Building Orientation**

The flow of pollutants in an area can determine if the UHI phenomenon will occur. If an area suffers from low ventilation (like in narrow pathways and street canyons), then there could be a buildup of UHI due to the stagnation of pollutants. This could be less frequent in rural areas because they tend to have more open spaces which allow the flow of pollutants more than in urban areas. Having streets exposed to solar radiation can also affect the air temperature buildup of the area, hence the orientation of the streets should also be considered when designing the urban environment (Priyadarsini, 2009, p. 263).

#### **c. Evapotranspiration**

Evapotranspiration is defined as “*the combined processes of evaporation, sublimation, and transpiration of the water from the earth's surface into the atmosphere.*” (Evapotranspiration, 2012). Implementing this process effectively through applying vegetation systems in urban areas can help reduce the temperature buildup during daytime and hence reduce the UHI effect (Priyadarsini, 2009, p. 261). Hence, the usage of green roofs or green walls reduces the amount of energy required to cool buildings. If more vegetation covers buildings or is planted around buildings, evaporative cooling will increase and building cooling demands will decrease (Priyadarsini, 2009, p. 268).

#### **d. Anthropogenic Heat**

Emissions of both vehicles and air conditioners are considered the main reasons for causing anthropogenic heat in the urban area. The amount of energy consumed by air conditioners can be affected by the outdoor urban temperatures. The more air conditioners are used, the more heat they emit in the urban environment. This can result in an increase in the urban environmental temperature, which will then result in an increase in energy consumption of air conditioners. It is also worthy to mention that having air conditioning equipment exposed to continuous high temperatures around them due to their continuous operation might affect their performance. Hence the less the anthropogenic heat is generated the more the longevity of equipment can be maintained (Priyadarsini, 2009, p. 263).

#### **1.2 Barriers of Greening Existing Buildings**

In terms of the barriers for greening existing buildings, a questionnaire was distributed in one research to a number of building professionals to determine their opinion on the barriers to widespread sustainable building practices. In the questionnaire, 12 reasons were listed as barriers and the professionals were asked to categorize them based on what they thought were primary and secondary barriers. Although the questionnaire did not specifically focus on sustainable building renovation, it looked at the factors that affect the building industry in general, including building renovation. There were a few barriers that ended up being questioned as they were not seen as significant factors of hindering the spread of green building practices (Table 1.1) (Landman, 1999, p. 28).

**Table 1.1** Questionnaire Respondents' Ranking of 12 Barriers to More Widespread Sustainable Building Practice (Landman, 1999)

Barriers	% of respondents who consider it a "major" barrier	% of respondents who consider it a barrier ("major" or "minor")
1. lack of expressed interest from clients (owners/developers)	84	100
2. lack of training/education in sustainable design/construction	64	100
3. recovery of long-term savings not reflected in service fee structure	52	76
4. sustainable building options too expensive	48	96
5. lack of technical understanding on the part of subcontractors	36	80
6. lack of technical understanding on the part of project team members	32	84
7. lack of interest from project team members	32	76
8. "green" products not available in my area	32	68
9. insurance/liability problems with offering warranty on non-standard materials or methods	24	60
10. lack of technical understanding on the part of the Clerk of the Works	24	44
11. difficult to obtain financing from banks for sustainable projects	16	68
12. not sure where to find information on sustainable building methods	12	44

The questionnaire results show that the primary barriers to widespread sustainable building practices which were chosen by the building professionals include the following four reasons:

1. The lack of expressed interest from clients;
2. The lack of training/education;
3. The failure of service fee structures to reflect long-term savings;
4. The higher cost of sustainable building options

About 84% of the questionnaire participants found this reason as a major barrier for constructing or renovating sustainable buildings. Another survey also found that when designers or contractors suggest sustainable solutions for their clients, less than 30% of them choose those solutions for

their projects. Some of the causes of why there is a lack of interest from clients to apply sustainable solutions include the lack of awareness on the benefits of sustainably constructing or renovating buildings, and the fear of having economic burden from applying those green solutions (Landman, 1999, p. 30).

About 8% of the participants had had frequent education on sustainable building issues in their academic programs or through professional training while more than one-fourth of them had never been educated on those issues. Some of the building professional participants believe that the academic curriculum should include education on the principles of sustainable building before going into the technical education. They also voiced out the importance of educating the public on sustainability and the issues that are associated with sustainable buildings (Landman, 1999, p. 31).

The lack of education about the financial benefits of implementing green building initiatives is another major barrier to the widespread of sustainable building practices. Implementing green building initiatives are not as costly as many perceive. For instance, green homes were estimated to cost from 0% to 5% more than the cost of a typical home, as estimated by Peter Yost, the project manager of environmental systems at the National Association of Home Builders' Research Center (Landman, 1999, p. 32). Another study conducted by New York's Office of sustainable Design compared the estimated lifecycle costs of green versus typical construction and found that the initial cost of green construction is projected to be only 1% higher; however, they found that they also save more than 30% of operating costs (Landman, 1999, p. 33).

It is unquestionable that some sustainable building strategies are more costly than the conventional ones, that is only when the initial costs are considered. However, if a full "*lifecycle costing*" exercise was carried out on many of the sustainable building strategies; it will eventually show how cost effective they are in the long run, especially from the operations and

maintenance costs of the building. Other elements will also be looked into from carrying out the “*lifecycle costing*” exercise, such as avoiding of initial costs of not installing additional systems (i.e. extra chillers) (Landman, 1999, p. 33).

In regards to the secondary barriers of implementing green building practices, one third of the questionnaire participants chose the following reasons:

1. The lack of technical understanding on the part of subcontractors;
2. The lack of technical understanding on the part of project team members;
3. The lack of interest on the part of project team members;
4. The lack of “green” product suppliers in the area (Landman, 1999, p. 34).

The remaining four barriers were selected by not more than one-fourth of the participants, which shows that they might not be significant reasons of why the concept of building or renovating buildings sustainably is not spreading widely. Those barriers are:

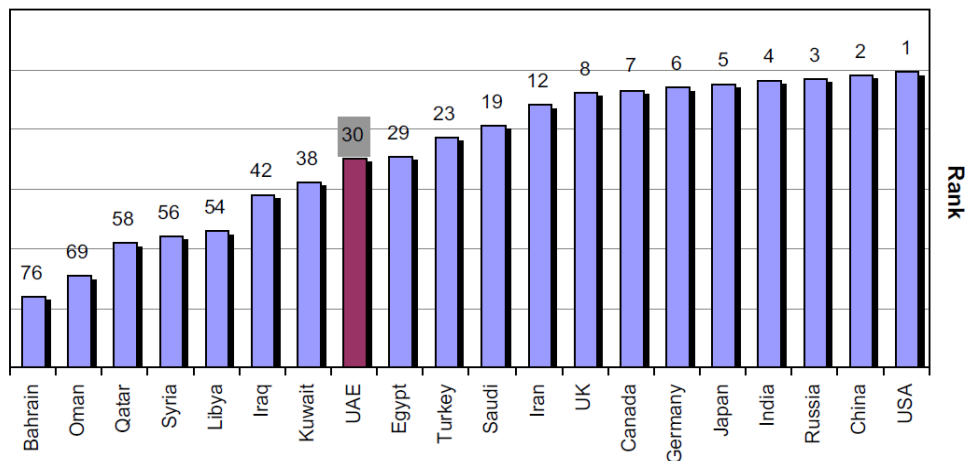
1. Insurance/liability problems;
2. The lack of technical understanding on the part of the Clerk of the Works (i.e. building operators);
3. Difficulty in obtaining financial support from banks;
4. Uncertain of where to find information on sustainable building methods (Landman, 1999, p. 37).

### **1.3 The Reality in Existing Buildings in the United Arab Emirates**

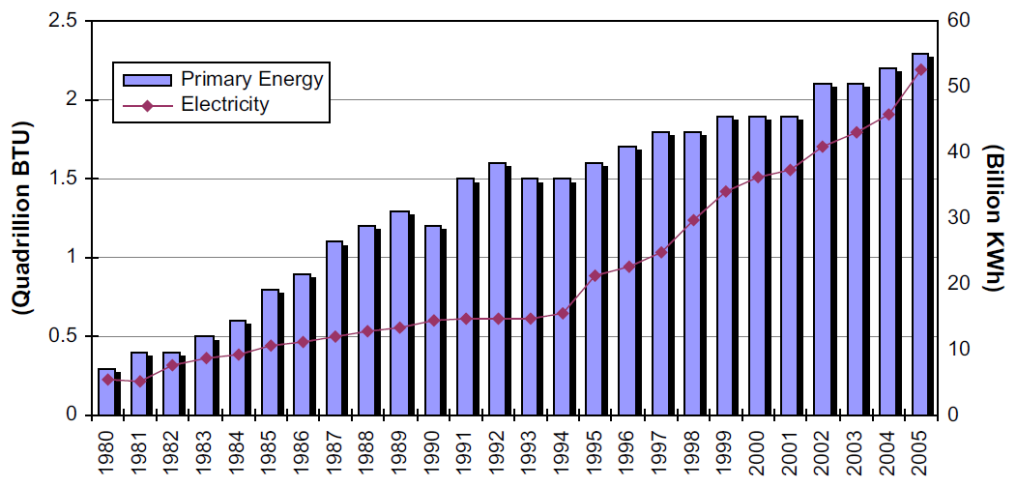
Since this paper is aimed to look at greening existing buildings in the UAE, it is necessary to understand the challenges and barriers that potentially or actually hinder the greening of existing buildings in the country as well as

understand the current situation in regards to how sustainable those existing buildings are, the amount of resources they use when operational and what the country is doing to tackle sustainability issues of existing buildings.

In 2003, the UAE was the 30<sup>th</sup> highest CO<sub>2</sub> emitting country in the world as shown in Figure 1.1 (Radhi. 2009, p.2453). The UAE is considered one of the most energy consuming countries (per capita) in the world due to various factors, such as the increased growth of population and economic development. Another important factor that influences the country to consume a lot of energy is having low electricity and energy bills (Radhi. 2009, p.2454). Figure 1.2 demonstrates the growth in electricity consumption between 1980 and 2005 (Radhi. 2009, p.2452).

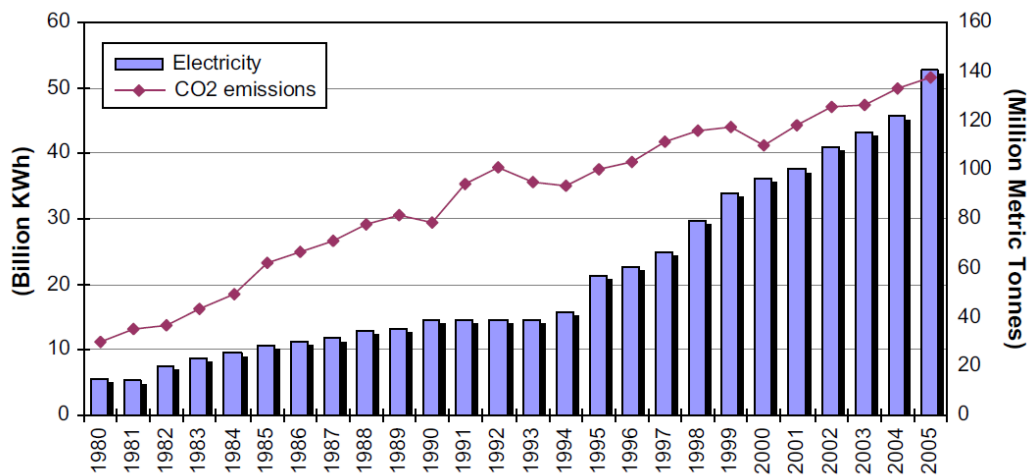


**Figure 1.1** Rank of UAE in terms of CO<sub>2</sub> emissions (Radhi. 2009)



**Figure 1.2** UAE electricity consumption from 1980 to 2005 (Radhi. 2009)

Since it is expected that energy production and consumption will increase even more due to the continuous development of the country, CO<sub>2</sub> production will therefore increase. In 2006 itself, the total electricity consumed in the UAE was around 52.6 Billion kWh, and thus, about 137.8 million metric tonnes of CO<sub>2</sub> was produced from the utilization of fossil fuels (Radhi. 2009, p.2454). Figure 1.3 shows the increase in CO<sub>2</sub> production as a result of energy consumption (Radhi. 2009, p.2453).



**Figure 1.3** Increase in emissions CO<sub>2</sub> relative to the use of energy (Radhi. 2009)



### 1.3.1 Ecological Footprint

Since the existence of human kind, we have known to consume natural resources to ensure our survival. However, people later on started to explore and look for more than what they needed to survive. They started to be creative with the natural resources and began producing products and items of value and use. Increasing the production of those items increased the consumption of the world's resources (WWF International. 2006). A method of calculation called the Ecological Footprint (EF) comes into the picture as it "*measures how much biproductive area (whether land or water) a population would require to produce on a sustainable bases the renewable resources it consumes, and absorb the waste it generates, using prevailing technology*" (Schaefer et al., 2006, p. 5).

By calculating the availability of land and water that are naturally being produced and comparing their measure with the area and volume that are being consumed by people, we can then determine whether or not there is a balance in the consumption of natural resources. The global ecological footprint was estimated to be 2.2 global hectares per person in 2003 while the world's overall supply of biologically productive land and water (biological capacity) was 1.8 global hectares in the same year (WWF International. 2006). A global hectare (acre) is "*one hectare (2.47 acres) of biologically productive space with an annual productivity equal to the world average*", it is a measure of the overall footprint for a specific population's activities (*Ecological Footprint*, 2003).

The United Arab Emirates (UAE) is considered one of several countries that went beyond its biocapacity limits. The WWF Living Planet Report for 2012 states that in 2012 the UAE had the highest ecological footprint in the world after Qatar and Kuwait, which means its residents consume more than the required earth resources per person (*Living Planet Report 2012: Biodiversity, biocapacity and better choices*, 2012). The UAE's energy footprint in the previous years scored the highest amongst the

remaining forms of footprints, especially in 2001 (Table 1.2) (Venetoulis et al. 2005). It was also scored as the world's highest water consuming country per capita in 2010, with a consumption rate of 550 liters of water per person per day (Eco-friendly Car Washing Firm Picks Up New Contract, 2010).

**Table 1.2** UAE's Ecological Footprint and Balance Per Capita in Global Hectares 2001 (Venetoulis et al. 2005)

Cropland	1.18
Pasture	0.42
Forests	0.83
Fisheries	4.22
Built Space	0.08
Energy	226.13
Total FP	232.86
Biological Capacity	19.43
Ecological Balance (2.0)	-213.43
Ecological Balance (1.0)	-13.76
Difference	-199.66

### 1.3.2 Building Performance and Operation

Along with the UAE's high ecological footprint, many disregard the fact that constructing and operating buildings can directly affect the environment (AboulNaga and Elsheshtawy, 2001, p. 555). When looking at Europe for instance, more than 50% of their local waste production appears to come from the building sector which a lot are either directly dumped in landfills or incinerated turning waste into ashes and then are dumped in landfills, in which some could be hazardous to human health and/or soil. Also, about 50% of Europe's natural resources and 40% of their energy consumption are building-related. Current studies that assessed the correlation between resource consumption and building construction and operation in the UAE concluded that the UAE figures are unfortunately even higher! (AboulNaga

and Elsheshtawy, 2001, p. 554). Building comparisons were also performed to compare between traditional and contemporary buildings in the UAE in terms of their consumption of total energy, artificial lighting and cooling. The research concluded that contemporary buildings consume about 6 times more energy and display less sustainable measures to improve their environmental and energy performances (AboulNaga and Elsheshtawy, 2001, p. 561). Statistics from 1999 show that around 43% of the CO<sub>2</sub> emissions come from electricity production, 4% from direct building emissions and 45% from the manufacturing and construction sectors. Such statistics show that building construction and operation do impact the amount of CO<sub>2</sub> production. The utilization of air conditions to cool buildings is another factor that impacts the production of CO<sub>2</sub> in the country as the figures increased more than 10 times from 5 to 50 billion kWh in the last 20 years (Radhi. 2009, p.2454).

A few important areas that need to be considered to ensure that buildings are constructed and operated sustainably include the efficient design of buildings, energy consumption, waste production, growth of population, carbon footprint, and sustainable resource consumption (AboulNaga and Elsheshtawy, 2001, p. 555). One research conducted in the Middle East concluded that if buildings were well insulated and had an effective ventilation system, around 50% of energy will be saved in the coastal areas while more than 90% of energy will be saved in the highland areas (Radhi, 2009, p.2453). In addition, ensuring that air tightness in buildings is maintained will reduce the uncontrolled leaking of air, which will then reduce energy wastage. Buildings are different from one another in terms of their sustainability performances (i.e. waste, energy, air). If building owners decide to have their buildings renovated in a sustainable manner, architects and consultants looking at the project will have to look at each building individually, assessing their orientation, surrounding, and resource consumption case by case to optimize their performances and reduce their adverse effects on the environment (AboulNaga and Elsheshtawy, 2001, p. 556).

## 1.4 Introducing Green Building Regulations and Initiatives in the UAE

In an approach to sustain the performance of existing buildings in the UAE so as to sustain the environmental, social and economic wellbeing of the country, a few UAE emirates started to impose green building guidelines and regulations on contractors, building owners and organizations. In 2008, the city of Sharjah decided to have their commercial and residential buildings apply green building regulations by January 2009 in collaboration with the Directorate of Public Works, Directorate of Town Planning and Sharjah Municipality (Al Serkal, 2008). In the capital city of Abu Dhabi, the Abu Dhabi Urban Planning Council, in association with the Environment Agency, developed the Abu Dhabi 2030 Urban Structure Framework Plan to tackle the city's sustainability issues by focusing its attention on a few major areas (i.e. the environment, economy, society and culture) throughout a 25 year development plan. This framework they developed is called *Estidama*, which means sustainability in Arabic. One of the sustainability issues that it is working on, which is relevant to this project paper, is the "*endangering interaction between citizens and their built environment*" (Abu Dhabi 2030, 2010). It basically is meant to reduce the effects of human activities towards the built environment, such as promoting the responsible consumption of resources, proper management of various types of waste, the use of sustainable transportation, etc.

Dubai, another important emirate in the UAE, that had a few non-governmental organizations (NGOs) established in the 1990s, like Emirates Environmental Group (EEG) in, for the purpose of raising awareness on environmental issues as well as promoting recycling. Recently, the city launched the Dubai Strategic Plan 2015 through the Executive Council as per the decision of its ruler; His Highness Sheikh Mohammed Bin Rashid al Maktoum, UAE Prime Minister and Vice president of Dubai. The strategic plan 2015 focuses on 5 important areas including: 1) economic development, 2) social development, 3) security,

justice and safety, 4) government excellence 5) and infrastructure, land and environment (*Highlights: Dubai Strategic Plan 2015*). A few of the outcomes that came out of developing the Dubai Strategic Plan 2015, which are related to sustainable buildings, were the establishment of the Emirates Green Building Council (Known as Emirates GBC) and the development of the Dubai Municipality Green Building Terms and Conditions manual. Emirates GBC was established in 2006 to develop green building policies and guidelines as well as implement green building rating systems tailored for this region to cut down on the ecological footprint of buildings by the year 2015 (*Who we are*, 2010). The Dubai Municipality Green Building Terms and Conditions manual was established to be voluntarily applied on new construction and building renovations (i.e. expansions, and restorations) that require approval from the municipality. However, the manual does not apply on current existing buildings that do not undergo renovations, unless they have substantial impact on the environment or health (*Green Building Terms and Conditions*, p. 8). At the same time, this manual, though its similarities with green building rating systems (i.e. LEED, BREEAM), is not considered a building rating system nor is it meant to replace the international green building standards that buildings can optionally achieve (*Green Building Terms and Conditions*, p. 10).

Decisions to comply with green building standards have been made and the country is now taking baby steps to achieve them. In Dubai for instance, one of the ways that the government is trying to convince private companies to take the green building regulations seriously is that they set up a policy to apply the guidelines on their new government buildings, like schools and hospitals, in the next few years. This will assist in optimizing the use of resources and reduce water and energy consumption (*Better buildings for a better UAE*, 2010). In Abu Dhabi, the use of renewable resources is encouraged and is going to be implemented in certain sectors as a start. Newly constructed villas and labour camps will need to install domestic solar water heating systems to supply as much as 75% of the

needed hot water in households. External lightings are also considered when using renewable resources. If external lights consume more than the acceptable level of light power density, and yet require more lighting, the concerned parties will then need to install renewable energy lighting sources (Smeerdijk and Nelson, 2010).

A lot of efforts are currently being put to develop and implement green building standards that suit this region's climatic and geographic conditions. At the moment, such efforts are scattered in different emirates and might not have uniform regulations and guidelines due to that. Looking at the positive side though, this is just the start and the different emirates might learn from each other and end up forming a collaborative standard that could be applied across the emirates.

Recent news in the late 2010 involves a federal decision that has been placed to add and complement on the various green building guidelines and regulations that are independently being used in the different emirates. The decision is the formation of a new building code to limit the use of glass facades on buildings to a maximum area of 60%, which will be executed in 2014. In addition, all new buildings that are going to be constructed after 2014 should comply with their green building standards. The standards will include the regulation of water consumption, material resources, and building temperature and energy consumption through effective insulation (The Future's Green for Construction, 2010).

Since the enforcement of green building regulations in the UAE, a few sectors came up with innovative ideas or initiatives to either reduce their environmental footprint or improve their systems and operations to consume fewer resources. In the construction sector for instance, more and more establishments are working towards registering their buildings as certified green buildings with the US Green Building Council. Currently, there are about 517 buildings in the UAE that are awaiting to be registered, which is far more than their neighboring GCC countries (i.e. 42 in Qatar, 37 in Saudi Arabia, 13 in Oman, 7 in Bahrain and 3 in Kuwait)

(Landais, 2010). Also, a few local construction companies have started producing locally made green products as a result of the green wave, like Bena for example, it makes its concrete products by using sand from Al Ain and natural gas provided in subsidized rates by Abu Dhabi (Lowe, 2010).

Dubai Municipality jumped in the green picture and brought in a new initiative in Dubai to facilitate suppliers, contractors and manufacturers in applying either the Dubai Municipality green building terms and conditions that new buildings are required to abide by, or any other green building related standards. They have set up an advanced world-class standards laboratory through the Dubai Central Laboratory as an initiative to test materials and items relevant to green building. In addition, a couple of guides were developed to provide the laboratory with information like the inventory for green building materials and the laboratory names that can examine the various green building materials (Dubai Municipality testing lab for green materials launched, 2010).

In the hospitality sector, Al Ain is soon going to embrace the UAE's first green five-star hotel in the Al Ain Wildlife Park and Resorts (AWPR) as part of the Green Hotels program developed by the Abu Dhabi Urban Planning Council (UPC) in conjunction with AWPR. The aim of having the hotel established is to become one of the first examples of "*sustainable hospitality*", where it will welcome its guests to enjoy a sustainable stay in the hotel. The hotel's value will also increase since it is not only going to be ranked as a five star hotel, but it will also be rated based on Estidama's Pearl Rating system for new hotels (Kazmi, 2010). Aside from that, existing hotels have a lot of potential to change their operational habits to the better by introducing green best practices. Lous Hakim, Chairman of Philips Middle East and vice president of Philips Electronics stated that: "*Green initiatives in the hospitality industry are developing as a core business strategy. Hotel guests keen to enjoy their travel and guest experience will increasingly seek out accommodation.*" "*By carrying out a*

*full analysis of the current consumption of lamps and other electrical equipment, room-by-room and floor-by-floor, it is possible to sketch an accurate picture of where savings can be made, and which products can best help realise them.*” Introducing a simple technology like lighting sensors can save a lot on operational costs, which could be around USD 40,872 (AED 150,000) annually for a 200-bedroom hotel, assuming that their occupancy rate is 80% (Badih, 2010).

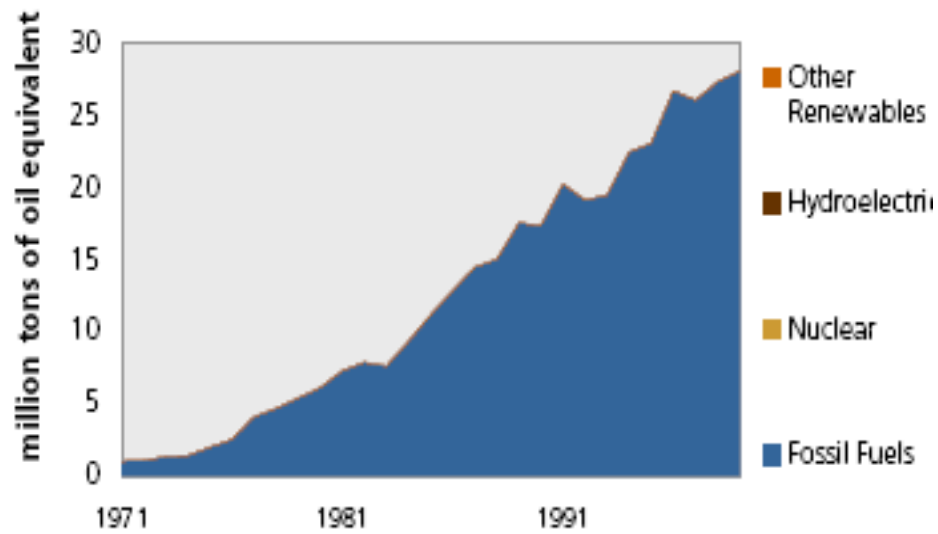
## **1.5 Challenges that Existing Buildings Face in the UAE**

Yes, the UAE has introduced a few guidelines, terms and conditions on green buildings to tackle the current climatic condition; however, there are a few challenges in this situation which cause to slow down the greening of existing buildings. Some of which include the following:

### **1.5.1 Developing Vs. Greening**

The UAE is still growing in different sectors, and for it to keep boosting itself for development it needs to utilize its available resources to meet its development targets. This poses a problem since it is majorly dependant on non-renewable resources, i.e. fossil fuel, for energy production (Figure 1.4), instead of taking the time and effort to look for more sustainable ones (Earth Trends, 2003). Furthermore, strong environmental and energy policies are not currently well established to effectively conserve environmental resources and reduce energy consumption in the UAE. The UAE has also developed a consuming culture over time due to a few factors such as: (1) the country was rated as one of the high income nations and over consumption is usually associated with such nations; (2) many items, products and resources (i.e. water, electricity) are made affordable; and (3) the society’s environmental awareness level is not strong enough to bring out responsible consumers (WWF International, 2006).





**Figure 1.4** Energy Consumption in the UAE by Source – UAE 1971-1999 (Earth Trends, 2003)

### 1.5.2 The Economical Issue

Another challenge for greening existing buildings lies behind the fact that building owners tend to become hesitant in doing so because of the initial investment required despite the fact that they and their occupants will gain great economic, environmental and health benefits. As Sogat Nandi, Executive Director of Asset Management and Sustainable Development, TECOM Investments, stated: *“Sometimes yes, there is an expense for example if fresh air needs to be let into buildings. But companies need to understand that occupant health increases productivity and more than compensates for the investment”* (Walter, 2010). Armen Vartanian, Director of Eco Ventures, also stated: *“Demand for environmental product is increasing, but there are still many companies that are making decisions made on price...without thinking about medium-term investments”* (Lowe, 2010).

### 1.5.3 The Reality of Existing Buildings

Along with the perception that it is too expensive to green existing buildings, the country is currently going through an experimental and under-study phase in the area of greening existing buildings. The only standard that is developed which is tailored to this region's climate is Estidama's Pearl Rating System, but it is yet to be applied on all buildings in Abu Dhabi and prove its effectiveness. As stated by Dr Sadek Owainati, founder of Emirates Green Building Council: *"It's not easy to create a set of rules that will apply to hotels, hospitals or residential buildings. They all have different needs, and it is the same in, for example, Saudi Arabia. Levels of humidity or access to water vary depending on where you are in the country"* (Landais, 2010).

Whether or not contractors and developers aim for green certification, like LEED and Pearl, we are seeing that the current green wave favors constructing green buildings more than sustainably renovating existing buildings. A green building survey created by Cityscape Intelligence was distributed between April and May of 2010 to a wide range of professional stakeholders that invested in the UAE's property marketplace (e.g. real estate, construction, development, architecture, interior design, and consultants) , which aimed to assess the *"institutional perspectives on the feasibility of green buildings in the UAE"* (Nelson, 2010). Results of the survey concluded that *"the main focus of much of the current policy development is on new buildings, whereas the survey makes it clear that some of the major opportunities (and challenges) lie with retrofitting existing buildings"* stated by Simon Clouston, the technical director of WSP Environment and Energy, who was involved in the development and analysis of the survey (Nelson, 2010). Hence, it is important that both green construction and renovation are given equal attention to ensure that the UAE real estate and development industry, along with the environment, are sustained.

## **1.6 The Way to Move Forward**

Whether or not existing buildings chose to adopt a specific certification to achieve their sustainability goals, there are many ways they can do to improve their operational efficiency, increase building performance, reduce consumption of various resources and save money. From what has been gathered in this chapter, the concept of greening existing buildings in the UAE is quite new and there is a need to move forward in finding for the best solutions to make the current developments more sustainable. Hence, this research paper will explore the area of greening existing buildings in the UAE by following the below research structure:

Chapter one gives an introduction about greening existing buildings. It looks into the need for sustainably renovating existing buildings worldwide and the barriers that hinder existing buildings from being greened. It then embarks on the reality of existing buildings in the UAE and the green regulations and initiatives put together locally for this purpose. Finally, it discusses the challenges that existing buildings face in the UAE and the way to sustainably move forward.

Chapter two goes through the literature review of the topic of greening existing buildings. It will display some examples and case studies of existing buildings in some countries that incorporated various initiatives to reduce resource consumption, save money and increase their building efficiency and performance. It will then conclude with the research question, aim and objectives.

Chapter three explores the various methodologies of research that can be used to study the area of greening existing buildings. It then evaluates the applicability of each methodology to answer the question and objectives set for this research. It concludes with the chosen methodology for this research with a justification of why it is most applicable. It then goes into

detail with how the research will be conducted using the chosen research method as well as the tools that will be used for data collection.

Chapter four takes Dubai Chamber of Commerce and Industry as a case study research and looks into its history and journey towards sustainability since the beginning. It then goes into detail with the sustainability initiatives the organization implemented to green its building headquarter, as well as the outcome achieved including certifications (i.e.ISO14001), benefits and challenges. Future improvement projects are also looked into as part of the organization's continual development goals.

In addition, it analyzes and discusses the results based on the objectives that were set in chapter two. It then gives a summary of Dubai Chamber of Commerce and Industry's implemented sustainability initiatives in the different phases it went through. It also identifies the barriers that the organization encountered along the line of implementing their sustainability projects.

Chapter six presents the final conclusion and recommendations of the research paper based on the research question and objectives. It also presents the factors that assisted in turning Dubai Chamber of Commerce and Industry's building headquarter green and what existing buildings can do to turn their buildings green. It then lists some recommendations that can assist organizations in successfully applying any sort of sustainable certification.

**2      CHAPTER TWO: LITERATURE REVIEW**

## **2.1 Case Studies and Examples on Greening Existing Buildings**

As mentioned in chapter one of this research, buildings contribute to producing more than 40% of GHG worldwide. At the same time, there have been many efforts given by many institutions and organizations around the world to reduce their burden on the environment as well as sustain their resources. This chapter will look into the literatures reviewed and case studies on greening existing buildings and focus on what organizations have done to improve their existing buildings' environmental performance, whether in one area or many.

### **2.1.1 Case Study: One Canada Square, UK**

One Canada Square is an iconic 15 story, 800 feet high, multi-occupied building that has been completed in 1991. Known as the tallest occupied tower in London, it has 3,960 windows, 32 passenger lifts and 4,388 steps. The building is part of the Canary Warf Group that has managed to apply ISO14001 certification on Environmental Management System across all areas of its business activities. In 2010, One Canada Square applied various energy efficiency improvements on its building which managed to lower its CO<sub>2</sub> emissions and cost of operations.

Some of their initiatives include them replacing their old cooling towers with more efficient ones and had inverter drives installed on the cooling tower fans. The inverter drives helped in regulating the speed of the fans which contributed to controlling the amount of power consumed by the motor rather than having the motor constantly work at full speed. They also improved the efficiency of their chillers by upgrading their chiller controls and recommissioning their chilled water system. Their lighting system has also been improved by replacing their old light bulbs with more energy efficient ones in occupied areas, stairways and toilet facilities; and installing motion and light sensors across the floors of the building.

Some of the benefits gained out of implementing these initiatives include the reduction of lighting energy with the percentage of 47% in occupied areas, 63% in toilet areas and 82% in the stairways. This helped in cutting about 914 tonnes of CO<sub>2</sub> emissions. They also reduced 37% of their energy consumption in air conditioning across 11 floors saving about 55 tonnes of CO<sub>2</sub> emissions. In terms of the financial benefits they gained out of implementing these initiatives, the replacement of light bulbs and installation of new controls in their stairways for instance costed them £22,000 of capital investment per stairwell. They get an energy cost saving of £5,500 per year out of it, which calculates to 4 years of payback period. It is expected that the building will gain additional savings from the installation of energy efficient light bulbs across the building since they have a longer life span, hence the cost of their lighting replacement and maintenance will reduce (*Case Study: Canary Warf, 2011*).

### **2.1.2 Case Study: York House, UK**

British Land's head office named York House is another multi-occupied building that worked on reducing its energy consumption. In order to achieve this goal, British Land developed a strict design brief with properly planned objectives, which included:

- Installing an automated meter reading (AMR) system and optimization process;
- Having the main building users report on their energy consumption through a comprehensively developed data reporting system;
- Using a "*remote monitoring service*" that can easily detect energy saving opportunities;
- Closing energy leakages by enhancing energy efficiency in the areas within their control and in shared areas;
- Developing an automated billing process for the tenants.

The installation of the AMR system and optimization process helped in automatically uploading electricity, gas and water readings to an online central system every 15 minutes. A sub-metering system was also introduced to breakdown the consumption reading per area/floor, tenants' consumption and the intensity of usage ranging from small to major consumption devices. Furthermore, the "*remote monitoring service*" comes into the picture to evaluate the data collected and identify opportunities for reducing consumption and increasing savings. With using the AMR system, British Land managed to enhance many of their operational activities and devices which in turn helped in reducing York House's energy consumption. This includes identifying and fixing defects with the Building Management System (BMS) programming for gas use for heating and cooling as well as chillers and air handling units (AHU). They also improved their way of cooling the building with no extra cost by using outdoor air (*Case Study: British Land, 2011*).

As of March 2011, after two years of implementing the energy saving initiatives, York House reduced 38% of energy in areas they occupy and other common zones and shared services. The tenants in the building also saved about 11% of energy. This means that the building managed to reduce its energy consumption by 2.4 million kWh over the last two years saving £141,000 and reducing 1,000 tonnes of CO<sub>2</sub> emissions. This project built up the relationship between the building management team and its tenants, which facilitated the effective implementation of the project and continual improvement of it (*Case Study: British Land, 2011*).

### **2.1.3 Case Study: 10 Exchange Square, UK**

10 Exchange Square is another British Land building that installed an AMR system and optimization process recently in order to achieve its long term energy efficiency goals. The 161,000 square feet building was



completed in 2004 and managed by Broadgate Estates Ltd., one of British Land's "*wholly-owned*" subsidiary. In addition to aiming for reducing the building's energy consumption, they also worked on reducing their water consumption and improving their waste disposal process through applying simple initiatives throughout the building.

Some of their energy reduction strategies include reducing the operational load of their air conditioning systems by switching them off at 7pm instead of 8pm as specified in their lease. This had saved them £22,800 per year. They also installed motion sensors for the lighting system in the tenant's areas which saved them £1,300 yearly in energy consumption. With this progress, they installed motion sensors and energy efficient light bulbs in common areas to gain more savings. Fuel conditioners were also fitted on gas supply pipes which lowered the building's gas consumption to about 10%.

Water consumption was also reduced through installing a few systems like flush saver bags in toilets and sani-sleeves in urinals, which reduced the amount of water used in every flush. To control the frequency of flushing, some tenants installed motion sensors and others reduced the number of times they flushed their toilets during working hours and deactivated flushing after working hours. Aerators were installed as well in 100% of the building's showers to reduce the flow of water which reduces the amount consumed.

Waste disposal and segregation was also managed in the building where a recycling system was introduced throughout the premises. The building management team ensured that the tenants were informed about this system through conducting awareness campaigns and distributing recycling signage all around. The tenants' cleaners were informed of the proper way to segregate, recycle and dispose waste. The management team even went beyond that by setting up meetings between their tenants and waste contractors to discuss ways to improving this system and tackling any issues.

In 2011, 10 Exchange Square managed to achieve 29% reduction in their “landlord-influenced” energy consumption, 26% reduction in their tenants’ electricity consumption and 41% reduction in the building’s water consumption. They also managed to increase their recycling rate from 30% in 2009 to 83% in 2011. All of these achievements had helped in reducing 1,530 tonnes of CO<sub>2</sub> emissions, saving 10.5 million liters of water and recycling more than 220 tonnes of waste. The remaining waste gets sent to incinerators, which means that 0% of waste goes to landfills.

In terms of the financial achievements gained from implementing the cost saving initiatives over two years from 2009, the building managed to save £222,100 on energy, £12,900 on water and £10,000 of landfill taxes. The calculated savings were based on £0.08 per kWh for electricity, £0.02 per kWh for gas and £1.23 per m<sup>3</sup> for water. The capital investment given for the AMR system was about £74,000 with 3 years of payback period. The recovery of their AMR system capital investment was taken out from their energy cost savings which were achieved from implementing various energy saving initiatives (*Case Study: British Land, 2012*).

#### **2.1.4 Case Study: 50 Pall Mall, UK**

50 Pall Mall, part of Legal and General Property group, is another building that managed to save 284 tonnes of CO<sub>2</sub> emissions through implementing various energy saving initiatives. It is a multi-occupied building that’s been constructed in 1995 behind a façade that goes back to the 1800s. It currently holds 33,620 sq ft of office space across various floors of the building. In 2008, it achieved ISO 14001 certification which guided them to implementing the basic environmental management system requirements and introduced a lot of building improvement ideas.

The building management team proactively sought to understand their building’s energy consumption so they upgraded their building

management system (BMS) software to give them more control over the heating and cooling operations of the building as well as reduce unnecessary energy wastage. Their billing process was also enhanced in order to obtain actual consumption readings rather than estimated ones. Tenant engagement was also in the building management team's agenda whereby they hold quarterly meeting updates with their tenants on the building's environmental performance. The management team will be adding sustainability requirements for their future tenants to follow before occupying the building space.

When building refurbishment was put in the plan of the 50 Pall Mall building, the building management team made sure to include a sustainable strategy to improve the building's environmental performance. Some of the initiatives introduced include changing their entrance doors to double doors in order to reduce the amount of heat lost by increasing air tightness. To control lighting consumption, their lamps were replaced with more energy efficient ones, atrium lights were permanently switched off and motion sensors were installed in some areas of their building's stairwells. Moreover, they replaced their boilers with around 30% more efficient boilers.

In terms of the benefits gained from implementing 50 Pall Mall building's sustainability initiatives in 2011 compared to 2010, the building managed to reduce its dependence on gas for heating and cooling for up to 54%, use 20% less electricity in common areas and 25% less electricity in occupied areas and offices. Hence, the building successfully saved 284 tonnes of CO<sub>2</sub> emissions. Their sustainable strategy's capital investment was about £60,000 (includes £52,000 new boiler; £6,600 BMS upgrade and £2,000 motion sensors) and from the initiatives they managed to achieve annual savings of £41,500 (includes £10,800 on gas use for heating and cooling; £18,500 on electricity consumption in common areas and £12,200 on electricity consumption in occupied areas) with a payback period of within 2 years. The calculated savings were based on £0.08 per

kWh for electricity and £0.02 per kWh for gas. It is worthy to note that the newly installed boilers and BMS upgrade came out of the service charge budget and the refurbishment project came out of the service charge surplus budget, tenants' contribution and Legal and General Property (*Case Study: Legal & General Property, 2012*).

### **2.1.5 Case Study: Prospect House, UK**

Prospect House, part of the Hermes Real Estate development, is another building that focused on reducing its CO<sub>2</sub> emissions, water consumption and waste production. But as part of their motive to achieve these targets, they developed a “*Responsible Property Management*” program in 2008 and ensured that their tenants are engaged with the implementation process. In terms of what has been done to reduce water consumption, motion sensors were installed in toilet urinals to control flushing, and water saving fixtures were placed in flushing tanks to reduce the amount of water flushed as well. Ongoing awareness campaigns are also put together for the tenants' awareness and engagement.

Some of the initiatives they introduced to reduce their energy consumption include conducting an energy audit within the building to understand where they are and monitor what they do to lower their consumption. They also lowered the storage capacity of their boiler and hot water as they noticed that the plant heated more than they needed. In addition, they modified their plant operational times to make it function as needed in the building rather than keeping the plant operational all the time. Also, every half a year the building management team carries out energy campaigns to raise awareness and engage the building occupiers.

In terms of the building's waste management initiatives, the building management team regularly carries out waste audits every four months to monitor their progress. A waste management contract was also put

together with their waste contractor to ensure that zero waste goes directly to landfills. Tenants are made engaged in this process by attending meetings with waste contractors to figure out the best ways to reduce their waste quantity and increase waste recycling and segregation. Awareness programs on waste management are also ongoing every half a year to engage the rest of the tenants and increase their awareness on the importance of conserving resources through reusing, reducing and recycling their materials.

Other initiatives they ran include promoting the use of public transportation and bicycles to work as well as carpooling. Sustainable procurement is also part of their environmental management plan where they have started to procure sustainable materials like energy efficient light bulbs, and regularly evaluate and monitor their suppliers' sustainability practices.

Adopting the "*Responsible Property Management*" program in 2008 had helped in reducing the building's CO<sub>2</sub> emissions by 15% compared to 2007 saving them 279 tonnes of CO<sub>2</sub>. The implementation of energy saving initiatives helped in reducing the building's energy cost by £50,000. From the water saving initiatives, they have managed to reduce 18% of water consumption which saved them 861,000 liters of water and £5,000 of water cost. Moreover, the team was successful in diverting 100% of their waste, total of 58 tonnes in 2008, away from landfills through recycling and waste energy recovery. This made them save £1,800 of landfill tax charges. All of these achievements made them receive the Mayor of London's Green Award in 2009 as the most improved property in London (*Case Study: Hermes Real Estate, 2011*).

### 2.1.6 Case Study: Merchandise Mart, USA

Merchandise Mart is a known landmark in Chicago that was built in 1930. Throughout the years, its owners slowly built an internal culture that advocated for environmental sustainability. It started long ago to implement some initiatives to reduce their burden on the environment such as having a thermal storage capacity which majorly reduces electricity costs yearly, as well as being part of the Clear Air Counts scheme that aims to reduce energy consumption and the formation of polluting smog in the city. As part of the company's efforts to continuously improve their environmental practices, they decided to apply for LEED Silver for Existing Buildings certification and managed after three years to achieve it. Getting this certification helped in formalizing, documenting and monitoring a lot of the company's sustainability practices. This would not have been achieved without the collaborative efforts of their internal team as well as an employed certified LEED consultant (*Regional Green Building Case Study Project: A post occupancy study of LEED projects in Illinois*, 2009, p. 58).

Within a year of achieving the certification, Merchandise Mart managed to reduce around 10% of its energy consumption due to implementing initiatives like replacing their halogen light bulbs with compact fluorescent ones, fitting motion sensors in private offices and installing variable frequency drives (VFD) to control the speed of pumps and fans. A major energy reduction initiative they introduced to increase their energy efficiency, reduce wastage and monitor performance was the installation of meters in many of their systems such as electricity meters, natural gas meters, sub-metering of both indoor and outdoor (i.e. irrigation) water usage, static pressures and ventilation air volumes, cooling load, boiling efficiencies and VFD operation. Meters were also installed in their tenants' facilities in order to encourage their participation in reducing energy consumption. The building's procurement department proactively distributed energy efficient light bulbs and energy management kits to the

tenants as well (*Regional Green Building Case Study Project: A post occupancy study of LEED projects in Illinois*, 2009, p. 59).

Merchandise Mart found it a bit challenging to interfere with the building's plumbing system since it dated back to when it was installed in 1930. Many of it was fixated in a way that made it difficult to be replaced, for example the toilets' flush valves were put behind a marble wall that represents the artistic design at that time, and due to that it was difficult to control the water flow. However, the building management decided to change the fixtures that were accessible in order to gain direct payback rather than destroying valuable structures of their building to access hidden water systems. They obtained their water efficiency prerequisite and credit through installing low flow fixtures in highly used fixtures. This made them gain the qualitative prerequisite and credit as well as meet all the quantitative requisites. Another initiative they introduced which made them save more than 6 gallons of water a year was the upgrading of its computer room AC system with a revamped feature that recycles water using a cooling tower instead of consuming domestic drinking water (*Regional Green Building Case Study Project: A post occupancy study of LEED projects in Illinois*, 2009, p. 60).

Merchandise Mart started using green cleaning products and adopting green cleaning practices in 1990. And since they have applied for the LEED certification recently, they made sure that all their internal and external housekeeping contractors used approved LEED green cleaning products. That and their participation in the Clear Air Counts scheme made them gain credits under the LEED Materials and Resources category. Moreover, when Merchandise Mart realized that certain waste materials could be recycled in the market (i.e. paper, metal and construction waste) more than 20 years ago, they started segregating them and sending them for recycling. They slowly expanded their recycling activity to more materials like cardboard, glass plastic and aluminum. With time they started composting waste as well as sending the ones that were

in good condition to local charities (*Regional Green Building Case Study Project: A post occupancy study of LEED projects in Illinois*, 2009, p. 60).

Moreover, Merchandise Mart's participation in the Clear Air Counts scheme made them voluntarily commit to reducing their use of Volatile Organic Compound (VOC) products and construction materials like paints, adhesives, carpets and coatings. These actions helped them meet the credits under the Indoor Environmental Quality category. More about the LEED credits that Merchandise Mart gained can be found in Appendix C (*Regional Green Building Case Study Project: A post occupancy study of LEED projects in Illinois*, 2009, p. 60). With all of these achievements, Merchandise Mart did not only reduce its consumption of resources and save costs, but also gained loyalty from its tenants and customers especially after it raised a lot of awareness on the importance of sustaining existing buildings (*Regional Green Building Case Study Project: A post occupancy study of LEED projects in Illinois*, 2009, p. 61).

### **2.1.7 Case Study: PRUPIM, UK**

On a macro level, a real estate fund manager called PRUPIM decided in 2005 to achieve ISO14001 certification on Environmental Management System (EMS) to reduce the environmental impact of 26 of its major multi-occupied office buildings, which in total consumed about 96 million kWh of energy in 2009/10. The certification is internationally recognized and promotes continual environmental improvement of the areas specified in the certification. Through applying the standards of this specification, PRUPIM aimed to focus on lowering expenditures and reducing its buildings' CO<sub>2</sub> emissions, water and energy consumption as well waste disposal.

Amongst what have been implemented in the buildings, PRUPIM enhanced the heating and cooling controls of the Building Management



System (BMS) to have them operate when needed and as per working hours instead of having them switched on all day long. Energy efficient light bulbs were used to increase lighting efficiency in the buildings. They also segregated and recycled waste which helped in reducing the burden on landfills. Tenants were involved in which they were engaged in the buildings' waste segregation and energy reduction campaigns to increase sustainability awareness. The running time of toilet faucets were reduced as well to 6 seconds compared to 14 seconds previously.

For two years since 2008, these and many other initiatives had helped in lowering 4,350 tonnes of CO<sub>2</sub> emissions. 9% of energy consumption per m<sup>2</sup> was reduced saving 9.1 million kWh of energy and £700,000 in two years. Water consumption was also reduced per m<sup>2</sup> to 23% which contributed to saving 54 million liters of water. Furthermore, 4,117 tonnes of waste was diverted from landfill due to recycling 42% of waste (Case Study: PRUPIM, 2011).

## **2.2 The Need for Research on Greening Existing Buildings in the UAE**

### **2.2.1 The Research Question**

From the case studies mentioned in this chapter, it shows that any existing building can be greened regardless of how old they are. For example Merchandise Mart was constructed in 1930 and that didn't stop its owners and management team to sustain the building's environmental performance. In addition, some of the cases mentioned focused their greening initiatives to a specific area like energy efficiency and others expanded their projects to implementing more than one initiative like including transportation, water efficiency and waste in their sustainability plan. Some of the projects used certifications (i.e. ISO 14001, LEED certification for existing buildings) to enhance their building's

environmental performance and others just depended on improving systems and/or raising awareness to reduce consumption and save costs.

There is no doubt that the concept of sustainably greening existing buildings became or is starting to become second nature to many industries around the world. The UAE, however, has not reached to that point yet. For instance, the Dubai Municipality Terms and Conditions manual is not necessarily going to be implemented on all existing buildings, where it only applies on existing buildings that meet certain conditions, like changing the facility type (from a school to an office) or if the renovation will affect the energy performance of the building or health and safety of the occupants (*Green Building Terms and Conditions*, p. 8). Furthermore, as stated earlier, greening existing buildings provides an opportunity for many building owners to optimize their building performance, save money and reduce their environmental footprint. All to sustain our future generations and establish a system similar to the *Cradle to Cradle (C2C)* concept. This concept means “*using environmentally safe and healthy materials; design for material re-utilization, such as recycling or composting; the use of renewable energy and energy efficiency; efficient use of water, and maximum water quality associated with production; and instituting strategies for social responsibilities*” (Bruce, 2009).

One way to move forward with sustaining the UAE’s resources and environment is to ensure that the resources used to operate the current developments and existing buildings are not wasted and are handled in a sustainable manner. Every region or country has its distinctive environmental problems that need to be tackled and the best way to understand how to tackle those problems is to learn from some examples of existing buildings that turned green in their area. Dubai Chamber of Commerce and Industry’s headquarter building is a good example of an existing building in the UAE that embraced the concept of sustainability early on when started operating in 1997. It is currently the only building in

the Arab World that achieved LEED certification for existing buildings and the fourth outside the United States of America (USA) and Canada. Moreover, it recently obtained an ISO 14001 certification for Environmental Management System. It is worthwhile to understand what this building has achieved throughout the years and what benefits other existing buildings in the UAE can gain from their experience.

### **2.2.2 The Research Aims and Objectives**

Given the fact that there is a drive and need for green buildings in the UAE, most of the efforts so far have focused on new buildings although the majority of buildings already exist here. This research aims to see if there are examples in the UAE of existing buildings that adopted certain strategies to save costs and sustain resources; and then see if those strategies can be adapted to other buildings in the UAE to achieve the same purposes. In particular, the research objectives below include what this paper aims to focus on to answer the research question:

- a. Identify an example(s) of an existing building in the UAE that turned green and determine what they have done to do so;
- b. Identify how cost effective it is to green existing buildings;
- c. Identify the barriers for greening existing buildings; and

Consequently, the research aims to learn from the experience of an existing building(s) that turned green in order to build on a relatively small body of knowledge about this concept and contribute towards assisting the UAE in making the transition to greener buildings and a more sustainable development.

### **3      CHAPTER THREE: RESEARCH METHODOLOGY**

### 3.1 Methodologies of Research

There are various types of research methodologies that can be considered for use to answer the research question of this paper along with the objectives set for it. This part of Chapter 3 will explore a few options of research methods (i.e. experimental, modeling, field monitoring and literature review approaches) and discuss the relevance of each, then eventually choose the best methodology for this research.

An experimental research method basically conducts intentional manipulation of certain elements (i.e. environmental) to observe the effects of such changes on the studied groups or matters. There are different ways of conducting the experimental research method. For instance, if the researcher chooses to conduct his experiment on a random group of people, this will then be called a “*true experiment*”. However, if the experimental groups were those that have volunteered to participate in the research, it will then be called a “*quasi-experiment*”. If the researcher was part of the experimental group, the research will then be called an “*action research*”. There is a fundamental structure of conducting an experimental research; though it is not always firmly followed due to causes like budget, ethics, and uselessness. In any case, ignoring a stage should be validated and explained. The five fundamental stages of conducting the experimental research method include sample specification, test groups (i.e. staff, visitors, tenants, contractors), sampling frequency and time-scale, conducting the experiment and data analysis (Shuttleworth, M., 2008).

For instance, an experimental research was conducted by the International Centre for Indoor Environment and Energy at the Technical University of Denmark on thirty female subjects (i.e. test group) to test the impact of indoor air temperature and humidity in an office on perceived air quality, sick building syndrome (SBS) and performance. The test group was placed in a real office space where they got exposed to 280 minutes of three levels of air temperature and humidity as well as two levels of

ventilation rate (20°C/40%, 23°C/50%, 26°C/60% RH at 10 1 s<sup>-1</sup> p<sup>-1</sup> outside air, and 20°C/40% RH at 3.5 1 s<sup>-1</sup> p<sup>-1</sup> outside air). The only thermal comfort that was maintained by the test group was having them adjust their own clothing with the different thermal conditions. After each exposure, the test group was asked to indicate their perception of each environmental condition as well as the intensity of SBS symptoms they had at that time. The analysis of the experimental research concluded that work performance was not considerably affected by the levels of indoor temperature and humidity; nevertheless, SBS symptoms (i.e. concentration of fatigue, headache and difficulty in thinking) were reduced when the test group worked in low levels of air temperature and humidity. Hence, the longer the test group got exposed to lower indoor temperature and humidity, the more this can help in improving their performance at work (Fang et al., 2004, p. 74)

Using the experimental research method in this research paper will only limit the results to understanding the test groups' feedback and reaction towards some of the green building initiatives implemented. In addition, there could be other initiatives implemented which do not necessarily affect the test groups like the ability of getting feedback from staff on the use of eco-friendly furniture and not being able to do that with the visitors, tenants and contractors. Hence, there will difficulty in gathering enough information to meet the objectives of this research if an experimental research approach was used.

Computer simulation is another research method that assists in explaining the occurrence of certain systems whether they are complex or simple. At the same time, it gives an indication of what might happen in the future while other types of research methods tend to go back in history to explain what, how and why certain events had happened or will happen. There are a few approaches to simulation in the "*organizational sciences*" like discrete event and agent-based simulation (see Appendix A).

Discrete event simulation models are used to identify variables of an organizational system that it wants to study, then introduces events to those variables to observe the changes in their values in “some role-oriented but stochastic manner”. However, this type of simulation is not suitable to look at variables interacting with each other (i.e. different systems with each other) and causing continuous changes in the study results. The agent-based simulation models are “best fit for situations when the organizational system is best modeled as a collection of agents who interpret the world around themselves and interact with one another via schema”. Such a model directs its attention on organizational participants (i.e. corporations, groups, staff, etc.) as well as their overall behavioral approach. Consequently, the agent-based simulation type of research method is more applicable for use to answer part of this paper’s research question. One of the reasons why the agent-based simulation model is better than the discrete-event models is because it can propose individuals’ behavior/work towards changes occurring in the organization.. If such a method will be implemented in this research, it should mainly follow seven basic steps including:

1. Conceptual Design: Planning for conducting the research, looking at the research limitations, and identifying the main variables.
2. Code Development: Looking at methods of successfully developing the software.
3. Validation: Evaluating between the actual system and the simulation outcome.
4. Experimental Design: Looking at methods of influencing the variables throughout the research investigation.
5. Implementation: Preliminary implementation of the software, and “*transit versus steady-state behavior*”.
6. Data Analysis: Analyzing the implementation outcome and considerable changes.

7. Result Interpretation: Comparing between the predicted theory and the simulation outcome (Dooley, K., 2002).

One example of a research that used computer simulation as part of its study was carried out by a couple of professors at the University of Athens to look at the energy performance of eight new and existing museum buildings in Europe in order to implement improvement measures to enhance the comfort levels of the building occupants as well as lower their consumption of energy. To achieve this, detailed simulations were carried out using analyzing tools like TRNSYS 2002, which calculated the buildings' energy consumption via heating, lighting, cooling, and other electrical consuming purposes. Identifying the consumption helped in proposing proper measures to improve the heating, cooling, and lighting consumption of each museum building (Zannis et al., 2006, p. 199).

Although any of the simulation approaches mentioned above can be quite useful in predicting certain results of research implementation, the modeling approach in general tends to fade away in certain cases, particularly when simulation is not commonly used in disciplines like strategy, organizational structure, and behavior (see Appendix B) (Dooley, K., 2002). Therefore, while the agent-based simulation model is a good tool to be used in this research paper, it will not verify all the required research objectives such as identifying the barriers for greening existing buildings.

In terms of the literature review research method, this approach basically looks into issued data that focuses on a particular subject area. Literature review can be in the form of a summary or a synthesis. In the summary form, the data is summarized into main headings of the topic source. The synthesis form of the literature review rearranges, and reclassifies the data of the topic source. It also reviews previous published information and may provide a new explanation for that, or it joins both old and new



explanations. However, literature review formats commonly use some sort of an “*organizational pattern*” where they join the two mentioned forms.

It is important to distinguish between an academic research paper and a literature review as the first tries to back up its research topic with evidences and argument while the second summarizes and/or synthesizes the argument itself and might add more opinions and concepts. Another difference between them is how the study was conducted, in which literature review contains sources of researches while the academic research paper contains the argument of the topic itself along with the sources. At the same time, both can have a few similar aspects like seeing a lot of academic research papers having a literature review segment in it (*Literature Reviews*, 2007). A literature review research style can partially be used in this research paper to assist in meeting the research objectives through looking at papers, documents, records and literatures to understand the concept of greening existing buildings as well as look at the various initiatives implemented in buildings to reduce their environmental impact.

In terms of the field monitoring research approach, there are several types of research methods that are applicable to this approach, such as the case-study method. The case study research method requires great monitoring and observation of a number of chosen individuals or occurrences. Such a method can be conducted via behavioral observation, looking for records, and carrying out interviews (*Introduction to Some Basic Issues Concerning Research Methods in Psychology*). The case study research method incorporates smaller groups of participants having conditions or issues that are not commonly known. It usually offers a lot of details of the cases the researcher looks into, such as participants’ experiences and knowledge (*Types of Research Design*, 2002).

For instance, one example of a case study research focused on the effects of green buildings on employee health and productivity. This was done by conducting two case studies to monitor the employees’ (study 1, n=56;

study 2, n=207) perceived health and productivity after moving from standard to green (as per the Leadership in Energy and Environmental Design ratings, i.e. LEED) office buildings in Lansing, Michigan. Surveys were put together after reviewing relevant survey literatures and health questionnaires and then distributed to the employees as a web-based form before and after they moved to their new offices, and each survey took them 20 minutes to complete. The study period lasted for about months, and then the survey results were extracted into an Excel spreadsheet and analyzed in Excel and Minitab 15<sup>36</sup> software programs. Results of the two case studies concluded that moving to the LEED certified buildings got the employees exposed to improved indoor environmental quality which contributed increasing the employees' productivity and reducing the perceived absenteeism and illnesses like asthma, respiratory allergies, depression and stress. Hence, these initial findings show that working in green buildings may positively contribute to its occupants' public health (Singh et al., 2010, p. 1665).

Since this research paper is targeted towards learning from green building experiences through observation, looking for records and carrying out interviews, it seems to be very applicable to be used as a research method. Moreover, using this type of method can provide a small body of knowledge about greening existing buildings. Hence, the following section of this chapter will go into detail about the case study approach and its relevance to this research topic.

### **3.2 Research Design: A Case-Study Approach**

Similar to other types of research studies, the case study research approach is one method of examining an empirical subject that is required to follow a set of procedures (Yin, 2003, p. 15). What differentiates this type of research approach from others is that it captures the complex happenings within one case study. The manufacturing of a notebook for

instance has its own story; however, it might not be as significant for it to be included as a case study topic. A topic is worthy of being studied if it has got the potential to deliver an important message to its concerned audience. We study a case when we want to look at how the details of interaction, whether internally or externally, affect its context (Stake, 1995, p. xi).

According to Yin (2003, p. 13), a case study research approach is “*an empirical enquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident*”. Yin (2003, p. 14) also adds that “*The case study enquiry copes with the technically distinctive situation in which there will be many more variables of interest than data point, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis.*”

According to Merriam (1988, p. 226), only a case study can offer a means of investigating the complex nature of an organization consisting of multiple variables of potential importance in order to understand a phenomenon. Thus, it is consistent with a descriptive and non-experimental research design, where description and explanation (rather than prediction based on cause and effect) are sought, in order to make sense of the “*big picture*” that gives individual events and causes their significations.

### **3.2.1 Distinguishing Case Study Research**

A case study research is sometimes confused with a qualitative research as in some cases, the second sticks to implementing ethnographic methods only in doing research (Yin, 2003, p. 14). The term ethnography

is defined as “*a study of culture and cultural processes that uses multiple ways to reach, observe, and document people, events, or artifacts*” (Glossary, 2003). At the same time, some qualitative researches aim to meet two conditions: (1) having the investigator observe the natural environment very thoroughly and taking notes of the detailed situation and (2) having the researcher not following any theoretical model prior to conducting the research. Hence, it is important to note that case study researches can have either one or both quantitative and qualitative evidences, while not restricting those evidences to immediate, detailed observations only (Yin, 2003, p. 14).

Any type of research study (i.e. experiment, survey, archival, case study, etc.) can either be exploratory, descriptive or explanatory. Consequently, a case study can be exploratory, descriptive or explanatory depending on how and what the researcher wants to take out of the research (Yin, 2003, p. 3). Though the three are distinguished and have specific qualities, they can still overlap on one another (Yin, 2003, p. 5). What distinguishes case studies from one another are not those three hierarchies mentioned, but are the following three conditions: (1) the type of research question, (2) the level of control the researcher has over the researched environment and people’s behavior, and (3) the time frame the research is being looked into (whether contemporary or historical):

In regards to the type of research question, research studies are carried out to answer the “who”, “what”, “where”, “how” and/or “why” of a particular circumstance, and each type of research approach is meant to answer one or more of those questions as specified in Table 3.1 (Yin, 2003, p. 5). Case study researches are meant to answer the “how” and “why” questions, in which researchers in this case have very little control over the course of events, and the topic in focus is of a contemporary situation within some real life context (Yin, 2003, p. 1). At the same time, these questions are posed to track changes over time to describe and analyze the evolution of change over time instead of focusing on specific occurrences and incidences (Grenier and Josserand, 2001, p. 425; Poole

*et al.*, 2000, p. 406). In regards to the level of control over research results, conducting a case study research will help in providing generalized and significant characteristics of contemporary events as long as the researchers do not influence over behaviors and results (Yin, 2003, p. 2).

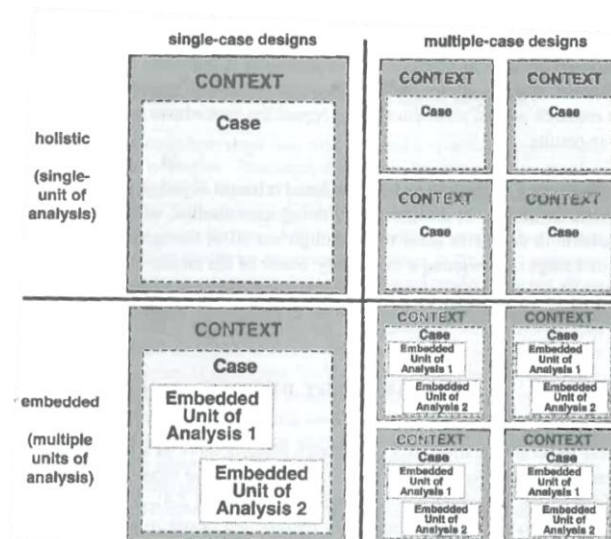
**Table 3.1** Relevant Situations for Different Research Strategies (Yin, 2003)

<b>Strategy</b>	<b>Form of Research Question</b>	<b>Requires Control of Behavioral Events?</b>	<b>Focuses on Contemporary Events?</b>
<b>Experiment</b>	how, why?	Yes	Yes
<b>Survey</b>	who, what, where, how many, how much?	No	Yes
<b>Archival analysis</b>	who, what, where, how many, how much?	No	Yes/No
<b>History</b>	how, why?	No	No
<b>Case study</b>	how, why?	No	Yes

There is an advantage for conducting case study researches as it can rely on multiple sources of evidence including: primary documents, secondary documents, cultural and physical artifacts, direct observation of events and interview of individuals engaged in the events (Yin, 2003, p. 7). At the same time, utilizing both survey and archival research approaches on a smaller scale would provide an advantage in answering the “what” questions which could arise while conducting case study researches. Several types of “what” questions are considered exploratory aiming to build generalized propositions and ideas for further investigation. Other types of “what” questions are meant to answer the “how many” or “how much” questions in a research, which largely apply on both archival and survey research approaches (Yin, 2003, p. 6). Both forms of “what” questions will be considered when conducting this research paper as this case study will rely on multiple sources of evidence, like document analysis, interviews, surveys, and direct observations.

### 3.2.2 Case Study Designs

Generally, there are four types of case study designs that researchers can choose from to frame their research depending on multiple factors including the number of case studies the research will include (single or multiple) and the number of units of analysis they will analyze their research on (unitary or multiple units). Figure 3.1 shows the four types of research designs include: (1) a single-case holistic design, (2) a single-case embedded design, (3) a multiple-case holistic design, and (4) a multiple-case embedded design. The dotted lines between the case and the context under each design might indicate the areas where the relationship between both might not be linked well (Yin, 2003, p. 39).



**Figure 3.1** Basic Types of Designs for Case Studies (Yin, 2003)

In addition, the same case study research could either be holistic or embedded. If a case study included multiple subunits that were used to analyze the research (i.e. interviews, surveys, simulations, etc), it is then considered an embedded case study design. Such a design provides a stronger opportunity to analyze the research results extensively, and could lead to strengthening the case study research. It also allows to include both qualitative and quantitative data for research analysis. However, when using this design approach, the researcher should be careful to not

be distracted with the details of one or more subunits from the main case study objective(s) (Yin, 2003, p. 46). Conversely, if the researcher studied the general approach of a case, like looking at the common direction of an organization due to certain factors, this will then be considered a holistic design (Yin, 2003, p. 43).

### **3.2.3 Rationales for Using Single-Case Designs**

Single case studies can be carried out under certain conditions, this section will discuss the rationale of conducting single case studies. It is important to bear in mind that conducting a single case study research could be equivalent to conducting a single experiment and a lot of the circumstances that are used to justify a single experiment could also be used to justify a single case study (Yin, 2003, p. 39). The main rationales for conducting a single case study include the following:

#### **a. Critical case representation:**

One rationale for conducting a single case study is to have it represent a critical case that has undergone observations and/or tests to prove a specified theory. The theory would have been developed and included a list of propositions that could be applied on the case to prove the theory right. Results of such single case studies can positively contribute to the development of new theories for further exploration and learning (Yin, 2003, p. 40).

#### **b. Extreme or unique case representation:**

The second rationale involves case studies that are not commonly prevalent, but are worthy to be studied as a focused topic. This includes subjects or issues that are new to a specific circumstance, like having an environmental phenomenon that rarely occurs but is significant to its surrounding community.

**c. A typical case representation:**

On the contrary to the second rationale, single case studies could also represent typical cases amongst many. The outcome of such case study researches could be used to represent typical cases of the same nature (Yin, 2003, p. 41).

**d. Revolutionary case representation:**

A fourth rationale for conducting single case studies is when researchers get the opportunity to observe a specific occurrence that scientists were not able to access previously due to their revelatory nature.

**e. Longitudinal Case:**

A fifth rationale for conducting single case study researches is when researchers intend to observe or study a single case at two or more chosen points in time, which explains why it is called a longitudinal case (Yin, 2003, p. 42).

### **3.2.4 Misconceptions about Case Study Researches**

Many researchers avoid conducting case study researches although they are considered a unique form of “empirical inquiry”, similar to what can be found in surveys and experiments. There are a few misconceptions and misunderstanding about the case study approach which include the following:

1. Some view the case study research approach as a lengthy form of research, which consists of extensive amounts of readings and produces documents that are scattered and cannot be understood. A lot confuse this study approach with a form of data collection called ethnography or participant-observation. They both usually require a long time in studying the subject for data to be collected and verified. However, case study research does not exclusively



depend on data collected through ethnography or participant-observation. Researchers can blend various data collection methods together and produce a valid research outcome (Yin, 2003, p. 11).

2. A few also do not believe that a case study research result can be generalized to represent a specific phenomenon or incident. However, when considering experimental researches for instance, people could ask the same question: How can a single experimental research result be generalized? It is true that scientific facts mostly come from conducting multiple experiments under various circumstances, which can also be applied on the case study research approach by conducting multiple researches on the same phenomenon. In addition, similar to conducting single experiments, carrying out single case studies can be generalized to “*theoretical propositions and not to populations or universes*”. Hence, the specific case study “*does not represent a “sample” as its main aim is to “generalize theories (analytic generalization) and not to enumerate frequencies (statistical generalization)*” (Yin, 2003, p. 10). Therefore, the objective of conducting case study research is “*to do a “generalizing” and not a “particularizing” analysis*” (Yin, 2003, p. 11).

### **3.3 The Case of Dubai Chamber of Commerce and Industry**

In an effort to learn from examples of existing buildings that turned green in the UAE so as to meet the objectives of this research and answer the research question, it was found that the Dubai Chamber of Commerce and Industry headquarter building is the only building in the UAE (so far) that achieved a green building certification which is the Leadership in Energy and Environmental Design for Existing Buildings (LEED EB 2.0). Since this is the case, then a single case study approach seems to be more

applicable for this research. Other grounds why the Dubai Chamber case study was chosen include the following:

1. Learning from this building's experience can provide answers to the research objectives, and hence the research questions. Dubai Chamber is known to be the fourth building that achieved the LEED Green Existing building certification outside the United States of America and Canada and the first in the Arab world. However, before they intended to achieve the certification, they have already made significant changes in their building towards sustainability. In addition, they were willing to provide further information about the building. Having access to such data allows for a detailed exploration of "what" changes took place in the building, "how" those changes were implemented, and "why" such changes came about towards sustainably renovating the building.
2. Dubai Chamber meets two of the mentioned rationales for conducting a single case study research. The first rationale includes the Chamber's representation of a unique case. The building is unique in the sense that it is the first, and is currently the only; building that achieved the LEED Existing building certification in the UAE. An example that other business buildings that experience the same climatic conditions in this region could look upon to achieve sustainability. The second rationale is that this research is aimed to study the changes that the building went through at a few chosen points in time in order to achieve sustainability. This, as a result, is considered a longitudinal form of study, which is less likely to depend on experimental or archival research approaches and would be better off carrying out a proper case study research. As Yin (2003, p. 23) states: "*case studies have been done about decisions, programs, the implementation process and organizational change*", which applies on the objectives of consulting this research.

### **3.4 Data Collection Methods**

Triangulation is the principle of using multiple sources of evidence when collecting research data. The more sources collected for case study research the stronger the research paper becomes in regards to its accuracy and assurance (Yin, 2003, p. 97). Following such an approach provides the investigator the ability to explore further grounds and touch upon wider issues relevant to the research area (Yin, 2003, p. 98). Hence, multiple sources of information are used to collect data for this research project and the results of the data collection will be integrated to conclude the findings in the results section of this research paper (Scholz, R., W., 2002, p. 14). This research involves a few methods of data collection, such as document analysis, archival analysis, participant observations and interviews. Further details about each method are elaborated in the following paragraphs.

#### **a. Document Analysis**

Documents are used in this case study research to support and highlight evidence taken from various sources. Such sources include communication materials, minutes of meetings, and administrative documents (*Data Collection Core Competencies*, 1998). A large portion of the documents that will be analyzed will be extracted from Dubai Chamber.

#### **b. Archival Analysis**

Archival research is “*the analysis of materials that have been stored for research, service, and other purposes both official and unofficial*” (Angrosino, 2007, p.51). Such research materials that are used in this research include survey results, and organizational documents and history.

### **c. Participant Observation**

Observation is the “*act of perceiving the activities and interrelationships of people in the field setting through the five senses of the researcher*” (Angrosino, 2007, p.37). Participant observation basically involves the researcher taking roles in the activities being studied rather than being a passive observer (Yin, 2003, p. 93). Such a role includes being a staff member in an organization for instance, and in the case of this study, being a Dubai Chamber staff member. One of the advantages of carrying out the participant observation technique is having the research observer able to get access to information that usually is not accessible to outside researchers or observers that conduct direct observations. The observer might then be able to influence the occurrence of minor events or the direction of thought, while bearing in mind to not be taken into potential bias conclusions from doing so (Yin, 2003, p. 94).

### **d. Interviews**

Interviewing is “*a process of directing a conversation so as to collect information*” (Angrosino, 2007, p.42). Conducting interviews is one of the most important ways of collecting data in a case study research. A few staff in Dubai Chamber who played a significant role in implementing the green building strategies and communicating such initiatives was interviewed to gather the key learning points and successful stories from them in order to assist in answering the questions of this research paper.

## **3.5 Data Analysis**

The best way to carry out a case study research analysis is to initially indicate a general analytic strategy that would suit the research topic and the way the research paper will display the data collected (Yin, 2003, p. 115). The strategy that is used to analyze this research project relies on *theoretical propositions* which led to the formulation of the research

objectives (Yin, 2003, p. 111). A couple of the hypothesis that was mentioned in the literature review section included:

1. The availability of simple strategies for building owners/operators to focus on so as to improve their building performance;
2. The importance of occupant awareness and building their sense of responsibility towards the environment in increasing the effective implementation of green strategies on existing buildings.

Hence, the following objectives were formulated as a result of the generated hypothesis:

- What has Dubai Chamber done to green its existing building?
- How has it overcome barriers (perceived or real) to greening buildings?
- What lessons can we learn to assist greening other buildings in the region?

The logic model technique is a specific analytic technique that is used to analyze this research alongside relying on theoretical propositions as the general strategy. Such a technique is used to tackle the development of both internal and external validity issues that could arise from conducting case study researches (Yin, 2003, p. 115). This type of technique studies a series of intricate occurrences over a period of time, where it illustrates continuous “*cause-effect-cause-effect patterns*”. As Joseph Wholey (1979), who developed the logic models as an analytic technique, states: “*the intervention could initially produce activities with their own immediate outcomes; these immediate outcomes could, in turn, produce some intermediate outcomes; and, in turn, the intermediate outcomes were supposed to produce final or ultimate outcomes*”. Hence, the main concept of this technique is to align the “*empirically observed events to theoretically predicted events*” (Yin, 2003, p. 127).

The type of logic model that is discussed in this research is the “*firm or organizational-level logic model*”, which basically follows events that occur

in a particular organization (Yin, 2003, p. 130). In the case of this study, the events that took place in Dubai Chamber were traced over a period of time in a chronological manner for analysis based on this paper's research objectives.

**4      CHAPTER FOUR: RESEARCH RESULTS, DISCUSSION AND  
ANALYSIS**

As a results of Chapter 3 on the methodology, Chapter 4 on the results, discussion and analysis will apply the single case study method on the Dubai Chamber headquarter building to learn from its green building experience and see how other existing buildings in the UAE can learn from them by finding answers to the research question and objectives. This will be done by understanding the organization's history and journey towards sustainability as well as exploring the various sustainability initiatives that the building implemented and their applicability on other buildings in the UAE.

## **4.1 History of Dubai Chamber of Commerce and Industry**

### **4.1.1 Overview of the Dubai Chamber's Establishment**

The Dubai Chamber of Commerce and Industry was established in 1965 as a private non-profit organization, whose mission is to represent, support and protect the interests of the business community in Dubai, by creating an encouraging business environment; supporting the growth and development of business; and by promoting Dubai as an international business hub. With the economic expansion of Dubai, the Chamber has rapidly been growing and it currently represents more than 120,000 Dubai businesses. Some of its services include mediation and arbitration, the issuance of certificates of origin, economic research, training, responsible business services, business groups, business awards and events.

The head office building is located in the Riggat Al Buteen community, along Dubai Creek and is part of the old Dubai downtown. At 91 meters (300 feet) in height, the Chamber was the seventh tallest building in Dubai at the time of its construction in 1992. The total floor area of 20,000 m<sup>2</sup> (Sq. m) is spreaded over 18 stories. It is occupied by about 500 individuals including the University of Dubai, Dubai Economic Council and Dubai International Arbitration Centre aside from its Dubai Chamber staff which



constitute to the majority of its occupants. It is connected to a 700 seater auditorium and also consists of conference rooms, plant rooms, as well as underground and outside parking spaces. Construction works of the building were completed during the late 1994. The building was then occupied in February 1995.

#### **4.1.2 Dubai Chamber's Journey towards Sustainability**

Dubai Chamber has played an important role in improving the business climate of Dubai. With a vision to the known vital source of competitive advantage for the business community in Dubai, it's well on its way to achieving its mission of being the first choice for support and assistance in all their accomplishments. It has also been actively seeking to show leadership and commitment to the enhancement and preservation of the environment for over a decade now. The story and the concrete initiatives towards sustainability are broken down into three phases.

The first phase included tweaking up of the building systems between 1998 and 2008 to have it function in a more cost effective and sustainable manner. The Chamber's main office building is an 18-storey, 91 meter high building with 20,000 m<sup>2</sup> of floor space that was completed in 1995. It was designed by Nikken Sekkei architects from Japan where strong health, safety and environmental elements were considered when constructing the building. Although the building was built like most other existing buildings in our region at that time, which is to consume excessive energy, water as well as produce too much waste, it did have a good foundation that maintained the quality of its structure and systems. One of which includes specifying that the building envelope, double glazed windows and roof insulation would meet ASHRAE 2004 standards for thermal transmittance, solar heat reflectance and solar heat absorption properties.

The floor and wall tiles were made to comply with low emissivity requirements. The lighting system was also made to comply with ASHRAE 90.1-2004 standards. The Japanese architects didn't stop there as they also made the building earthquake resistant, where they separated the foundation from the walls by a rubber shock absorber to facilitate the building's movement. These all gave the building a great health, safety and environmental foundation compared to many other existing buildings in Dubai and the UAE.

As mentioned earlier, the Dubai Chamber head office building was over-engineered where they consumed too much energy and water, which was common at that time. The head engineer had then wanted to find for ways to reduce energy and water consumption, however, when the building was initially occupied in 1995, it had a warranty period of two years where he couldn't apply any of the improvement ideas he had in mind. But in 1997, when the building was handed over to the Chamber after the warranty period, engineer Gunawardena was able to take full control over the building operation, which enabled him to begin applying his green ideas. At that time, there was no budget dedicated to work on reducing the building's resource consumption as no one took this idea seriously at that time, so engineer Gunawardena and his team implemented zero-budget cost saving initiatives behind the scenes and used the building's normal operational budget to have them implemented.

Phase two then goes through the steps of applying and achieving the LEED Existing Building 2.0 certification from the U.S. Green Building Council. In 2009, Dubai Chamber decided to demonstrate that it had successfully greened its existing building without a major renovation or investments by applying for the internationally recognized green building certification LEED for Existing Buildings. It wanted to break down the myths that greening existing buildings was costly, required major renovations and not feasible in the Middle East. However in 2002, a few years before achieving LEED for existing buildings certification, a green

building team was established to work on the Chamber's green building initiatives and they consisted of employees that played essential roles in assisting to apply those initiatives. A LEED AP consultant was also hired to assist the team with documentation.

Since phase 1 involved numerous initiatives related to energy and water consumption as well as waste minimization and recycling, the team was able to easily gain credits in the LEED scoring scheme. From the assessment results, both sustainable transport and green cleaning were required to be improved in order to comply with the LEED requirements. Given that it was the first time that the team had to look into sustainable transport and green cleaning, they faced a little bit of challenge in understanding exactly what was required, like what constitutes an eco-friendly product, how to source greener products and services in the market as well as how to encourage sustainable transport in the office. In addition, even with having a green building team and a LEED AP consultant available, it was somehow challenging to collect the required documentation to fulfill some of the requirements given the technical specifications required by LEED. These were not always obtainable or easy to collect from suppliers and staff. However, the team managed to meet enough requirements in the end to achieve the LEED certification in 2009.

Finally, phase three started after achieving the LEED Existing Building certification in 2009 which involved retrofitting the building further by using the LEED framework as a guide to the building's renovation. By 2010, Dubai Chamber's head office had already been operational for about 15 years, so it was due for renovation. When planning for renovation, the green building team took it as an opportunity to further enhance the health, safety and environmental practices of the office using the LEED framework along with a few other initiatives like ISO14001 standards on environmental management system. This fit out, which began in 2009 and is due to be completed in the end of 2013, showcases a highly appealing

aesthetic which has won design awards with multi-functional high tech spaces. It was not an easy job to have this achieved as the contractors were less aware on the subject of sustainable renovation. The green building team found it challenging to educating the contractors on sustainable renovation as the contractors were used to the conventional ways of renovating buildings. Hence, a lot of time was invested by the green building team to source sustainable construction products for the contractors to use as well as and train the construction workers on applying green renovation practices.

*“It definitely was not the fashion back then but it was the passion of a few employees who identified the water and energy wastage and understood the importance of improving practices,”* said H.E. Hamad Buamim, Director General of Dubai Chamber (2009). The team responsible for the eco-friendly building recognized that savings could be made by adapting the over-engineered building. The changes were implemented gradually since 1997. The team was not formally formed from the beginning as each member provided his/her contribution when they took over the building responsibilities.

The head engineer Jagath Gunawardena, Project and Building Development Manager, was the mastermind of the major green building initiatives that were implemented in the building, which will be mentioned in the following sections. Mr. John Sinthurayaen, Building Services Manager, took on the responsibility of implementing the operational assignments of the initiatives applied by the team including the head engineer. Mr. Mohamed Mahgoub, Administration Director, made sure to provide support towards the planned initiatives as well as to obtain as much buy-in and support from the staff.

Ms. Annelies Hodge, Corporate Social Responsibility (CSR) Manager, played a role in coordinating and communicating Dubai Chamber’s green building initiatives as well as their benefits both internally to staff and externally to the media and the broader community. Mr. Abdullah Darwish,

Building Services Executive, assisted in monitoring and ensuring that regulations are implemented when applying the green building initiatives in the Chamber.

The passionate team members mentioned above were interviewed in this research where they collectively assisted in developing the timeline of Dubai Chamber's journey towards sustainability since its occupation until the present time. It is worthy to mention that the Chamber wanted to take the initiative of greening its building to inspire many of their members to undertake projects that would enhance their competitiveness and the quality of the UAE environment. The following sections will go in detail to explain what has been done in each phase of greening the Dubai Chamber building.

## **4.2 Implementation of the Sustainability Initiatives**

This section of Chapter 4 will list the various sustainability initiatives that were implemented in Dubai Chamber throughout its three sustainability phases under specific categories including water, energy, solid waste, transportation and products and services. This is aimed to understand "what" they have implemented and "how" and "why" they chose those initiatives. And this was done by using multiple sources of evidence (i.e. document analysis, archival analysis, observations, interviews, etc.) to answer those questions and collect research data.

### **4.2.1 Water Saving Initiatives**

#### **a. Installation of an infrared detection system**

During phase 1 (between 1998 and 2008), an infrared detection system was installed for water taps (automatic faucets) in all wash rooms within the building. This allowed water to automatically run when user's hands

were detected in a sink. Such a technology is commonly used for its convenience, hygiene as well as water saving performance. The automatic faucet has an infrared sensor mounted on it which permits water to run when detecting objects. US EPA carried out a detailed study and revealed that using automatic faucet systems help in reducing water consumption by an order of 1 gallon (3.8 liters) per use (*Conserving Water*, 2010). Assuming that about 200 individuals will consume the automatic faucets in the Chamber head office building per day, around 1000 liters of water will be saved per day due to implementing this system as calculated by the head engineer.

The infrared detection system was also installed in all urinal bowls. The movement of the user is detected by the control module and detector and after a delay of around 50 seconds; the urinals get flushed by the water actuator. User movements are ignored for about 60 seconds after the urinals are flushed so as to reduce excessive water wastage. After that time period, the sensor reactivates for another user. The head engineer found that installing this system had helped in reducing the flushing rate from approximately 10 per hour to 3 per hour. Hence, water consumption was reduced to 30 liters per day per urinal bowl, and this accounted for around 12,000 liters of water per day. The payback period for implementing the infrared detection system for both urinals and taps was less than two years, and this can be applicable to all toilets if a budget was allocated for it.

#### **b. Installation of aerators**

In addition to installing the infrared detection system, the taps had non costly aerators fitted on them, which helped in reducing the water flow by around 40% and contributing to saving thousands of liters of water per day with a payback period of less than 2 years. This is one of cheapest and easiest ways to save water and can be applied in most taps and faucets.

### **c. Reducing the water flushed in toilets**

During phase 1, bricks and water bottles were put in flushing tanks in toilets. This had led to reducing water consumption from between 11 and 13 liters down to about 9 to 10 liters per flush with an immediate payback period since no major investment was done. When the building was being renovated in phase 3, the Chamber was able to save even more water by replacing their previous 11 liter flush valves to the 4.5 liter flush valves, which was the lowest they could find in the market. This contributed to reducing the consumption of up to 60% of water. If existing buildings don't have a plan to renovate their toilets anytime soon in order to purchase urinals with low flushing volumes, they can simply put bricks or water bottles in the toilets' flushing tanks and instantly save water.

### **d. Installing a PLC based control system in toilets**

Moreover, a Programmable Logic Controller (PLC) system was installed in toilets to ensure that leakages are not attended during out-of-office hours. This system consists of a digital computer that automates the electromagnetic process of deactivating the flushing of toilets when light fixtures are switched off (*What Is a Programmable Logic Controller (PLC)?*, 2012). Using this system helped in saving more than 30,000 liters per day of water from deactivating flushing activities during out-of-office hours, and provided less than two years of payback period. This is a system that can be installed and connected by a technician, so it can be extended to other existing buildings around.

### **e. Using the recovered condensate water**

When operating our normal air conditioning systems, we usually notice that they generate condensate water, which is the humidity that comes out of having those systems used. The head engineer wanted to make use of the recovered condensate water, so he started collecting it from the air conditioning systems in 2004 during phase 1 and utilized it in the Chamber's outdoor fountain. The head engineer was initially not sure if the

quantity of condensate water would be enough for the fountain as no one was doing anything about it at the time, however, the commissioning of this project was successful and the Chamber was able to recover around 850,000 liters of water per year from the air handling units (AHU) with less than two years of payback period. The excess water collected was also used to clean windows instead of having them disposed. Since the collected condensate water was not infused with minerals, they have an advantage of not causing streaks on the windows. This did not cost anything and in fact it helped in reducing the building's cleaning soap requirements.

If an existing building doesn't have a fountain to supply it with collected condensate water or if the water collected was not enough to fill up a fountain, then the water can be used in many other ways like cleaning outdoor windows, irrigation or even using it for flushing toilets by connecting a pipeline to flushing tanks.

#### **f. Using polished treated sewage effluent (TSE) water in toilets**

One of the pioneering technologies that Dubai Chamber introduced in this region was the use of treated sewage effluent (TSE) (i.e. treated municipal grey water) for toilet systems. The TSE polishing system was installed and completed in February 2010 after getting municipal approval, and it was fine-tuned over a few months after that. It was no easy task to obtain the municipal approval initially as it took the head engineer a few years of convincing that this technology is safe and can work. Once the approval was granted, it was only a matter of days that the TSE polishing system was installed.

The installation of the TSE polishing system involved linking the TSE pipeline (taken from Dubai Municipality) to the building basement. TSE water then gets collected and processed in the following steps:

1. TSE water is collected into a collection tank and sodium hypochlorite is used for primary disinfection.



2. Inlet wastewater is then directed “down flow” through a sand filter media and out of the bottom distributor.
3. In order to maintain proper filtration, cleaning of the filters is done regularly via an automatic backwash system to remove accumulated solids.
4. Sand and anthracite are used for removing the suspended particles. Pebbles and gravels are provided as support for both media.
5. The filtrated water then passes through Activated Carbon Filter. It is also used for removal of chlorine, sediments organics, taste, color and odor. The large granular surface area has a large capacity to absorb impurities, resulting in clean water.
6. Bromine is then added for further disinfection after the series of filtration.
7. Treated water is then collected in a Storage Tank before being pumped through a separate plumbing system to the toilets.

Having to use this method encourages the reuse of TSE water and saves a lot of Dubai Chamber’s overall consumption of desalinized water. The Capital Expenditures (CAPEX) of the project was USD 27,740.40 which includes the equipment, supply, installation and commissioning (cost of installation). The Operating Expenditures (OPEX) of the project is USD 222.75, and USD 72.75 is spent on chemicals per year to treat the TSE water. The polished TSE water gets tested twice a year and it costs USD 150 to be executed. After carrying out the calculations, the payback period of implementing this project took 8.5 months due to the USD 39,730.99 savings (USD 3310.916 savings per month) from avoiding the cost of desalinized portable water purchased to flush toilets at the current Dubai Electricity and Water Authority (DEWA) tariff of 4.56 fills per IG.

A potential water saving project that other existing buildings can execute is to connect a separate pipeline for flushing toilets using TSE instead of having one pipeline for both taps and toilet flushing. This might require some cost investment, however, it is a worthy project as long as the

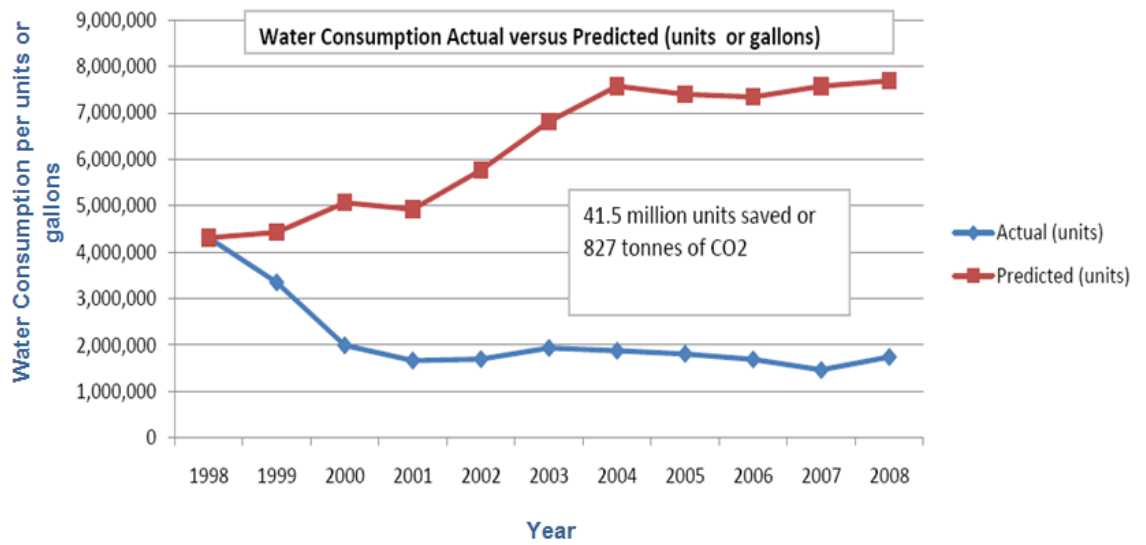
building obtained municipal approval and got access to the TSE in the area they are in.

#### **g. Sustainable greenery**

Municipal Treated Sewage Effluent (TSE) water is used to irrigate the landscape gardens instead of using desalinated drinking water. Drip irrigation is also chosen as a method of irrigating the gardens because it minimizes water loss through evaporation compared to hosing down the landscape with water. These initiatives provided an immediate payback as no extra cost was required. A major part of the landscape is planted with greenery, and desert or desert adapted vegetation (i.e. date palm, neem, cactus, etc.) is used because of its ability to survive the harsh climate and requires less water for irrigation. In addition, gardeners compost the mowed grass within the premises to be used as soil which reduces the cost of purchasing extra soil for the landscape.

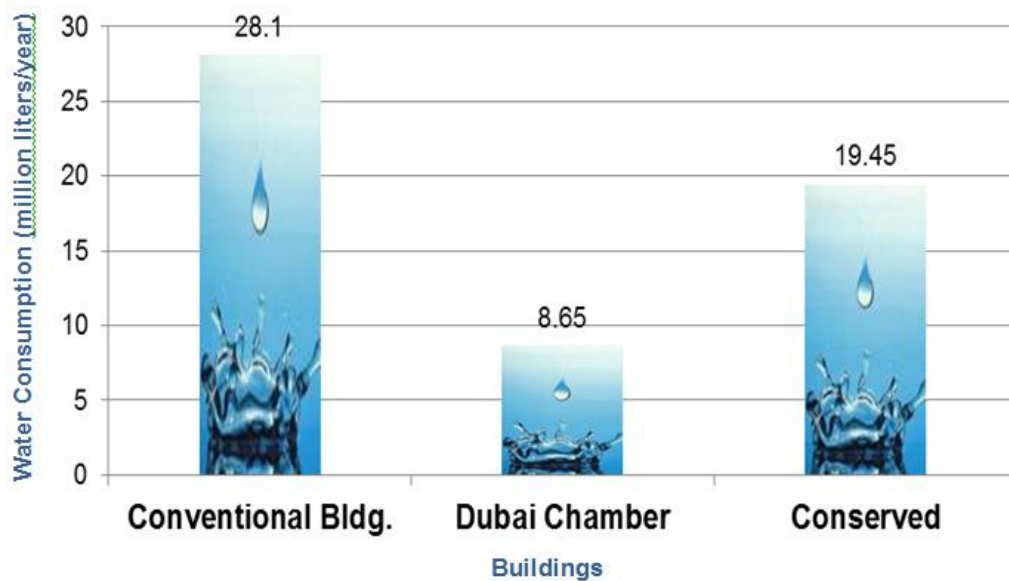
Existing buildings can implement all of the above initiatives to sustain their greenery (if they had any). They can take advantage of the free irrigation using TSE if connected to it and get the gardener to use the drip irrigation method for watering the plants. Desert and desert adapted plants are the best options for greenery used as they are not that costly, don't require that much water to live and can survive the hot UAE climate. Composting within the same premises is also a great idea to implement if there is enough space for it.

When narrowing down the water saving initiatives in phase 1 (between 1998 and 2008), the data collected in that period has shown that Dubai Chamber managed to save 77% of water consumption, which is equivalent to saving 41.5 million units (gallons) of water, 827 tonnes of CO<sub>2</sub> emissions and 1.6 million dirhams in 10 years (see Figure 4.1).



**Figure 4.1** Dubai Chamber’s Water Consumption (actual versus predicted) per units or gallons.

From all the water saving initiatives, Global Tech Safety and Environmental Consultancy, the company that Dubai Chamber worked with during the collection of their LEED submission documents, conducted a survey and found that Dubai Chamber was able to consume 8.65 million liters of water a year instead of 28.1 million liters for a comparable sized conventional building and that means it saves about 70% of water per year (see Figure 4.2). This shows that there are a lot of simple ways to make water consumption more efficient in existing buildings (*Global Tech Safety and Environmental Consultancy, 2007*).



**Figure 4.2** Survey Conducted by Global Tech Safety and Environmental Consultancy comparing the water consumption of conventional and conserved buildings against Dubai Chamber’s headquarter building in million liters/year, 2007 (*Global Tech Safety and Environmental Consultancy, 2007*).

#### 4.2.2 Energy Saving Initiatives

Similar to the water saving initiatives, a few energy saving initiatives were implemented in Dubai Chamber during phase 1 and 3 and they were all achieved out of the normal operations and maintenance budget of the building.

##### a. Enhancement of chiller performance

During phase 1, the head engineer tried to improve the cooling system by instigating a few initiatives to optimize its performance, such as insulating the chiller water line by using glass wool to comply with ASHRAE 2004 standards. The chiller water circulation requirements were also reduced leading to energy savings of 100,000 kWh per year. Moreover, the chiller operating loads were optimized which lead to an immediate payback as 5 out of the building’s 8 chillers were permanently shut down. Though this one seems to be a significant achievement, this is considered a common practice for architects especially in this region as they often construct

buildings with additional air conditioning capacity than what they actually require, said engineer Gunawardena. Hence, existing building technicians are encouraged to properly maintain their chillers and improve their efficiency depending on the areas that need to be enhanced. And this can be done by conducting regular inspections and getting updated with new chiller enhancing technologies and techniques.

#### **b. Adapting Dubai Chamber's energy management code of practice**

In addition, an energy management code of practice was introduced where air conditioning systems were switched off after working hours. In the 1990s, many thought that switching off the air conditions in a building will lead to the growth of moulds, spoilage of furniture and increase in the humidity levels. What they don't realize is that relative humidity decreases as the temperature increases in a sealed building. Having Dubai Chamber's furniture still in good condition after 15 years of operation proves this fact, and because of having the furniture not damaged all these years, they were donated to charity afterwards. Furthermore, the cleaning and maintenance of the building is done during working hours. The cleaners are not then required to go back to the building to switch on all the lights and appliances after working hours. The cleaning schedule is planned in a way where disruption does not affect the staff, and this is done by:

- Having all of the cleaning staff clean at the same time instead of letting one or two do all the job. This method allows the tasks to be completed in a short period without costing any additional charges.
- Every cleaning staff is given a schedule of the areas they are appointed to clean, so tasks are handled in an organized manner.
- The cleaners start working on their scheduled areas about an hour before the end of a working day to reduce the time spent cleaning in the office. Areas that might cause disruption of the employee's work are cleaned after they leave in order to not affect their performance.

Existing buildings can develop an energy management code of practice of their own to reduce their building's energy consumption. One of the elements they can include is to switch off all lighting and air conditioning systems after working hours while ensuring that the building is properly insulated to reduce the risk of humidity being developed. The efficient use of the building management system (BMS), if owned by the building operator, is also key to ensuring that chosen energy consuming devices (i.e. lighting and ACs) get switched off automatically instead of having the technicians forget or not do it due to other reasons. In addition, any existing building can have its cleaning and maintenance carried out during working hours (especially closer to the end of the day) as much as possible. This means that a lot of the initiatives mentioned can be carried out in other existing buildings too.

#### **c. Maintaining adequate room temperature**

Room temperature sensors were also installed (with less than two years of payback period) during phase 1 for the purpose of minimizing the cooling loads of the building during off-peak hours and this was done through maintaining a temperature of 24°C during working hours automatically via the building management system (BMS). This rises to around 27°C after working hours especially in summer with no negative impact on the building and its furniture due to maintaining proper insulation. Since this initiative is something that can easily be applied, any existing building that can control their indoor temperature (manually or automatically via BMS) is encouraged to set their office temperatures to 24°C and benefit from the energy savings.

#### **d. Enhancement of lift efficiency**

The enhancement of lift efficiency (excluding the service lift) was pioneered in 2003. The lift capacity was initially made to occupy 17 persons, but the head engineer noticed that not many people occupy the whole space at one time. So the green building team decided to conduct a

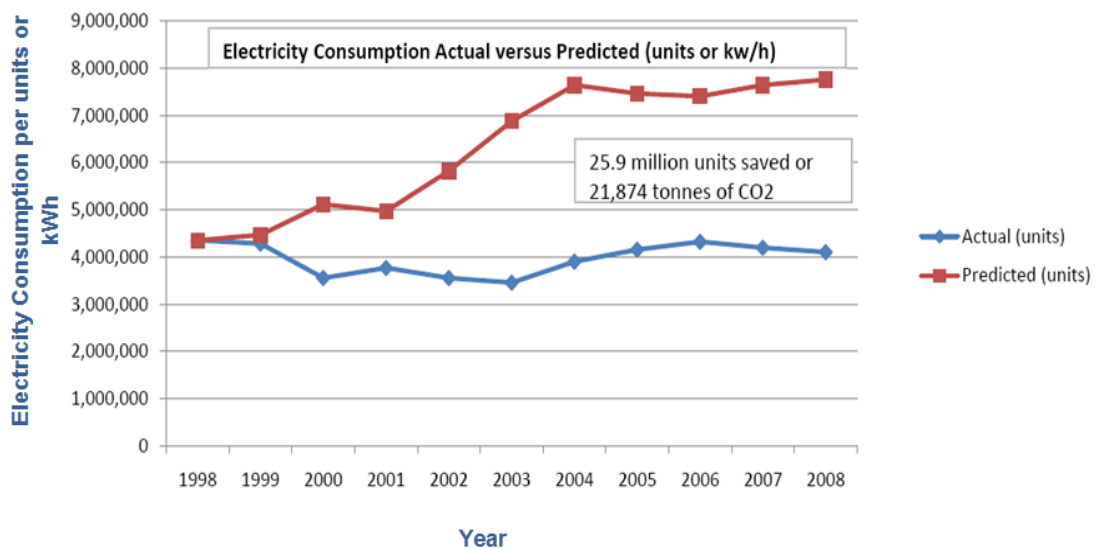
survey for one week to look at the number of people that frequently occupied the lifts, they then realized that the lifts barely accommodated more than 11 people in one trip even though the counterweights were designed to carry 17 people. Hence, the counterweights were adjusted and reduced by 20% which reduced electricity consumption by 20% and provided a payback period of less than two years. The safety of using the lifts did not decrease by implementing the adjustments; the weight load has never exceeded its limits since then (around 8 years ago). And even if this happens, the lifts will stop moving until people exit them and the weight load goes back within its acceptable weight range. At the same time, staff is encouraged to use the stairs to save energy and improve their health. Existing buildings can apply a similar initiative to this one if they are willing to invest some money on it and if there is a need to it. There are buildings where lifts are extensively used and might require the original counter weight load to take occupants to the floors they wish to go to. So once there is not much need for the extra weight, building operators can reduce the weight load while considering the health and safety aspects of using their lifts.

#### **e. Improvement of lighting efficiency**

Moreover, there were major reductions in electricity consumption from the lights through gradually improving their efficiency. 72 watts of light bulbs were initially installed in the building and during phase 1 they were replaced with 56 watts of light bulbs which helped in saving about 22% of electricity. Of course, the luminosity level was not compromised, especially in the offices and meeting rooms. Low mercury LED light bulbs were also installed in the building, hence, use 25% less energy and can last 10 times longer than the conventional light bulbs. Light and motion sensors were later on installed, which helped in the automatic switch off of the lights when rooms, hallways and toilets were not in use. And finally, a web interface for lighting and air-conditioning control was installed in staff's computers which enabled them to control the lighting and air-conditioning

systems from their own workstations instead of having all workstations consume energy excessively. This control provided less than two years of payback period due to its efficiency in consuming energy. There are many ways for existing buildings to improve their lighting efficiency and this will partially depend on the budget they have. Instead of using the conventional light bulbs, existing buildings can use LED or any energy saving light bulbs they choose to use, and this mainly can be installed in offices, hallways and meeting rooms. Caution should be given to operations that are highly dependent on high luminosity levels of lighting (i.e. in manufacturing industries). If more money can be invested to increase the lighting efficiency, light and motion sensors can be installed to activate the lighting system whenever the area is in use. And this can similarly be installed in office areas, hallways and meeting rooms.

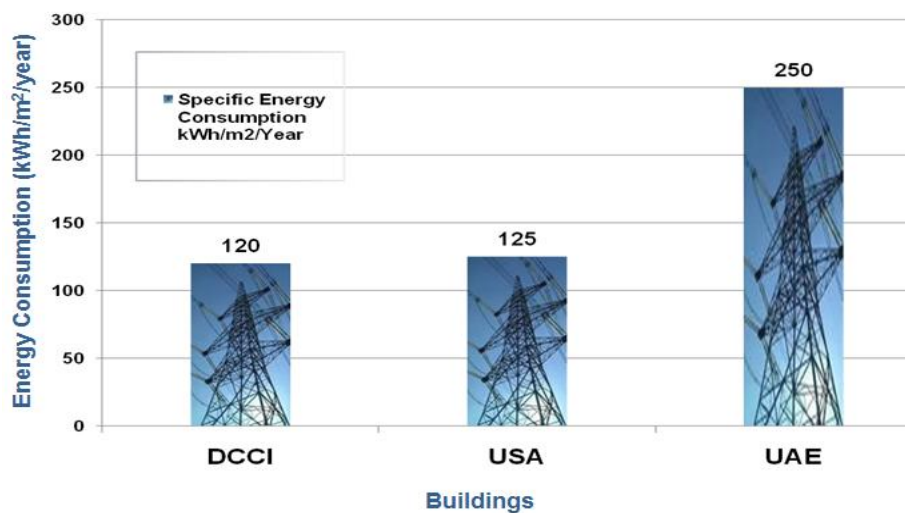
When narrowing down the energy saving initiatives in phase 1 (between 1998 and 2008), the data collected in that period has shown that Dubai Chamber managed to save 47% of energy consumption, which is equivalent to saving 25.9 million units (kWh) of electricity, 21,874 tonnes of CO<sub>2</sub> emissions and USD 1.5 million (AED 5.5 million) in 10 years (see Figure 4.3).



**Figure 4.3** Dubai Chamber’s electricity Consumption (actual verses predicted) per units or kWh.



Mr. Sinthurayaen, Building Services Manager, calculated all of the energy savings carried out above and found that Dubai Chamber was able to consume 120 kilowatt per hour per m<sup>2</sup> of electricity each year instead of 250 for a comparable sized conventional building and that means it saves about 52% of energy per year. This shows that there are a lot of simple ways to make energy consumption more efficient in existing buildings. The consumption comparison (see Figure 4.4) was provided by Global Tech Safety and Environmental Consultancy (*Global Tech Safety and Environmental Consultancy, 2007*).



**Figure 4.4** Survey Conducted by Global Tech Safety and Environmental Consultancy comparing the energy consumption of buildings in the UAE and USA against Dubai Chamber’s headquarter building in kWh/m<sup>2</sup>/year, 2007. (*Global Tech Safety and Environmental Consultancy, 2007*).

**f. Replacement of the conventional heat exchanger**

Another innovative technology that the head engineer applied in the Chamber is the use of the outdoor fountain as a heat exchanger for the building’s server room instead of building a separate cooling tower, which could result in consuming more energy (as the tower would require the chillers to operate 24 hours). The capital expenditure (CAPEX) of installing the heat exchanger was USD 3,594 and its operational expenditure was

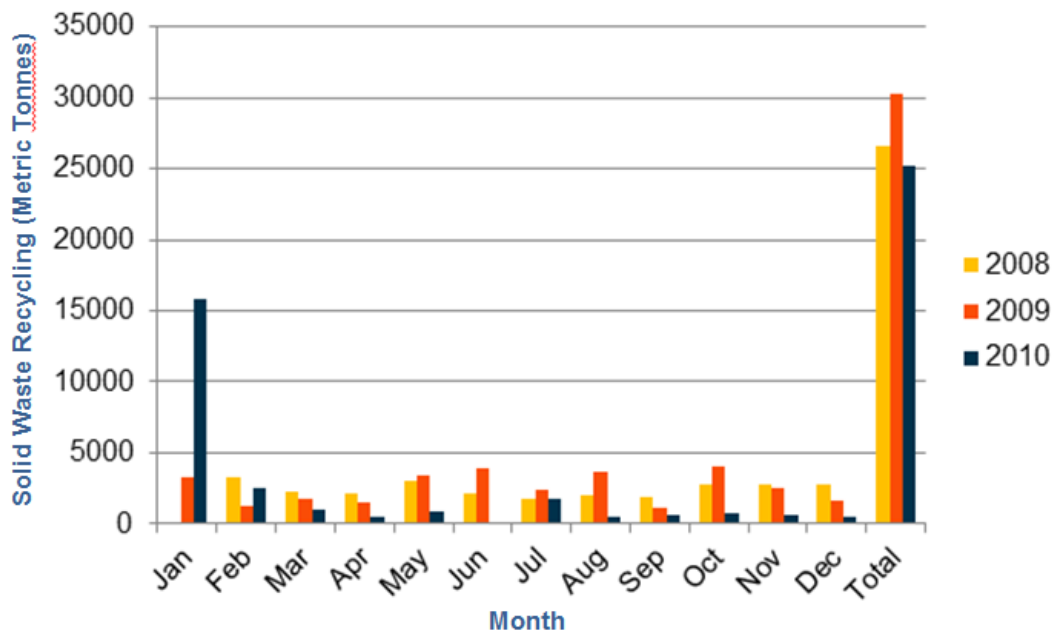
USD 1,000 with immediate payback. If a cooling tower was installed instead of using the outdoor fountain as a heat exchanger, the Chamber would have paid USD 18,919 for installation and about USD 4,054 per year to have it running as well as pay about USD 44,392 per year in extra costs as part of the main air-conditioning system. Hence, using the new innovation would reduce pollution by saving tons of CO<sub>2</sub> emissions per year instead of having sections of server rooms cooled down 24 hours a day by the air-conditioning system in one building (see Appendix G). This initiative was applicable in our area due to the availability of the outdoor fountain, other logistical facilities and experts in this area. However, this could not be extended to other existing buildings if they did not have a fountain or proper water means to be used as a heat exchanger. So this will depend on the facilities available in the building and the experience of the people installing it.

#### **4.2.3 Solid Waste Reduction and Management Initiatives**

Moving from energy saving initiatives, Dubai Chamber implemented a few programs to reduce the amount of solid waste going to landfills, such as introducing a reduce, reuse and recycle (RRR) program in 2008 to redirect hundreds of kilograms of solid waste from landfills to recycling collection points. Around 2000 tonnes of paper and plastic were being recycled per month according to 2008 and 2009 figures. When the offices were renovated in phase 3, bins were removed from under staffs' desks and instead a central waste disposal section was created. Every office floor in the building currently has a central waste disposal section installed which contains three types of collection bins: electronic, recyclable and general waste bins. Taking out the trash bins from under the office desks created an issue initially because some staff were not happy about moving away from their desks to segregate and dispose their waste in the central waste disposal section. However, after raising more environmental awareness

via different means along with having the support of leadership on this initiative helped in convincing many of the staff about the importance of recycling. Cleaners were also instructed to assist in segregating waste while cleaning in order to increase the recycling rates of the waste disposed. These all have helped in lifting the recycling rates from around 15% to over 85%. Figure 4.5 below displays the recycling results of solid waste since 2008.

Any existing building can establish a waste management program where they can source a recycling company, remove waste bins from under the staff's desks and set up the work areas with centralized recycling systems that can be accessed by the staff in the area. It is necessary at the same time to train contractors on the proper collection and disposal of waste. Both contractors and staff should also be trained on the proper way of segregating waste to increase their involvement. Another way to increase involvement is to have the staff see leadership committed to the same cause.



**Figure 4.5** Dubai Chamber's solid waste recycling results in metric tonnes between 2008 and 2010.

In addition, many efforts were made to make use of the interior building materials instead of disposing them in landfills. Some of the efforts include the following:

- Furniture items (i.e. workstations, chairs, tables, carpet, computers, and light bulbs) that were in good condition were donated to a number of charity organizations since the start of renovation.
- Some of the old building materials, like the doors and roofs, were used in the new offices instead of sourcing new building materials.
- Any item that is not useful for charity but could be recycled, like aluminum cladding, was taken to recycling centers. Recycling companies benefit from the disposed recyclables, so one of their incentives to increase organizations' participation is to provide them with some money for every amount of waste collected. The money Dubai Chamber receives from recycling its items gets donated to the Chamber's subcontractors (i.e. cleaners) as an appreciation of their efforts in helping to maintain the Chamber's green building practices.

#### **4.2.4 Sustainable Transportation Initiatives**

##### **a. Promoting the use of public transportation and eco-friendly vehicles**

When applying for LEED during phase 2, one of the areas that Dubai Chamber needed to focus on to gain extra points is enhancing its sustainable transportation initiatives. Hence, 6 bicycle racks were installed as per the LEED requirement to enable at least 1 % of the building occupants to use this facility. Building occupants were estimated at 500 full time individuals. The racks were used by staff previously, but they currently are being used by the Building's security guards and it remains to be popular.

Another LEED requirement in the area of sustainable transport was to provide at least 4% of parking space from the total vehicle parking capacity and dedicate it to the Chamber staff's eco-vehicles. Hence, from the 184 parking spaces in Dubai Chamber's parking lot, 6 spaces were dedicated to staffs' eco-vehicles as VIP parking. The method Dubai Chamber used to test if staff's cars were fuel efficient (being a hybrid or a small vehicle) or not was by entering staff's car details in the U.S Environmental Protection Agency's (EPA) Green Vehicle Guide page (EPA's Green Vehicle Guide link: <http://www.epa.gov/greenvehicles/Index.do>). If a "Smart Way" logo appeared in the results page, this means that the vehicle is fuel efficient and eco-friendlier than the big and high fuel consuming vehicles. For the Chamber's visitors, free valet parking gets provided by the security staff to those who have eco-vehicles. The eligibility of the visitor's vehicles to obtain free valet parking gets validated by the building services executive.

Given the benefits of using public transportation means, Dubai Chamber also sponsors a couple of buses for the University of Dubai (one of Dubai Chamber's building tenants) to promote carpooling. About 90 of their staff and students use this service on a daily bases, which is equivalent to 22,950 passengers a year. At the same time, the Chamber's support staff (i.e. cleaners, waiters, and technicians) uses a mini-bus to come to work daily.

Existing building occupants can contribute to reducing the GHG emissions globally by having awareness raised amongst their building occupants to carpool, use public transportation or drive eco-friendly vehicles. In many occasions this is optional for anyone to do. To encourage more people to participate, incentives can be introduced (i.e. giving out prizes for the most users, provide subsidized public transportation options, etc.) to the occupants and building users.

#### **b. Reducing of the urban heat island (UHI) effect**

Shading was installed in the outdoor car park of the Dubai Chamber building along with growing creeper plants on their poles and roofs. The extra spaces next to the car park were also planted with greenery. In addition, Dubai Chamber's building roof has a sun-reflecting nature that is also white in color which facilitates in reflecting as many solar radiation as possible. All these elements would help in reducing the need to cool the building down and minimize unnatural heating in the surrounding area which eventually reduces the UHI effect.

#### **4.2.5 Sustainable Products and Services**

A few measures and initiatives were implemented at Dubai Chamber to source and procure products that were more sustainable, environmentally friendly and do not cause harm to the human health. Some of which include the following:

##### **a. Developing sustainable procurement guideline**

As part of Dubai Chamber's efforts to conduct their operations in an economically, socially and environmentally responsible manner, they have put a plan to ensure that their purchase and use of materials, products and services is aligned with their goal. This was carried out for the purpose of assisting in improving the environmental and social impacts of the organization's operations as well as providing a healthier and more productive working environment. A sustainable procurement guideline was developed (see guidelines in Appendix D) as part of the plan to ensure that the organization is committed to implementing the following:

- Purchase the most sustainable alternatives, evaluating purchases according to economic, social and environmental criteria;

- Act ethically with all suppliers, using transparent procurement methods, communicating in an honest and open manner and respecting agreement terms;
- Raise awareness on sustainable procurement to all relevant parties, including staff, procurement officers and suppliers, and ensure it is written into procurement contracts and other documents.

All departments and individuals involved in the purchase of products and services for Dubai Chamber are required to follow the sustainable procurement guidelines. Nevertheless, there were a few challenges in executing some of the green procurement projects like when the use of disposable plastic and Styrofoam cups was discontinued in Dubai Chamber. This project was part of a campaign (see communication poster in Appendix E) to phase out disposable cups and urge staff to reuse their glasses and mugs and serve the same to their visitors and customers who visit the office. It was estimated that purchasing disposable plastic and Styrofoam cups costed Dubai Chamber about USD 5,449.6 per year (AED 20,000/year).

When the campaign was launched, it did not gain a lot of popularity at first and faced a lot of resistance from the staff. Some even brought in their own plastic cups to use at work. After some time, staff slowly started to use the glasses and mugs provided for them at the office and gradually phased out their use of disposables with gaining immediate payback. Customers and visitors, except in big events, were also served with glass cups and mugs. Currently, very few staff bring in their disposables, which helped in reducing the amount of plastic and Styrofoam waste compared to before implementing this project.

Purchasing green materials that are officially approved was also a challenge. For instance, the team found out that one of the paper suppliers claimed that they were FSC certified, but after the team enquired about the list of FSC certified papers, it turned out that they were not included in the

list, hence Dubai Chamber did not source their paper supply and searched for other options.

#### **b. Green cleaning products**

Another area that Dubai Chamber needed to focus on to gain more LEED points when going through the requirements is the use of green cleaning products. Such products were preferred to be used because they have little effect on the environment and do not contribute to major or chronic illnesses. At the time of implementing the LEED requirements, the team needed to source green cleaning products to earn a point but did not find any in the market. Hence, they decided to search internationally and finally managed to source green cleaning products in concentrate from Germany that were less costly, gave an immediate payback and were safer for cleaning staff and building users.

#### **c. Enhanced workspaces and indoor environmental quality**

When the building was due for renovation in phase 3, the old workstations were replaced with ones that came from a sustainable source. Ergonomics was also enhanced in the office areas where fully adjustable chairs (Herman Miller Aeron chairs) and screens were used to suit the height and posture of every staff member. The ergonomically friendly chairs are also 94% recyclable, comprise of 62% recycled materials, and are produced in a LEED and ISO14001 (Environmental Management System) certified factory.

A few researches indicate that people usually spend 90% of their time indoors and many are not aware that indoor air pollution has a higher risk in harming the human health than outdoor air pollution (*The Inside Story: A Guide to Indoor Air Quality*, 2011). A few measures were applied to improve the indoor air quality within the Chamber offices. Some of which include the following:



- **Carbon dioxide (CO<sub>2</sub>)** sensors were fitted in various locations within each floor in order to monitor the Indoor air quality of the office areas. The sensors were linked to a variable air flow system which only allows to bring in fresh air when there is a lack of oxygen concentration instead of automatically flushing the building four times every hour and wasting energy due to that. The payback period of installing the sensor was less than two years and the energy consumption was also reduced since less air was filtered and cooled due to the use of this system. As a result, the overall energy consumption decreases for this operation.
- **Products of Low Volatile Organic Compounds (VOC)** was also introduced. VOCs are known to emit pollutants that were linked to causing sicknesses like cancer (*Volatile Organic Compounds (VOCs)*, 2011). That is why the Chamber decided to purchase eco-friendly low-VOC level products like the paints, furniture and carpets.
- **Photocopying and printing machines were separated** from the staffs' workstations where they had separate ventilated areas (required more than two years payback). This idea was taken from one of the LEED requirements of having high health and safety standards because photocopy and printing machines emit chemicals and contribute to indoor air pollution and sickness. That is why they were placed in separate glass rooms away from staff.

Any existing building can be involved in sourcing and providing sustainable products and services by having a tailor-made sustainable procurement guideline that is applicable to the building/office's operations and occupant's tasks. It is necessary that the individuals involved in purchasing products or organizing events are aware of the guideline once it gets established, and training them is very much recommended. Policies can also be developed to ensure that such practices are well embedded in the tasks of each responsible procurer and service provider. As mentioned in this section, the procurement of sustainable products can include office

desks and supplies, building materials, food products, etc. Sustainable services can however include choosing a venue that consumes less energy and resources and many more (see Appendix D). There is a wide range of sustainable procurement options for existing buildings to choose as long as the resources are available around, so being creative in sourcing legitimate suppliers can help in establishing a good database of sustainable products and services.

#### **4.3 Applying ISO14001 on Environmental Management System**

Aside from achieving LEED in 2009, Dubai Chamber was looking for certifications that would help the organization lock in the various sustainability initiatives implemented throughout the years in order to ensure that they can be sustained even after the change champions leave the company. After doing some research, Dubai Chamber decided to go after achieving ISO14001 on environmental management system as it gives global recognition to help attract business worldwide, which is one of the objectives that the company aims for.

In order to achieve this certification, Dubai Chamber formed a task force of 7 employees to look into the certification standards and apply them within the organization. A couple of those employees undergone ISO14001 Internal Auditor training to further understand the specifics of the certification. After 6 months of implementing the standards, Dubai Chamber managed to successfully achieve ISO14001 certification.

In terms of the costs involved to improve operations internally in order to achieve ISO14001 certification, Dubai Chamber spent about USD 8,992 (AED 33,000) over 3 years along with a few small investments like generating a reporting system to monitor employees' paper consumption in the office. Also, having a couple of the team members get training in ISO14001 Internal Auditor course helped in enhancing the organization's

in-house capacity and avoided at least USD 68,120 (AED 250,000) in consultancy costs.

The certification allowed Dubai Chamber to benchmark, assess and improve their environmental practices in line with global standards. Moreover, it facilitated in managing, measuring, communicating and developing their sustainability initiatives like having quarterly meetings with the task force to review the environmental objectives that were set and follow up on what is required to be improved upon on a regular bases. Publicizing this achievement in the media and highlighting the importance of this certification in improving practices helped in fulfilling Dubai Chamber's strategic objectives of promoting Dubai as the heart of international business where best practices are applied.

#### **4.4 Further Building and Operational Improvements**

Aside from achieving LEED and ISO14001 certifications as well as implementing other sustainable initiatives, there are a few more projects in the pipeline of implementation to further enhance the environmental performance of the head office building. Such initiatives include improving the current sustainable procurement practices within the organization in which more efforts will be given to purchase sustainable products (i.e. FSC certified wood) as well as improve operational practices (i.e. serving sustainable food in events).

#### **4.5 Summary and Analysis of the Results**

In terms of the first objective which is to identify what Dubai Chamber has done to green its head office building, many initiatives were introduced since the early years of occupying the building to reduce its resource consumption. Those initiatives were implemented in phases which were

not pre-planned ahead of time but they came up as a result of the positive impact of each phase that came before it. Table 4.1 below is a summary of the steps taken to green Dubai Chamber's head office in three phases.

**Table 4.1** Summary of Dubai Chamber's Implemented Sustainable Initiatives in phases

<b>Beginning in / period:</b>	<b>Steps Taken Towards Greening Dubai Chamber's Head Office:</b>
<b><u>Phase 1</u></b> <b>1998 – 2008</b>	Design, plan and construct the head office building
	Worked on gaining full control over the building's management system (BMS) to fully operate in-house and manage resource consumption
	Start of implementing 0-budget cost saving initiatives (i.e. reduce lighting consumption, reduce flushed water in toilets, indoor temperature and humidity control)
	Chiller operation reduction
	Secondary pump bypass arrangements
	Trend analysis (people behavior, complaints and equipment performance)
	Condensate capture from air conditioning systems for reuse in the outdoor fountain
<b><u>Phase 2</u></b> <b>2009</b>	Earning the LEED certified Existing Building 2.0 from the U.S. Green Building Council. Enhancements applied to achieve this certification include: <ul style="list-style-type: none"> <li>- The formation of the Green Building team comprising of staff from key departments</li> <li>- Reduction of lift counter weights to reduce energy consumption</li> <li>- CSR department more involved in sustainability awareness of staff and community</li> </ul>
<b><u>Phase 3</u></b> <b>2010 &amp; Beyond</b>	Building renovation to perform more sustainably and use sustainable products and equipment
	Use of the outdoor fountain in the building's heat exchanging process
	Installation of more efficient custom-made chillers
	Achieving ISO14001 certification on Environmental Management System

For companies and building owners that are interested in greening their existing buildings, they can start with small initiatives that can have a direct impact on them in terms of their performance, cost and resources saved. Those are the low hanging fruits that can be applied with less effort but will provide a big positive impact in the long run. As observed in Dubai Chamber's case study example, the savings and benefits gained within 10 years of phase 1 helped in convincing leadership to approve for the application of LEED certification for existing buildings, and this elevated them to move to phase 2 of greening Dubai Chamber.

After achieving LEED for existing buildings, the green building team did not have a choice but to move forward in improving their building further (i.e. phase 3). They did not see LEED as the end point for their success. They found many rooms for improvement in many areas and took advantage in including green initiatives when planning for the building renovation. Other existing buildings may not undergo renovation anytime soon, as with the Dubai Chamber example, but can still look for other opportunities to enhance their buildings' environmental performance and save money and resources.

Other existing buildings can also choose to apply for some environmental certifications to improve their environmental management system or practices such as applying for ISO14001 certification or LEED. Since every building is different in terms of the systems they have and practices that are applied, it is worthy to note that some of the initiatives implemented in Dubai Chamber might not work for them in their building. Hence, understanding what systems are used, how their building functions and how they get to operate it are important to identify improvement opportunities.

In terms of the second research objective which is to identify how cost effective it is to green existing buildings, many savings have been seen from implementing various initiatives in the building throughout the years. For instance, during the first 10 years of occupying the building (i.e. phase

1), Dubai Chamber managed to save 77% of water consumption, which is equivalent to saving 41.5 million units (gallons) of water, 827 tonnes of CO<sub>2</sub> and USD 435,611 (AED 1.6 million) (see Figure 4.1). In addition, they saved 47% of energy consumption, which is equivalent to saving 25.9 million units (kWh) of electricity, 21,874 tonnes of CO<sub>2</sub> and USD 1.5 million (AED 5.5 million) (see Figure 4.3). When accumulating both savings, Dubai Chamber managed to save about 22,701 tonnes of CO<sub>2</sub> emissions and USD 1.9 million (AED 7.1 million) between 1998 and 2008 by implementing simple initiatives using their normal operational budget.

Many savings were achieved even after achieving LEED certification. There were further reductions in the amount of water flushed in toilets when the 11 liter flush valves were replaced with 4.5 liter flush valves during renovation. This helped in reducing 60% of the flushing water. The installation of a PLC based control system in toilets to control leakages saved about 30,000 liters of water per day due to deactivating flushing activities after working hours. In addition, flushing toilets using polished TSE water instead of desalinated drinking water helped in saving the cost of paying more than USD 3,311 (AED 12,151) to DEWA per month. In terms of energy savings, the replacement of the conventional heat exchanger with a fountain cooled heat exchanger provided the opportunity to save USD 15,325 on installation charges, save USD 3,054 on operational expenditure per year as well as save USD 44,392 per year in extra costs as part of the main air-conditioning system.

In the case of other buildings in the UAE, the savings will basically depend on many factors like the type of building, building size, the level of occupant awareness to assist in some of the saving initiatives, systems and technologies used and the availability of expertise who can understand what the building needs and find for innovative ways to increase savings and reduce their building's environmental impact.

In terms of the third objective of identifying the barriers for greening existing buildings, Dubai Chamber encountered a few barriers along the

line of implementing their sustainable projects, some of which include the following points:

**a. Lack of technical understanding on the part of the green building team members:**

As mentioned in Chapter 4, the green building team faced a little bit of a challenge in understanding the technical specifications required by some of the LEED requirements, as well as challenges with getting the right documentation to fulfill some of the requirements. From this experience, the green building team made sure they understood the requirements of ISO14001 certification before applying for it in order to not go through the same experience. Hence, a couple of their team members had undergone ISO14001 Internal Auditor training for that purpose. With that and with the whole team effort afterwards, Dubai Chamber managed to achieve the certification in 6 months' time.

**b. Lack of easily available green products in the country**

Sourcing green or sustainable products was initially a challenge for the green building team where they were not sure where to find suppliers on sustainable building and office materials. At the time of implementing the LEED requirements, the team needed to source green cleaning products to earn a point but did not find any in the market. Hence, they decided to search internationally and finally managed to source green cleaning products from Germany and despite suggestions that green cleaners are more costly, purchasing them in concentrate proved cheaper and safer for cleaning staff and building users. It was also challenging to purchase green materials and products that had a trusted line of custody. For instance, the green building team found out that one of the paper suppliers claimed that they were FSC certified, but after the team enquired about the list of FSC certified papers, it turned out that they were not included in the list. This poses a problem for companies and people who are not aware of

the legitimacy of some products and services, which is why it is necessary to spread awareness on this issue amongst the society and organizations.

**c. Lack of awareness, technical understanding and training from contractors on sustainable renovation:**

The Chamber building was initially over engineered which reflect the trend of construction at that time. Even when the Chamber decided to renovate their building after more than 10 years of operation, they found it challenging to educating the contractors on sustainable renovation as they were used to the conventional ways of renovating buildings. Hence, a lot of time was invested by the green building team to source sustainable construction products for the contractors and train construction workers on applying green renovation practices.

From this learning experience, the green building team decided to expand their training and awareness on sustainable working practices to their subcontractors like the gardeners, waiters, security, cleaners and building technicians. For instance, the gardeners are now composting green waste within the premises to be used as soil. The security workers are aware of Dubai Chamber's sustainable transport initiative and are currently managing the VIP parking area for staff to park their eco-friendly cars as well as managing the free valet parking service to park the visitor's eco-friendly cars. The cleaners are instructed to clean the office during working hours using green cleaning products and assist with segregating waste for recycling. Since the phasing out of disposable plastic and Styrofoam cups, the waiters now serve the customers drinks using glasses and mugs. These and many other green practices were included as part of the subcontractors' trainings.

**d. Lack of awareness and interest from staff**

In order to ensure that some of the initiatives implemented go successfully, they needed to have the support and cooperation of the staff, however; some were not interested enough to follow on with the initiatives. For



instance, when waste bins were taken out from under staffs' desks some were not happy about it and wanted their bins back. However, having leadership support such causes kept those initiatives successfully continue. That and many other examples of the lack of interest or awareness from some of the staff, but the green building team found that continuously communication with the staff on the importance of supporting the organization's environmental causes help in raising more awareness and support from their side.

## **5 CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS**

## 5.1 Conclusions

The results, discussion and analysis of the findings taken from the Dubai Chamber case study concluded that existing buildings can easily be greened in the UAE as well as save costs and sustain resources at the same. As discussed in Chapter 4, not every building is alike as each is unique in terms of the systems it uses to operate the building and the practices that are applied there. Hence, understanding what systems are used, how their building functions and how they get to operate it are important to identify improvement opportunities.

There have been a few significant factors which successfully helped in turning Dubai Chamber's headquarter building green. One of those factors includes having leadership support throughout the process of greening the building. Another factor is having a motivated and productive team that worked together to achieve the goals set. In addition, effective communication with the staff, contractors and subcontractors was key in sustaining the initiatives applied. Gradual implementation of the green building initiatives (in phases) instead of doing them all in one go provided an advantage of getting more support from management after seeing the achievements year after year. This was also economically feasible for the organization. And finally, understanding the barriers helped the green building team find for ways to overcome them and achieve their targets. The main areas that Dubai Chamber focused on to green its headquarter building include the following:

### **a. Saving water:**

Some of the water saving initiatives Dubai Chamber implemented include installing an infrared detection system in their toilet taps and urinals, installing aerators in their water taps, reducing the flushing volumes of their urinals, installing a PLC-based control system in their toilets, reusing

collected condensate water, flushing toilets with polished TSE and planting sustainable greenery.

**b. Saving energy:**

In addition to saving water, some of the initiatives that Dubai Chamber implemented to save energy include enhancing the performance of their chillers, adapting an energy management code of practice, maintaining adequate room temperature (i.e. 24°C), enhancing the efficiency of lifts, improving lighting efficiency and using the outdoor fountain as a heat exchanger instead of building an energy consuming cooling tower.

**c. Reducing and properly managing solid waste:**

Moving from water and energy saving, Dubai Chamber worked on a few projects to reduce their waste production and properly manage what gets disposed of, such as implementing a reduce, reuse and recycle (RRR) program where it focused on educating staff and contractors on the proper way of segregating waste and increasing recycling activities. In addition, when the building went under renovation, the old building items (i.e. doors, carpentry, office equipment, etc.) were either reused in the same building or donated to divert them away from landfills.

**d. Promoting sustainable transportation:**

Moreover, building occupants were encouraged to contribute to the reduction of GHG emissions by commuting to work via public transportation and/or using vehicles that are environmentally friendly (i.e. bicycles, low fuel emitting cars). One of the ways Dubai Chamber did to encourage sustainable transport was to introduce incentives for staff, contractors and visitors, such as giving VIP parking spaces to staff coming to work with eco-friendly vehicles and provide free valet parking to visitors driving eco-friendly vehicles.

**e. Sustaining products and services:**

Sustaining products and services was one of the main areas that Dubai Chamber gave attention to, especially when it intended to apply for the LEED for Existing Buildings certification. In order to do so, it developed a sustainable procurement guideline for all the staff and contractors involved in procuring products or offering services, like purchasing green cleaning products and paints that are less toxic and emit low levels of volatile organic compounds (VOC). The workspaces and indoor environmental quality was further enhanced when more initiatives were implemented such as the segregation of printers and photocopiers from staffs' work areas to reduce their exposure to toxic fumes that the devices emit, as well as the installation of CO<sub>2</sub> monitors to ensure that their levels in the office areas are adequate.

Throughout the years of greening Dubai Chamber's headquarter building; they have applied for green building and environmental certifications like LEED certification for Existing Buildings and ISO14001 certification on environmental management system. These two certifications provided a framework for the organization to manage the building in a more sustainable manner. Having a certification is not necessarily the only reason to have buildings identified as green. Buildings can be greened with or without certification as long as they aim to deliver a sustainable, cost-effective and resource efficient building that benefits its owner, occupants and the community it serves. If organizations are looking for implementing certifications, the below list are a few recommended tips:

**a. Choose certifications that help you address the risks and opportunities of your business:**

There are hundreds of certifications out there, both global and local, also many industry specific labels like organic for food or FSC for wood products. You could spend all your organization's resources going for

certifications so you need to make sure the ones you do go for fulfill a need in your organization.

**b. You can avoid consultancy fees if you have competency and commitment of your organization:**

As mentioned in Chapter 5, Dubai Chamber managed to avoid at least USD 68,120 (AED 250,000) in consultancy costs. They only used external consultants for the independent certification in the end.

**c. Get influential people on board early:**

This point is very important because once the influential people are on board and the project gets signed off on, your team will have no reason to not get the certification.

**d. Use the certification to develop your organization's in-house capacity:**

If you leave everything to consultants, you will always be dependent on them. However, if you do use consultants to assist with implementing a certification for your organization, make sure that they are working closely with the employees who are responsible for maintaining the system. You should also make sure to set it up in a way that helps in developing their capacity to take over the monitoring and implementation of the system.

**e. Build a strong team with an effective leader to keep the certification process on track.**

**f. Continual improvement is key:**

Work does not stop once certification is achieved. Efforts need to continue to ensure that the organization continues embedding the system and locking it in.

Even with the success that Dubai Chamber had had in greening its headquarter building, it encountered a few barriers throughout its journey

towards sustainability, some of which include the lack of technical understanding and training on applying some of the LEED requirements, the difficulty in sourcing sustainable products locally, the lack of contractor awareness on sustainable renovation during the retrofitting period of Dubai Chamber and the lack of awareness and interest from staff. All of these barriers were gradually tackled (and some still exist) through training of staff and contractors, raising awareness, teamwork of the green building committee, supervision of management and leadership commitment.

Nevertheless, Dubai Chamber demonstrated that it is possible to green existing buildings in the UAE without major renovation or investments and can be financially beneficial too. There are many simple ways to make existing buildings more sustainable and green. The breakdown of Dubai Chamber's green building initiatives (see Appendix F) is a simple guideline that organizations can choose to go for depending on what is financially and logistically appropriate for them. The best way to start is to pick the low hanging fruits that have an immediate to little years of payback period, and then continue on with higher financial and technical investments.

In conclusion, this research paper has provided a relatively small body of knowledge about greening existing buildings in the UAE by providing a case study example of Dubai Chamber of Commerce and Industry's green building experience. It is not that necessary for organizations and building owners to reinvent the wheel in this area or start from scratch. They can learn from best practices locally, i.e. Dubai Chamber, and internationally, adapt them in their building and improve them.

## **5.2 Recommendations**

The strategies that were used to green Dubai Chamber's headquarter building can practically be translated into three main areas of focus, the mechanical, procedural and behavioral aspects. Existing buildings can

consider these three aspects when wanting to implement various sustainable strategies, which will help in focusing their efforts and making them more efficient. When looking at the mechanical aspect of sustainability for instance, considerations should be given to the devices and systems (i.e. computer devices, lighting systems, chillers, etc.) used in terms of their efficiency, energy saving capabilities, maintenance plan, and other technical aspects. For instance replacing conventional light bulbs with energy efficient ones and having the BMS automatically switch off lights and air conditioning systems after working hours.

The procedural aspect basically looks at how things are done and whether or not they are done well. This includes the procedures involved to carry out operations that can affect sustainability. For example, changing cleaning timings from “after working hours” to “during working hours” to save up on energy costs. Another example of a change in procedure is to reuse collected condensate water for cleaning windows instead of using desalinized drinking water.

The behavioral aspect of sustainability is usually a very difficult one because it is hard to change people’s behavior when they are used to doing a certain thing for years. That is why awareness and education are important to making them understand the purpose of the work and the need for their involvement. Similar to what happened when Dubai Chamber phased out their disposable plastic cups; many still brought disposables from home to resist the change. However, with more communication awareness (i.e. posters, emails, presentations, etc.) and leadership support a lot of the staffs’ behavior slowly changed and it made them start using reusable cups instead.

Along with the three main areas of focus that existing buildings can consider to sustain their resources and save money, below are a few tips that have been listed to reemphasize on some of the main strategies that can assist in greening existing buildings based on the learnings taken from Dubai Chamber’s green building experience:



- Existing buildings should focus on the low hanging fruits first when implementing sustainable initiatives as great savings in water and electricity can be achieved with no major investments;
- Properly insulated buildings can sustain building interiors and furniture longer, even when air conditioning systems get switched off (as the relative humidity decreases when the temperature rises in a sealed building);
- Green building systems like LEED can be used as a guide (not necessarily for certification) to a holistic approach to greening existing buildings. Such systems tend to cover a lot of areas of sustainability like energy, water, waste, indoor environmental quality, materials and resources, etc.;
- Stakeholders (i.e. staff, cleaners, contractors, technicians, etc.) should be involved early on through various means like training, incentives, surveys, participation, instruction and communication. This will make them more susceptible for change, appreciate the efforts that are being made on the environment and provide further support when needed;
- Establishing an environmental management system to lock in the change applied in the building in order to avoid “unsustainable” practices from coming back again;
- Having leadership involvement and support is very important to back up the initiatives and encourage building occupant involvement
- Having a proactive and competent team is also important to facilitate in implementing the sustainable initiatives effectively.
- Having on-going supervision of building operations and practices, while considering the environmental aspects/requirements applied in the building, can assist in the building’s sustainable improvement.

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## **APPENDICES**

## Appendix A

### A SUMMARY OF THE MAIN CHARACTERISTICS OF THREE SIMULATION APPROACHES

<b>Simulation approach</b>	<b>Conditions for use</b>	<b>Main characteristics</b>
Discrete event	System described by variables and events that trigger change in those variables	Events that trigger other events sequentially and probabilistically
System dynamics	System described by variables that cause change in each other over time	Key system variables and their interactions with one another are explicitly (mathematically) defined as differential equations
Agent-based	System described by agents that react to one another and the environment	Agents with schema that interact with one another and learn

## Appendix B

### CHALLENGES IN ORGANIZATIONAL SIMULATION

<b>Implementation step</b>	<b>Key decisions</b>	<b>Key decision criteria</b>	<b>Common problems</b>	<b>Follow-up resources</b>
<i>Conceptual design</i>	Boundaries of system, key variables, agent/entity attributes	Driven by theoretical propositions or research questions	Lack of linkage between model and theory(ies) of interest	Exemplars: March, 1991; Sterman et al., 1997
<i>Code development</i>	How to effectively manage the software development project	Effective project management practice	No explicit requirements; poor change control; little reuse of code; untested code; lengthy development times	McConnell, 1997
<i>Validation</i>	Match between simulation results and real system	Extent to which validity is important	Validity completely ignored	Axelrod, 1997; exemplar: Sterman et al., 1997
<i>Experimental design</i>	How to manipulate variables across experimental conditions	Effective experimental design practice	No (formal) experimental design used	Box et al., 1978
<i>Implementation</i>	Initial configuration, transient versus steady-state behavior	Statistical theory	Simulation runs not long enough; or not enough runs	Law and Kelton, 1982
<i>Analysis</i>	Determination of significant effects	Statistical theory	Transient and steady-state behavior intermixed; independence assumptions violated; dynamics not examined	Law and Kelton, 1982; Dooley and Van de Ven, 1999
<i>Interpretation</i>	Link simulation results back to theory	Logical arguments	Over-interpretation of results	Exemplar: Sterman et al., 1997

## Appendix C

### SUMMARY OF ACHIEVED LEED POINTS FOR MERCHANDISE MART, USA

#### ● Summary

LEED system rating	Existing Buildings v 2.0
achieved rating	Silver 40 pts
energy use intensity	75 kBtu/sf/yr
greenhouse gas emissions	22.4 lbs CO <sub>2</sub> e/sf/yr
water usage	7.9 gal/sf/yr

#### LEED categories



#### ● LEED Energy & Atmosphere

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EA credit 3.1	Staff Education
EA credit 3.2	Building Systems Maintenance
EA credit 3.3	Building Systems Monitoring
EA credit 4	Additional Ozone Protection
EA credit 5 (2pts)	Enhanced Metering
EA credit 5.4	Emission Reduction Reporting
EA credit 6	Sustainable Building Costs



● Purchased Energy Costs

	total	electricity	gas	chiller
annual energy use	315,963,126 kBtu	11.2 kWh/sf	.21 therms/sf	1.36 ton hrs/sf/yr
annual energy cost	-	-	-	-

● Measured Energy Usage



● LEED Sustainable Sites

6 of 14

SS credit 1 (2pts)	Site & Exterior Management
SS credit 2	Development Density
SS credit 3.1	Public Transit Access
SS credit 3.2	Bicycle Commuting
SS credit 6.1	Site Heat Island Reduction

● LEED Water Efficiency

1 of 5

WE credit 3.1	10% Water Use Reduction
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● LEED Materials & Resources 11 of 16

MR credit 1.1	Construction Waste Management	75%
MR credit 2.1	Sustainable Products	10%
MR credit 3 (2pts)	IAQ Compliant Products	90%
MR credit 4 (2pts)	Sustainable Cleaning Products	60%
MR credit 5 (3pts)	Occupant Recycling	50%
MR credit 6	Reduced Mercury Light Bulbs	

● LEED Indoor Environmental Quality 9 of 22

EQ credit 1	Outdoor Air Delivery Monitoring	
EQ credit 3	Construction IAQ Mgmt Plan	
EQ credit 9	Contemporary IAQ Practice	
EQ credit 10 (6pts)	Green Cleaning	

● LEED Innovation in Design 5 of 5

ID credit 1.1	Innovation in Upgrades, O & M	
ID credit 1.2	Innovation in Upgrades, O & M	
ID credit 1.3	Innovation in Upgrades, O & M	
ID credit 1.4	Innovation in Upgrades, O & M	
ID credit 2	LEED Accredited Professional	

## Appendix D

### DUBAI CHAMBER'S SUSTAINABLE PROCUREMENT GUIDELINES



#### SUSTAINABLE PROCUREMENT GUIDELINES

Save Money. Conserve Resources. Improve Health.

#### Gifts

- Select items that are reusable and refillable, made from non-toxic ingredients (such as natural fibres instead of plastics).
- Ensure little or no packaging or packaging that containing recycled materials.
- Choose items that have recycled content and are recyclable.
- Favour organic cotton, jute or recycled material ahead of pvc or synthetic bags.
- Ensure electronics are energy efficient (see "Electronics" section) and avoid batteries especially non rechargeable ones.
- Source locally and minimise transport.



#### Events

- Site - ensure it is accessible to public transport, has energy & water conservation initiatives like recycling, with good health & safety practices.
- Catering - ensure crockery and other items are reusable (i.e. no disposables like bottled water, plastic or styrofoam cups) and serve condiments in bulk (e.g. no individual packaging for milk & sugar). Plan menus that are healthy, seasonal and regionally sourced. Avoid endangered fish and provide vegetarian options.
- Handouts - minimise handouts including papers by providing documents electronically. Use biodegradable or recyclable paper and packaging (see "Paper & Wood" section). Avoid all disposables like single use pens and bags (see "Gifts" section).
- Promotion - Communicate electronically and minimise printing. Where items must be printed, favour double sided black and white on recycled paper (see "Paper & Wood" section). Communicate event sustainability initiatives too.
- Other - Have recycling facilities available and visible. Recollect badges and other items for reuse where possible and otherwise recycle them. Gather feedback about ways to improve (e.g going carbon neutral).



#### Travel

- Use virtual communication wherever possible such as web conferencing.
- Carpool or use public transport or eco-vehicles as far as possible.
- Make appointments in groups to minimise trips.
- Select hotels and travel partners that have green practices.
- Fly during the day using new and efficient airplanes where possible.



#### Coatings & Fittings

- Purchase paints, sealants, finishes, varnishes, lacquers and adhesives that respect the Volatile Organic Compound (VOC) limits of LEED certification.
- Source eco friendly furniture and carpets that respect minimum VOC limits.



### Paper & Wood

- Minimise paper by communicating electronically.
- Print double sided black and white using smaller fonts on a plain background.
- Avoid all wood from endangered forests (like tropical hardwood) and purchase sustainable woods (like FSC certified).
- Source FSC or equivalent (i.e. 100% recycled paper with a high post-consumer recycled content, not chlorine-bleached) recycled paper for communications.
- Avoid coated (gloss or laminate) papers.
- Print Arabic and English versions separately rather than combined.



### Electronics

- Purchase the most energy efficient appliances with the highest Energy Star or other Energy Label rating.
- Ensure appliances can be switched off remotely and go into power saving mode.
- Lease equipment where possible and ensure regular maintenance to extend the product life.
- Send all electronic waste for reuse where possible or otherwise send it to e-waste recycling (not to the dumpster).
- Refill printer cartridges or, if not possible, send them for special recycling.



### Crockery & Cleaning

- Provide reusable cups and jugs only (avoid all disposables like throw away cups, sugar sachets and bottles).
- Use Green Seal, Eco-Label or the equivalent eco-labeled cleaning products that respect the Volatile Organic Compound (VOC) limits of LEED certification.



### Waste & Recycling

- Place all recyclables like clean paper, plastic, metal in the green recycling bins.
- Place all electronics and hazardous waste in the yellow recycling bins (e.g. memory sticks, printer cartridges and CFL light bulbs).
- Give items that can be reused to administration department for donation.
- Avoid all unnecessary purchases and reuse items before disposing of them.

### Contractors & Suppliers

- Tender only contractors that provide adequate work conditions in line with UAE labour law.
- Select contractors that demonstrate good management of environment, quality, health and safety issues (e.g. ISO 14001, ISO 9001, OHSAS 18001, SA 8000).
- Go paper free with transactions (e.g. make the purchase and payment processes electronic).
- Communicate sustainable purchasing policy to suppliers and contractors.
- Ensure contractors adhere to our green building, health & safety policies.



## Appendix E

### COMMUNICATION POSTER - PHASING OUT OF DISPOSABLE PLASTIC AND STYROFOAM CUPS AT DUBAI CHAMBER

# Reuse your Mug

to Help the Environment & our Hospitality Team!



**Did you know that plastic, styrofoam and paper cups are expensive?**  
We spend nearly AED 20,000 each year purchasing them!!

**Did you know that they also make you sick?**  
Some of the contents, like bisphenol-a (BPA), are toxic and have been linked to hormonal problems and even cancer!

**Did you know that they also destroy our environment?**  
Each cup takes between 5 to 100's or even 1000's of years to decompose and release all sorts of pollutants that enter our air, water and food we eat, yuck!

**This is why Dubai Chamber has decided to phase out all disposable cups and bottles, BUT...we need your help in using just 1 or 2 mugs a day so we do not overload the dishwasher or our wonderful kitchen staff.**

**Thank you for making a difference!**

غرفة دبي  
DUBAI CHAMBER

**Appendix F**  
**BREAKDOWN OF DUBAI CHAMBER'S GREEN BUILDING**  
**INITIATIVES**

**WATER INITIATIVES**

Area	Immediate Payback (0)	Payback of less than 2 years (2)	Payback of greater than 2 years (2+)
<b>Water</b>	<p>Sweeping instead of cleaning using water</p> <p>Using condensate water to clean windows (reduces soap requirement)</p> <p>Placing a stone or water bottles in cistern to reduce flushing volumes from flush fixtures</p> <p>Using municipality treated sewage water (TSE) for landscape irrigation with drip irrigation and desert adapted vegetation</p>	<p>Installing a PLC-based control system and infrared detectors for urinal flushing linked to lighting system via saving 42,000 litres a day</p> <p>Installing automatic faucets with infrared sensors on taps, allowing water to run only when required saving 1,000 litres a day</p> <p>Collecting condensed water from air handling units since 2004 saving 850,000 litres a year</p> <p>Using aerated water flow fixtures on taps reducing water flow by 40%</p> <p>Installing a polishing system for TSE water to replace desalinated drinking water use for toilet system, reducing water use by more than 1million litres a year</p>	<p>Installing of air-cooled chillers to eliminate the need of water for cooling which reduced waste water substantially by around 50m3 a day</p>

## ELECTRICITY INITIATIVES

Area	Immediate Payback (0)	Payback of less than 2 years (2)	Payback of greater than 2 years (2+)
<b>Electricity</b>	<p>Switching off lights where daylight is sufficient</p> <p>Switching off lighting and air-conditioning throughout the building after hours</p> <p>Conducting cleaning and maintenance during office hours</p> <p>Optimising chiller operating loads leading to permanent shut down of five out of eight chillers</p> <p>Disconnecting central hot water system completely since 1996 – commercial offices occupants hardly use hot water</p> <p>Having a building envelope and roof insulation that conform to ASHRAE 2004 standards for thermal transmittance, solar heat reflectance and solar heat absorption properties</p> <p>Adopting an energy management code of practice and efficient use of the Building Management System</p> <p>Using LED low mercury T5 lamps that consume 40% or more, less energy and last up to 10 times longer</p> <p>Using a lighting design in renovated areas of between 4.5-6.5 watts/m<sup>2</sup>) depending on the areas use</p>	<p>Optimising lift weighting loads to reduce energy consumption by 20%</p> <p>Reducing chilled water circulation to meet actual requirements leading to savings of 100,000 kWh/yr</p> <p>Installing temperature sensors to reduce cooling loads by maintaining comfortable temperatures of 24 degrees during working hours</p> <p>Installing CO<sub>2</sub> sensors for fresh air on demand system and a variable air flow AC system</p> <p>Installing combined lux and presence detectors in 2009-2010 to switch on/off lights on demand</p> <p>Reduction of lighting load from 200 watts to 20 watts, leading to a 90% reduction in energy consumption</p> <p>Using the outdoor water feature as a heat exchanger to cool the server room CCU units thus eliminating the cooling tower</p> <p>Using a web based interfaces to allow occupants to adjust area lighting and temperature to their preference</p>	<p>Installing a half and full chiller system which has enhanced the energy consumption by more than 26%</p> <p>Free cooling in winter periods by introducing fresh air and switching off chilled water valve in AHU when temperatures are 24°C or less</p>

## OTHER INITIATIVES

Area	Immediate Payback (0)	Payback of less than 2 years (2)	Payback of greater than 2 years (2+)
<b>Other</b>	<p>Preventative maintenance practices to avoid breakdown and improve efficiency</p> <p>Using green cleaning products to reduce indoor air pollution</p> <p>Removing disposable cups and bottles to reduce waste, enhance health and safe costs</p> <p>Having a committee to plan and overview building performance and greening initiatives</p> <p>Reusing over 80% of materials during the renovation including metal ceilings, wall cladding, joinery works, doors, mechanical, plumbing and electrical systems</p> <p>Running awareness campaigns and green building tours</p> <p>Applying the LEED EBOM framework to the renovation</p>	<p>Removing individual bins and the installation of a centralised waste system for regular rubbish, paper and plastic recycling, as well as electronic recycling and hazardous waste disposal</p> <p>Installing segregated printing areas with air extractors to enhance indoor environmental quality</p>	<p>Installing bicycle racks and an eco-parking system for staff and guests</p> <p>Using eco-friendly furniture, carpets, paints and segregated printing areas to reduce indoor air pollution</p>



**Appendix G**

**FOUNTAIN HEAT EXCHANGER LAYOUT**

**Fountain Heat Exchanger Layout**

