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Implementing Green Building Procedures for the Construction of Residential Buildings in Abu Dhabi

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Abstract: **ESTIDAMA is a green building framework used to improve the environment, energy efficiency and water use in Abu Dhabi. The high rate of water and energy consumption in Abu Dhabi necessitates an investigation into the implementation of Green Building initiatives in Abu Dhabi. The challenges were to achieve the desired results of reducing energy consumption, reducing water consumption and building comfortable and environmentally-friendly residential areas. All these challenges stimulate to study and investigate the current situation of the implementation of Green Building initiatives in residential building developments in Abu Dhabi. This was conducted by evaluating the Estidama Pearls Rating System to reveal how the Green Building procedures were implemented in residential buildings in Abu Dhabi. The findings suggest how the situation can be improved. A case study was used to illustrate how the Green Building procedures can be embraced for residential buildings. The study also used questionnaires and interviews to evaluate the Green Building procedure. Data was collected from 150 participants and analyzed by using descriptive statistics. The results reflected the prevalence of the implementation of the Green Building procedures in Abu Dhabi and also the current success rate of this implementation in practice. The findings showed that the understanding of Green Building regulations (ESTIDAMA) for Residential Building in Abu Dhabi by construction firms is in the medium range, which means the Green Building procedure (ESTIDAMA) requires more efforts in training the construction firms and increasing their awareness. Furthermore, the implementation of Green Building procedures in residential building faces some obstacles and challenges including a lack of related training courses, a lack of professional expertise in Green Building design firms, a lack of building materials and information, a lack of familiarity with Green Building procedures within the building firms, the costly nature of the Green Building process and a lack of understanding of the Estidama framework and regulation.**

Keywords: **Green building, Estidama, Pearl Rating System, environmental, residential building.**

I. Introduction

Green Building was defined by the U.S Green Building Council (USGBC) as a complete effort to convert the technique for creating a built environment from the provision of separate buildings to the development of communities and their design, construction and operation**.** The scope of the green building technique starts from the earliest stages of design and continues to the end of the structure's life (USGBC, 2009). Another definition for green building from China (also known as green construction or sustainable building) recorded by Yan Ji and Stellios Plainiotis refers to a structure and the use of procedures that are environmentally responsible and resource-efficient throughout a building's lifecycle: from design, construction, operation, maintenance and renovation to final demolition. This needs the close support of the design team, the architects, the engineers and the client in all project phases (Ji and Plainiotis, 2006).

In Abu Dhabi, the green building system is known as Estidama; which refers to the Arabic word for green building or sustainability methodology. Estidama is an idea developed and encouraged by the urban planning council in Abu Dhabi in 2008 with the aim of developing Abu Dhabi's cultural character by generating an ever-improving quality of life for its residents based on four elements of sustainability: ecological, financial, community and social (PBRS, 2010). The main objective of this paper is to investigate and evaluate the current situation of the implementation of green building procedures for residential buildings in Abu Dhabi in order to help in evaluating how these procedures are moving together with Abu Dhabi's Plan 2030 which was established by the Abu Dhabi government to optimize the city's development through a 25-year program of urban evolution by establishing a clear vision for green building as the foundation of any new development occurring in the Emirate and capital city of Abu Dhabi. This paper will reflect whether the implementation of Estidama regulations in Abu Dhabi, which is represented by the green building procedures and guidance, has been successful in increasing the amount of green building. This paper helps to transfer the implementation of green building in the residential buildings from an optional to a compulsory procedure to be applied throughout the project stages from the concept design, construction, operation and maintenance. This paper will review the benefits and values which are resulting from implementing green building procedures in Abu Dhabi and other countries.

Residential Building in Abu Dhabi:

Abu Dhabi is the capital of the United Arab Emirates (UAE). It is the second largest city of the UEA in population; the city had a population of 2.12 million in 2011 and is the largest emirate of the UAE in area - about 67,340 km^2. Abu Dhabi is located on the Arabian Gulf coast (Abu Dhabi eGovernment Gateway, 2013). In the 1970s Abu Dhabi was planned for a maximum population of 600,000. According to what was considered to be perfect urban planning at the time, the city has high-density tower blocks and a wide network of roads. The maximum population density is located on the northerly end of the island. The main streets are lined with twenty- to thirty-story buildings or towers. In this area of towers there is a typical network of roads with lower density buildings between two-story villas to six-story. Abu Dhabi's Urban Planning Council was established in 2007; it is the authority responsible for the future of Abu Dhabi's urban environment and is the expert authority behind Abu Dhabi Plan 2030 to enhance the city's development through a twenty-five year program of urban improvement (Abu Dhabi Urban Planning Council, 2011).

Due to the rapid development in Abu Dhabi, some challenges to the organization of the city's urban environment have developed; today, the population has increased dramatically compared to the original designed maximum population. This has led to traffic congestion and car parking shortages and overcrowding in the city center (Abu Dhabi Urban Planning Council, 2011).Residential building numbers in Abu Dhabi have rapidly grown since 1968, see Fig. 1 below.

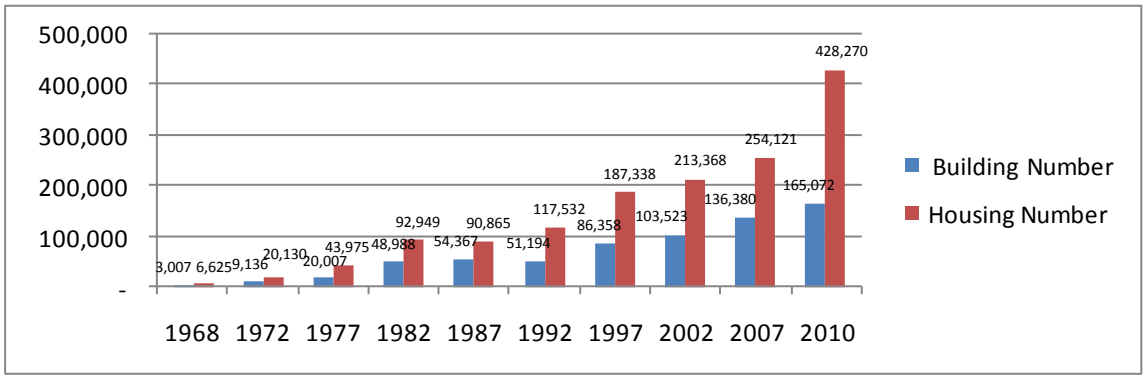

Figure 1: The growth of Building and Housing in Abu Dhabi from 1969 up to 2010 (Abu Dhabi Statistical Center, 2010).

Recently the Abu Dhabi Government has strongly focused on planning and building family housing for its nationals based on the heritage and traditions of the Emirati people. The Emirati housing consists of high-quality, modern, sustainable homes that

build on Emirati traditions and heritage and comfortably accommodate the requirements and traditions of Emirati families. The developments form flexible and adaptable homes and communities, a network of pathways and streets that link people to places, community services that meet the requirements of the residents and open places for meeting and playing, in short they support a lively and cohesive society. The new Emirati housing provides around 5,000 homes for Emirati families in nine different types of villas in Al Falah, 1,372 luxury villas in Khalifa City A, 488 villas on Yas Island (Phase l), 2,000 Emirati villas in Ain Al Fayda, 600 villas in Al Ghuraibah (Phase I), 422 villas in Al Ghuraibah (Phase II), 3,000 villas in Jabal Hafeet and a 448-villa development in Sila'a (UPC Emirati Housing Brochure, 2010).

The rapid development of residential buildings in terms of quantity, quality and style of construction is a major achievement in Abu Dhabi, but the biggest achievement is the transformation within a few years from conventional building to green building. Now all new villas in Abu Dhabi have to achieve a minimum Estidama rating. Emirati housing is an important model for the implementation of the Estidama system requirements and achieving its goals of improving the quality of life for its residents based on four elements of sustainability: ecological, financial, community and social. Thus, the above-mentioned Emirati housing totaling 13,330 homes, and other homes under construction that meet the minimum requirements of Estidama, are a valuable addition to the green building program in Abu Dhabi since 2010.

*Figure 2***:** *Photos for Emirati Housing on Yas Island (Phase l) (UPC Emirati Housing Brochure, 2010)*

The Early History of Green Building until its Adoption in Abu Dhabi:

From the 1930's up to the 1960's, the cooling approach opened the way to some new building techniques that changed the construction of city buildings especially the invention of air conditioning and reflective glass and the widespread use of glass enclosed in structural steel. These buildings were able to be heated and cooled with huge HVAC systems that relied upon huge amounts of cheap and smoothly available fossil fuels (NAIMA, 2006). The American Institute of Architects (AIA) formed a Committee on Energy that was broken into two camps. "One group looked toward passive (methods), such as reflective roofing materials and environmentally beneficial siting of buildings, to achieve energy savings, while the other concentrated more on technological solutions, such as the use of triple-glazed windows (NAIMA, 2006). When Bill Clinton was elected President in 1992, the green build/sustainability communities began consider the idea of "Greening the White House" as a way of bringing their ideas to the attention of everyday American society. Twenty-three years after the initial Earth Day, Bill Clinton announced a plan to make the White House the "model for efficiency and waste reduction (NAIMA, 2006). In March 1996, and during the two years of the "Greening", it was reported that $150,000 per year in energy, water and landscaping costs and all the expenses related to the management of solid waste were saved. The savings reached $300,000 in 1996 due to additional projects. Some of the methods implemented to "green" the White House are reducing energy lost through the roof, windows and walls; using energy-saving lights and natural light. Energy-saving office equipment was used; a recycling program was started and vehicles that used cleaner-burning fuels were leased. With the great success of the "Greening of the White House" other governmental facilities have been following the same green method including the Pentagon, the Presidio and the U.S. Department of Energy (NAIMA, 2006). From 1990 up to 1995, The United States Green Build Council (USGBC) worked extensively with the American Society of Testing and Materials (ASTM) in

establishing a rating system for sustainability (NAIMA, 2006). Although it was the outcome of extensive and detailed negotiations, the ASTM's process moved too slowly for the USGBC and in 1995 it was decided that they would create their own rating system to exist under the USGBC streamer (NAIMA, 2006). A committee was established to investigate the other green building programs currently in existence and three years later, in 2003; LEED was refined to its current form that makes it a major reference for the construction and design communities (NAIMA, 2006). The World Green Building Council (WorldGBC) was founded at a meeting of representatives from eight national GBCs in November 1999 in California. The countries represented were Australia, Canada, Japan, Spain, Italy, Russia, the United Arab Emirates, the United Kingdom and the United States. This meeting predated the creation of the Green Buildings Councils in most of the countries in attendance. The WorldGBC was formally incorporated in 2002, and a secretariat was established in 2007, based in Toronto, Canada. The World Green Building Council is a network of national green building councils from around the world, making it the largest international organization influencing the green building marketplace. Green Building Councils are member-based organizations that partner with industry and government in the transformation of their building industries towards sustainability through the adoption of green building practices. On the ground in more than 90 countries, GBCs create change in their local markets as a way to globalize environmentally- and socially-responsible building practices.

The development of green building in the USA from the early appearance of the idea, through stages of green building development and studies conducted by the American Institute of Architects (AIA) and the American Society of Testing and Materials (ASTM) led to the establishment of the United States Green Build Council (USGBC), which issued LEED in 2003, and the establishment of the World Green Building Council (WorldGBC) in 2007.
All these successive and successful events for green buildings in the United States has encouraged many countries around the world to experience and apply green building procedures in their countries while taking into account the climatic, environmental, social and cultural differences in these countries. UAE was one of first countries that adopted green building ideas and it was one of the first countries to join the World Green Building Council in 2007 one year after the establishment of the Emirates Green Building Council in 2006. Therefore, it was necessary to specify the reasons that prompted the UAE to be one of the first countries to adopt green building procedures.

Abu Dhabi has one of the toughest climates with hot season temperatures up to 50°C in shade and dry conditions throughout each year. Comfortable, air conditioned places, water on demand and a varied range of foods are available. All of these are made possible by oil and gas and, at the same time, energy derived from oil is plentiful. However, it is also a product and using growing amounts of it locally impacts on Abu Dhabi's future. The precious water which is used in agriculture and industry requires the use of significant fossil fuel resources to purify the sea water sourced from the Arabian Gulf. Despite this, utility charges are heavily subsidized by the government; the water subsidy in residential buildings ranges from 79% to 100% and the electricity subsidy ranges from 55% to 90%. Currently, the number of government-sponsored projects, including housing for its citizens, accounts for 72% of all new development. The total cost to government for these projects contains capital and a major amount of operational spending as a result of the large subsidies. Decreasing consumption, and thus government spending, is therefore a key factor of the business situation for sustainable development in Abu Dhabi (Abu Dhabi UPC, 2010).

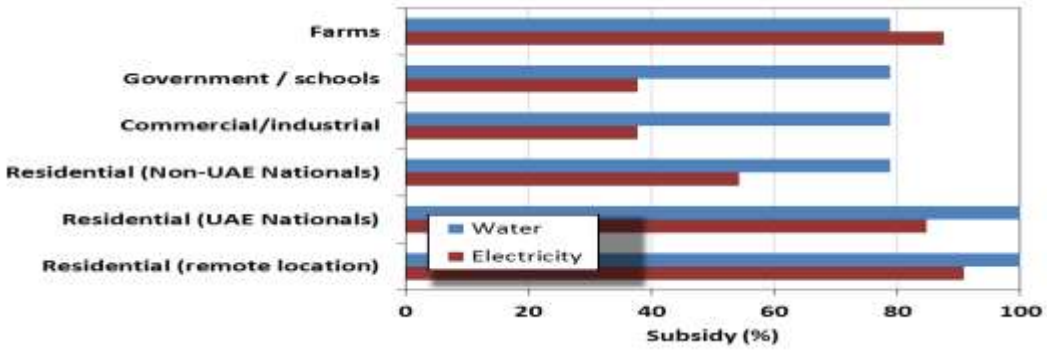

Figure 3: The Government Subsidy for Electricity and Water in Abu Dhabi (Abu Dhabi UPC, 2010).

Also, as discussed in the April 2006 UAE Initial National Communication to the United Nations on climate change, it is a distinct possibility that the UAE will become even drier due to the effects of global warming. Coupled with future population increases, the importance of accelerating water conservation and recycling efforts is clear (PBRS, 2010).

For all the above-mentioned reasons, The Emirates Green Building Council (EmiratesGBC) was established in 2006, with the aim of promoting green building values for defending the environment and safeguarding sustainability in the United Arab Emirates and ESTIDAMA - which is the Arabic word for sustainability - was launched in Abu Dhabi In 2008. In 2010, green building is more widely known than ever before along with climate change, oil dependence, sick building syndrome, water efficiency and general environmental degradation. There are green building programs, green rating systems and sometimes even government incentive programs in many areas now, but in spite of that, conventional building is still much more common. With more and more very green homes being being built by pioneers, the construction industry is slowly adopting some green building techniques.

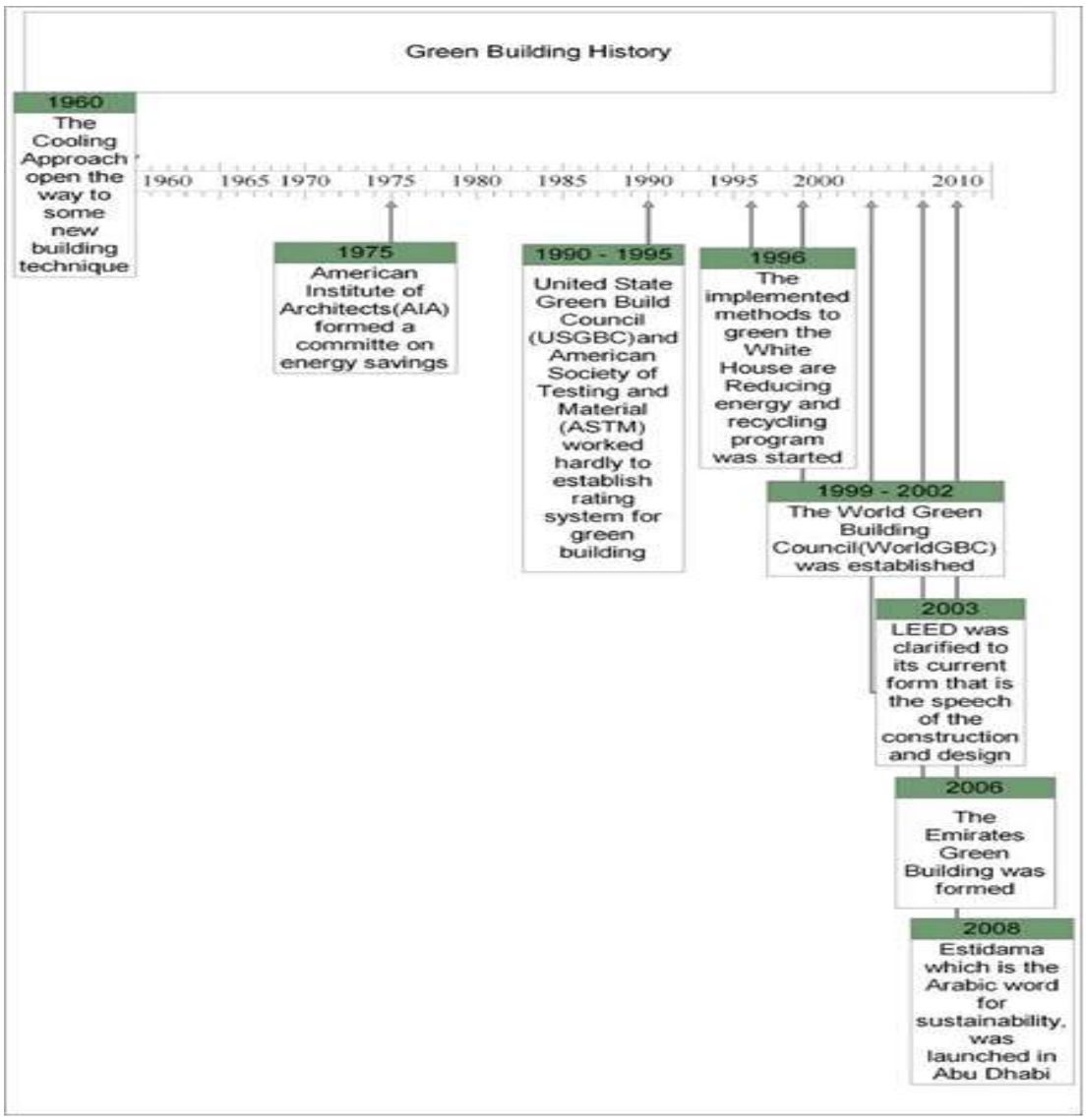

Figure 4: The Early History of Green Building prior to its Adoption in Abu Dhabi.

IN THE ABOVE: The cooling approach opened the way to some new building techniques. American Institute of Architects AIA focused on energy saving issues. United States Green Building Council(USGBC) and American Society of Testing and Material (ASTM) worked hard to establish a rating system .The implemented method to green the white house are reducing energy and a recycling program was started. Council (WorldGBC) was established in 2002. LEED was refined to its current form to support the speech of the construction and design .Then the Green Building idea transferred to the UAE in 2006 when the Emirates Green Building Council was formed and Estidama was launched in Abu Dhabi in 2008.

The Importance of Applying Green Building Procedures in Abu Dhabi:

During the process of developing a project, green building principles and techniques aim to provide best value from a whole life perspective and the tools for the evaluation and improvement of green building construction during the early stages of project (Federal Facilities Council, 2001). Some of the significant values for implementing green building procedures are reducing cost, reducing liability, a healthy built environment and energy saving. For several projects there is a feasible sustainable or green development enhancement (Federal Facilities Council, 2001). Green building may include more recycled materials, need less energy and water consumption, decrease construction waste and increase natural lighting as well as offering other chances that lead to an optimum facility (Federal Facilities Council, 2001). Green buildings deliver economic advantages that conventional buildings do not such as securing energy and water savings, decreasing waste, enhancing indoor environmental quality, securing greater employee comfort and productivity, decreasing employee health costs and lowering operation and maintenance costs (Gregory H. Kats, 2003). Evaluation of the green building values in Abu Dhabi is not yet complete as green building is still a growing concept in Abu Dhabi compared with, for example, Australia. The Green Building Council of Australia has issued a new report, *Valuing Green*, which reflects how green buildings affect a building's value and how the value evaluation method can be made reliable. Romilly Madew, Chief Executive of the Green Building Council of Australia, specified that "With a growing amount of Green Star certified buildings presently on the market and a further 480 projects presently listed for certification, valuers will be required to value in a changing market". The report also aims to inspire controllers, policymakers and business and expert associations to examine ways to develop awareness of the effect of sustainability features to support values in quickly discovering and evaluating sustainability market developments (Green Building Council of Australia, 2008). On the other hand, there are 30,000 projects using the LEED System in America and 200,000 BREEM buildings in the UK (Yudelson, 2011).

However, green building transforms the way buildings are designed, built and operated to create more comfortable, healthier and sustainable built environments, whilst reducing energy consumption, greenhouse gas emissions, water consumption and solid waste generation. Moreover, reducing costs and liability whilst increasing value and achieving more predictable results in built environments is thought to be achievable. The cumulative impact of the design, construction and operation of built environments has profound implications for human health, the environment and the economy (USGBC, 2009).

A full review of 60 LEED valued buildings in the USA proves that green buildings, when compared to non-green buildings are, on average, 25-30% more energy efficient. They are categorized by even lower electricity peak consumption, an increased possibility of creating renewable energy onsite and of obtaining network power produced from renewable energy sources through energy efficiency and related measures that are part of green building design (Kats, 2003).

Abu Dhabi is one of the cities that follow and implement green building procedures for saving energy, water and cost. In the UAE, which has one of the highest *per capita* water and energy consumptions, individuals are expected to make a considerable contribution to decreasing their consumption. Indeed, a united community effort to achieve this may eliminate the need for new power and desalination plants to be built. The average consumption of water per person is 350 to 500 liters per day. If every one of the 4,000,000 population of the U.A.E. were to decrease their water consumption by 3.5 liters per day (which about 10% or less), 14,000,000 liters could be saved every single day (EmiratesGBC, 2012).

> "The UAE has almost the highest rate of energy consumption per person in the world. If we continue at the current rate, the demand for energy will simply exceed the supply. At the same time, our consumption of energy adds to the worldwide problem of global warming. Clearly, we need to do something to prevent this" (Heroes of the UAE, PBRS, 2010).

Also, the importance of applying green building procedures in Abu Dhabi could help in reducing fossil fuel energy consumption with a proportion of energy production shifting to renewable sources. Reduction in water usage is also a primary focus due to the amount of fossil fuels currently used to desalinate seawater, along with the residual air pollution and brine production that this entails. Waste infrastructure is now being developed along with the supply of sustainable products to reduce the quantity of waste being sent to landfill and to deal with legacy waste deposits. With Estidama, Abu Dhabi is making a positive contribution to the global need for sustainable development by focusing on the four pre-defined pillars of economic, social, cultural and environmental sustainability which echo the Bedouin ideals and historic ecological and cultural principles. Abu Dhabi may well be on its way to nurturing a first generation green society (Abu Dhabi UPC, 2010), which is in line with the EmiratesGBC vision for the UAE as one of the 5 global leaders in the reduction of the built environment's ecological footprint by 2015 (EmiratesGBC, 2012).

II. The Procedures for Implementing Green Building in Abu Dhabi

The green building procedure will be implemented in all stages of the project in Abu Dhabi according to the Estidama Pearl Building Rating System, Version 1.0, April 2010. The Pearl Rating System is a frame for green building in the design, construction and operation stages of buildings and villas. It has been designed to support sustainable development from design to construction to operational accountability and provides guidance and requirements to rate a project's potential performance in relation to the four pillars of Estidama (PBRS, 2010). However, a separate file, *Planning for Estidama*, identifies Estidama-linked submissions for each phase of the Development Review Process. These submissions confirm that projects are on a pathway to achieve the required 1 Pearl credits. After a project obtains Detailed Planning Approval, then the complete requirements of the PRS (The Pearl Rating System) recognizes the reality of ownership and responsibility transitions as a project evolves from a design team to a construction team to a facility management team. Accordingly, three rating stages have been established: Design, Construction and Operation, and so Design Rating have become applicable. Achievement of the Design Rating is required before obtaining building permits from the Municipalities (Estidama, 2010).

Figure 5: Estidama & Development Review

Recognizing the need for support and to speed up the implementation of green building goals, the Pearl Rating System (PRS), which is a key factor of the Estidama program, obtained a government decree in July 2010. Implementation of the Estidama program is therefore compulsory and, in essence, delivered free by the government to ensure that all new projects are involved

and maintained. Training is dynamically delivered to speed up the extent of awareness throughout both the construction business and the broader population (Abu Dhabi UPC, 2010).
The PRS has been the implementation instrument for Estidama for the last 2 years. All new building and communities must adhere to the minimum requirements during the design, construction, operation and maintenance stages to confirm that the developed resources remain sustainable (Abu Dhabi UPC, 2010).

The parts of sustainable development are incorporated in the PRS - the integrated development procedure - by encouraging cross-disciplinary teamwork to deliver environmental and quality management throughout the life of the project; natural systems by conserving, preserving and restoring the region's critical natural environments and habitats; liveable buildings by improving the quality and connectivity of outdoor and indoor spaces; managing the use of precious water by reducing water demand and encouraging efficient distribution and alternative water sources; managing energy resources by targeting energy conservation through passive design measures, reduced demand, energy efficiency and renewable sources; stewarding materials by ensuring consideration of the 'whole-of-life' cycle when selecting and specifying materials and innovating practice by encouraging innovation in building design and construction to facilitate market and industry transformation (Abu Dhabi UPC, 2010).

The PRS is flexible, enabling it to be applied through all building types and scales. Qualified consultants, or Pearl Qualified Professionals (PQPs), guide projects during the Rating System from the first concept stage through to construction to obtain ratings from 1 to 5 Pearls. The Pearl Qualified Professional (PQP) should be on board from day 1 of the project as he/she will be responsible for preparing all the required documents as well as studying the most feasible credit points to be pursued within the project budget and to communicate with Estidama and get the final relevant approvals (Abu Dhabi UPC, 2010). The following chart illustrates the general Estidama approval process and the PQP role in design and construction:

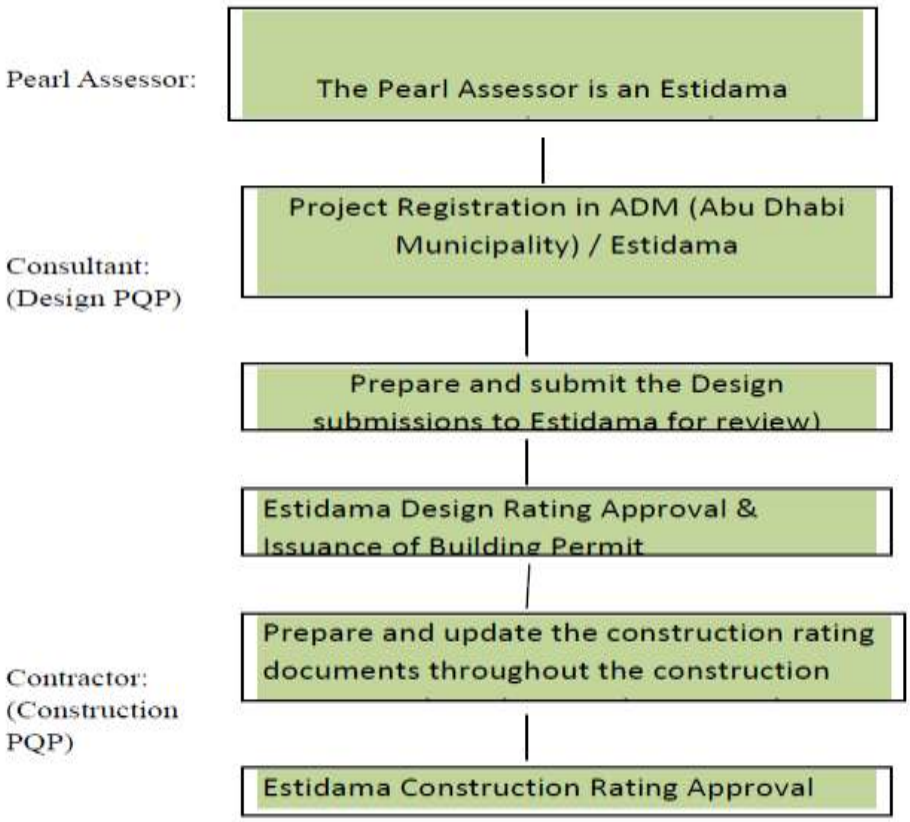

Figure 6: General Estidama Approval Process and the PQP Role in Design and Construction

For each section there are both compulsory and optional credits and credit points are given for each optional credit obtained. To achieve a 1 Pearl rating, all the compulsory credit requirements must be met. To achieve a higher Pearl rating, all the compulsory credit requirements must be met along with a minimum number of credit points (PBRS, 2010).

Table 1: Pearl Building Rating Levels (PBRS, 2010).

Requirement	Pearl Rating Achieved
All compulsory credits	1 Pearl
All compulsory credits + 60 credit points	2 Pearl
All compulsory credits + 85 credit points	3 Pearl
All compulsory credits + 115 credit points	4 Pearl
All compulsory credits + 140 credit points	5 Pearl

The amount of credit points obtainable in a given section defines the weighting of that section, as shown in Table 2 below.

Table 2: Maximum Credit Points Available for each Section (PBRS, 2010).

Credit Section	**Maximum Credit Points**
Integrated Development Process (IDP)	13
Natural Systems (NS)	12
Livable Buildings (LB)	37
Precious Water (PW)	43
Resourceful Energy (RE)	44
Stewarding Materials (SM)	28
Innovating Practice (IP)	3
Total	177

Three rating stages have been established: Design, Construction and Operational:

Pearl Design Rating: Rewards measures accepted during the design development of the project that meets the objectives and requirements for every credit. A Pearl Design Rating is effective only until construction is handed over and that needs all guarantee, branding and communication materials to be in place if a project is to be classified as a Pearl Design Rated project (PBRS, 2010).

Pearl Construction Rating: The commitments prepared for the Design Rating have been attained. The Construction Rating needs all guarantee, branding and communication materials to be in place for a project to be classified as a Pearl Construction Rated project (PBRS, 2010).

Pearl Operational Rating: Evaluates the built-in structures and operational performance for the current building and confirms the building is operating sustainably. The operational rating can only be obtained after a minimum of two years from construction completion and when the building has reached 80% of occupancy (PBRS, 2010).

There are two main processes for implementing green building procedures; the first is the Pearl Rating Process and the other the Development Review Process (PBRS, 2010**).**

The Pearl Rating Process

This is designed to be a simple and active way of learning to evaluate the sustainability of a specific development. The general stages required to be followed by developers and consultants in the process are summarized as follows:

Table 3: All Pearl Ratings (PBRS, 2010)

Steps	Requirements
Step 1	Register the development with Estidama for the relevant Pearl Rating System.
Step 2	Appoint a PQP to facilitate the rating process and co-ordinate the submission.
Step 3	Conduct workshops in compliance with the Estidama Integrated Development Process (EIDP) with facilitation by the PQP.

Table 4: Pearl Design Rating (PBRS, 2010)

Steps	Requirements
Step DR4	Review and update credit submissions on a regular basis throughout the design process**.**
Step DR5	Issue the final design credit submissions to Estidama at the end of the construction documentation stage.
Step DR6	The submission will be reviewed by a Pearl Assessor, who may request clarifications or additional information from the PQP as necessary.
Step DR7	The Pearl Assessor will award a Pearl Design Rating based on the credits achieved by the development.

Table 5: Pearl Construction Rating (PBRS, 2010)

Steps	Requirements
Step CR4	Review and update credit submissions on a regular basis throughout the construction process.
Step CR5	Issue the final construction credit submissions to Estidama after construction is complete.
Step CR6	The submission will be reviewed by a Pearl Assessor, who may request clarifications or additional information from the PQP. Estidama reserves the right to undertake on-site verification if deemed necessary.
Step CR7	The Pearl Assessor will award a Pearl Construction Rating based on the credits achieved by the development.

Pearl Operational Rating:

Two years after construction completion, after a building has reached a minimum occupancy of 80%, submissions can be prepared for the Pearl Operational Rating which is currently under development by Estidama and UPC (PBRS, 2010).

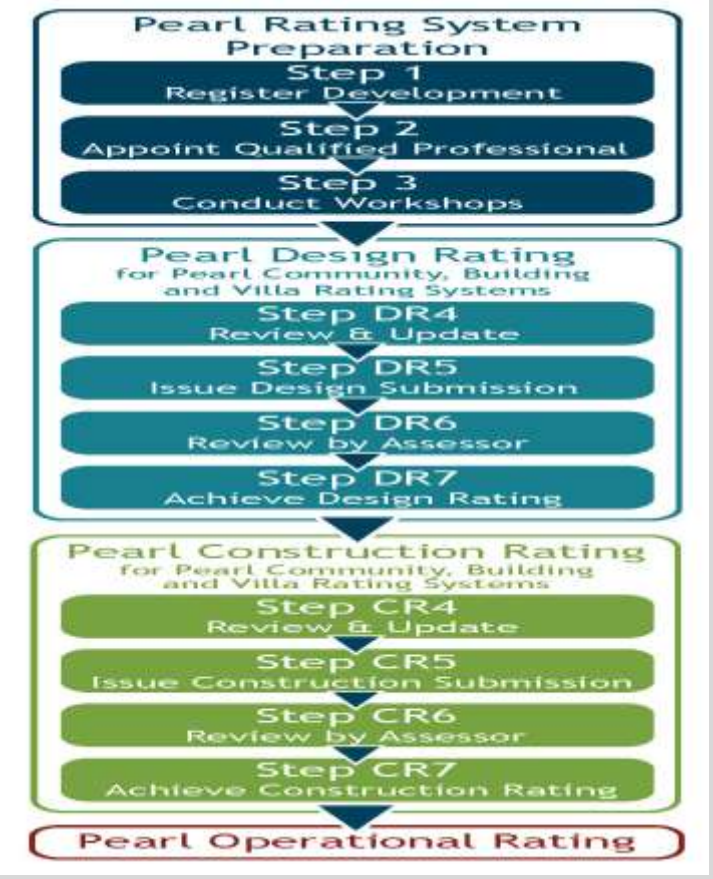

Figure 7: The Pearl Rating Process (PBRS, 2010).

The Development Review Process:

The Development Review Process has been presented by the UPC to deliver an efficient process for studying development proposals. The process includes four steps: enquiry, pre-concept stage, concept planning review and detailed planning review. The UPC uses this review process to ensure development proposals are in line with the Emirate's urban planning policies such as Estidama, land uses and densities and to coordinate the review and approval of development submissions by external government authorities (PBRS, 2010).

To confirm technical conformity with the original design, throughout the construction stage, audits are carried out at four key stages. On-site testing to observe the design being provided decreases defects and liability problems and eliminates cases of non-compliance, enhances the efficiency of the construction development and keeps costs down. The (PORS) Pearl Operational Rating System confirms stability of building performance and efficiency by mandating operational maintenance protocols, spreading throughout both the building and system lifecycle (Abu Dhabi UPC, 2010).

Credit Points for the Pearl Building Rating System:

Basically, the development of the green building procedure in design and construction has been supported by implementing the Pearl Building Rating System (PRS) which consists of an Integrated Development Process (IDP), Natural Systems (NS), Livable Buildings (LB), Precious Water (PW), Resourceful Energy (RE), Stewarding Materials (SM), and Innovating Practice (IP) as shown in Table 2 above. This applies in design, construction and at the whole structure life cycle.

Integrated Development Process (IDP): used for cross-disciplinary teamwork and is based upon sound thinking to provide good quality ecological management during the life of the project in order to reach the successful integration of construction, community, natural and economic systems. The process needs an integrated design method from very early on in the design, a clear idea and sustainability goals and implementation strategy. Implementing the IDP Credits will create a more cooperative and iterative design development, enhance construction activities that value workers' welfare, quality and sound environmental management; and create the groundwork for good operation and maintenance where the handler plays an informed dynamic role (PBRS, 2010). The tables below provide a summary of the credit points for the IDP which is required for green buildings.

Table 6: Integrated Development Process (IDP) Credit Points and Objectives (PBRS, 2010).

IDP	Integrated Development Process	Maximum Credit Points	Objectives
IDP-R1	Integrated Development Strategy	R	Achieving better interaction between project systems, resulting in high-performance buildings by ensuring that new developments implement an Integrated Development Process (IDP).
IDP-R2	Tenant Fit-Out Design & Construction Guide	R	Confirming that the design and construction of internal space fit-out will contribute to achieving the overall project's sustainability objectives and targets.
IDP-R3	Basic Commissioning	R	Ensuring that the building performs as designed to achieving targets for the care of occupants' health, providing luxury and ongoing building efficiency.
IDP-	Life Cycle Costing	4	To enable effective long-term decisions about building design

1	(LCC)		and construction in order to maximize efficiency over the whole life of the development.
IDP-2	Guest Worker Accommodation	2	To promote fair labor practices in building construction.
IDP-3	Construction Environmental Management Plan (CEMP)	2	To reduce the environmental impacts associated with construction practices.
IDP-4	Building Envelope Verification	1	To ensure the building envelope meets the design intent and minimizes building impacts from condensation, water ingress, air infiltration and improper drainage.
IDP-5	Re-commissioning	2	Ensuring that the building continues to perform as designed to achieve the targets for enhancing occupant health and providing luxury and ongoing building efficiency.
IDP-6	Sustainability Communication	2	To promote the efficient ongoing operation of the building by enabling occupants to appreciate, understand and therefore contribute to responsible resource use in the building.
	Total	**13**	

Natural Systems (NS): The Natural Systems Credit is anticipated to enhance the control of natural resources and sustainable land usage through analysis and valuation of all natural systems on the site; the preservation and protection of existing valuable resources; the provision of a natural system design and management strategy; enhancing the reuse of land; remediation of polluted land; and the enhancement of environmental value, habitat creation, renovation and the provision of habitat connections (PBRS, 2010).

Table: 7 Natural Systems (NS) Credit Points and Objectives for Multi- Residential Buildings (PBRS, 2010).

NS	Natural Systems	Credit Points for Multi-Residential Buildings	Objectives
NS-R1	Natural Systems Assessment	R	Ensuring that at the start of the design process, the environmental baseline circumstances adjacent, linked to and on the site are assessed and considered.
NS-R2	Natural Systems Protection	R	Protecting valuable and significant natural systems resources.

NS-R3	Natural Systems Design & Management Strategy	R	Encouraging soil protection, reducing the consumption of resources and maintaining the natural landscape and neighborhoods.
NS-1	Reuse of Land	2	To encourage new developments to reuse land that has already been built on and infill existing urban areas rather than using undisturbed land.
NS-2	Remediation of Contaminated Land	2	To encourage and promote the remediation of land for building development.
NS-3	Ecological Enhancement	2	To enhance the ecological value of the site.
NS-4	Habitat Creation & Restoration	6	To restore or re-create a habitat that is self-sustaining.
	Total	**12**	

Livable Outdoor (LBo): This credit is encouraging the provision of outdoor space - private, as well as public - to encourage active urban environments; the facility of shaded walkways and other measures to provide more thermally comfortable outdoor environments; the facility of local comforts; the use of alternative modes of transport such as buses, trams and metros, car sharing, the use of alternative-fuel automobiles, cycling and walking and decreasing the urban light pollution (PBRS, 2010).

Table: 8 Livable Outdoors (LBo) Credit Points and Objectives for Multi- Residential Buildings (PBRS, 2010).

LBo	**Livable Outdoors**	**Credit Points for Multi-Residential Buildings**	**Objectives**
LBo-R1	Plan 2030	R	Ensuring that all new development advances the Abu Dhabi Plan 2030.
LBo-R2	Urban Systems Assessment	R	Ensuring that before the design process proceeds, a thorough study of the project site is developed within its urban environment to improve connectivity and better-inform project programming.

LBo-R3	Outdoor Thermal Comfort Strategy	R	Increasing outdoor thermal comfort by reducing thermal discomfort during summer in public spaces and footpaths.
LBo-1	Improved Outdoor Thermal Comfort	2	Developing outdoor thermal comfort and reducing thermal difficulties during summer months in public spaces and footpaths.
LBo-2	Pearl Rated Communities	1	To encourage new buildings to be built within Pearl Rated communities.
LBo-3	Accessible Community Facilities	1	To minimize reliance on private car use by locating buildings in areas with a mix of uses and amenities.
LBo-4	Active Urban Environments	1	To encourage active lifestyles by providing a building's occupants and users with recreational public open spaces.
LBo-5	Private Outdoor Space	1	To improve the occupants' quality of life by providing private outdoor space.
LBo-6	Public Transport	3	To encourage the use of public transport by building occupants and visitors.
LBo-7	Bicycle Facilities	2	To minimize greenhouse gas emissions, improve connectivity and encourage bicycle use. (particularly during the cooler winter months).
LBo-8	Preferred Car Parking Spaces	1	To encourage car sharing and more fuel-efficient forms of personal transport.
LBo-9	Travel Plan	1	To reduce single-occupancy vehicle use by managing the demand for travel and by maximizing the availability of alternatives to traveling by car.
LBo-10	Light Pollution Reduction	1	To encourage the reduction of night-time light pollution and its associated impacts on human and ecological health.
	Total	**14**	

Livable Indoors (LBi): The livable indoors credit aims to create comfortable environments and contains many features that are significant in the design of a building interior such as ventilation quality during normal building operation, indoor air quality management performance during construction and after occupation; material selection to reduce harmful radiation; developing thermal comfort by encouraging beneficial design practices and outcomes that adopt a well thought through HVAC strategy; and a greater degree of occupant control and use of natural daylight, which is consistent and abundant in the region, together with suitable artificial lighting (PBRS, 2010).

Table: 9 Livable Indoors (LBi) Credit Points and Objectives for Multi- Residential Buildings (PBRS, 2010).

LBi	Livable Indoors	Credit Points for Multi-Residential	Objectives
LBi-R1	Healthy Ventilation Delivery	R	To ensure minimum delivery of outdoor fresh air and protecting the quality of air drawn into buildings for ventilation.
LBi-R2	Smoking Control	R	To reduce exposure of building occupants to the negative risks of smoking.
LBi-R3	Legionella Prevention	R	Risk management of bacteria in the construction of water-based systems.
LBi-1	Ventilation Quality	3	To promote the provision of building systems that support the wellbeing and comfort of occupants by providing sufficient outside air ventilation.
LBi-2.1	Material Emissions: Adhesives & Sealants	1	Confirm the use of low emission adhesives and sealants to encourage the desirability of these spaces in relation to improved occupant health.
LBi-2.2	Material Emissions: Paints & Coatings	1	Confirm the use of low emission Paints and Coatings to encourage the desirability of these spaces in relation to improved occupant health.
LBi-2.3	Material Emissions: Carpet & Hard Flooring	1	Confirm the use of low emission flooring systems to encourage the desirability of these spaces in relation to improved occupant health.
LBi-2.4	Material Emissions: Ceiling Systems	1	Confirm the use of low emission ceiling systems to encourage the desirability of these spaces in relation to improved occupant health.

LBi-2.5	Material Emissions: Formaldehyde Reduction	2	To mitigate the health risks associated with formaldehyde in building materials and products.
LBi-3	Construction Indoor Air Quality Management	2	To implement construction practices that promotes a high degree of indoor air quality (IAQ) for construction workers and building occupants.
LBi-4	Car Park Air Quality Management	1	To facilitate the provision of adequate air quality within enclosed car parks.
LBi-5.1	Thermal Comfort & Controls: Thermal Zoning	1	To promote logical thermal zoning strategies in relation to the on-floor ventilation system, to achieve improved occupant comfort, future flexibility and energy
LBi-5.2	Thermal Comfort & Controls: Occupant Control	2	To promote projects that provide individual comfort controls for the wellbeing, productivity and thermal comfort of occupants.
LBi-5.3	Thermal Comfort & Controls: Thermal Comfort Modeling	2	To promote projects that are designed to deliver optimal thermal comfort.
LBi-6	High Frequency Lighting	1	To promote indoor visual comfort through the use of high-frequency lighting solutions.
LBi-7	Daylight & Glare	2	To promote building designs that maximize the use of natural daylight indoors.
LBi-8	Views	1	To provide building occupants with a visual connection to the outdoors.
LBi-9	Indoor Noise Pollution	1	Provide acoustic conditions that are commensurate with the sensitivity and/or acoustic privacy requirements of the proposed use.
LBi-10	Safe & Secure Environment	1	To provide a safe and secure environment for building occupants and visitors.
	Total	**23**	

Precious Water (PW): The Precious Water credit of the Pearl Building Rating System: Design and Construction contains the building water calculator that should be used during the entire design procedure. This calculator will help the development team to measure inputs and flows of water to and from the project with a complete perception and support in identifying how and where decreases in the use of potable water may be made (PBRS, 2010).

Table: 10 Precious Water (PW) Credit Points and Objectives for Multi- Residential Buildings (PBRS, 2010).

PW	Precious Water	Credit Points for Multi-Residential	Objectives
PW-R1	Minimum Interior Water Use Reduction	R	A comprehensive strategy for water during the early stages of the design to reduce the consumption of internal potable water for the project.
PW-R2	Exterior Water Monitoring	R	To enhance the delivery of water metering for each external water consumer to enable effective management of water consumption outdoors and prevent leaks.
PW-1	Improved Interior Water Use Reduction	15	To promote further reductions in the project's interior potable water consumption through the use of efficient fixtures and appliances and the use of recycled water.
PW-2.1	Exterior Water Use Reduction: Landscaping	8	To minimize landscaping water demands through effective plant selection, irrigation strategies and promoting the use of recycled water.
PW-2.2	Exterior Water Use Reduction: Heat Rejection	8	To reduce potable water use for heat rejection by promoting the use of recycled water and/or alternatives to water-based heat rejection.
PW-2.3	Exterior Water Use Reduction: Water Features	4	To reduce potable water use for heat rejection by promoting the use of recycled water and/or alternatives to water-based heat rejection.
PW-3	Water Monitoring & Leak Detection	4	To encourage the provision of metering facilities that allow the water consumption of the building to be recorded and monitored to allow future improvement and understanding of the use of water in buildings.

PW-4	Storm water Management	4	To minimize peak storm water discharge and protect the storm water drainage system and
	Total	**43**	

Resourceful Energy (RE): The Resourceful Energy credit requires an energy calculation and assessment procedure to be assumed. This assessment will enable careful concern of energy issues during the design of buildings, resulting in **good,** knowledgeable, decision making that focuses on reducing the demand for energy through passive environmental design, suitable selection of highly efficient mechanical and electrical equipment and the enablement of renewable energy systems.

Table: 11 Resourceful Energy (RE) Credit Points and Objectives for Multi- Residential Buildings (PBRS, 2010).

RE	**Resourceful Energy**	**Credit Points for Multi-Residential Buildings**	**Objectives**
RE-R1	Minimum Energy Performance	R	Decision support to assist the project team to make effective decisions about the options available and the effects and benefits of the design of various aspects of the building to achieve a higher level of energy efficiency.
RE-R2	Energy Monitoring & Reporting	R	To encourage the provision of metering facilities that allow the energy performance of the building to be recorded and monitored to allow future improvement and understanding of the use of energy in buildings.
RE-R3	Ozone Impacts of Refrigerants & Fire Suppression Systems	R	Promote the selection of fire extinguishing systems that minimize negative impacts on the environment.
RE-1	Improved Energy Performance	15	To promote further reductions in the project's energy consumption and hence carbon emissions associated with building operation.

RE-2	Cool Building Strategies	6	To determine the most effective solution to reducing a building's cooling demand by incorporating passive design strategies as a priority.
RE-3	Energy Efficient Appliances	3	To minimize the energy consumed by
RE-4	Vertical Transportation	3	To promote projects that specify and install energy efficient vertical movement
RE-5	Peak Load Reduction	4	To reduce energy demand and consequent increased infrastructure requirements to cater for loads at peak use times through efficient building and services design and site-based renewable energy generation.
RE-6	Renewable Energy	9	To reward projects for the use of renewable technologies, therefore reducing the carbon emissions associated
RE-7	Global Warming Impacts of Refrigerants & Fire Suppression Systems	4	Promote the selection of fire extinguishing systems that minimize negative impacts on the environment.
	Total	**44**	

Stewarding Materials (SM): The Stewarding Materials credit of the Pearl Rating System helps design and improvement teams to consider this entire continuum life cycle when choosing and identifying materials, with an overall objective to develop the community and ecological outcomes linked with their manufacture, transport, installation and disposal.

Table: 12 Stewarding Materials (SM) Credit Points and Objectives for Multi- Residential Buildings (PBRS, 2010).

SM	Stewarding Materials	Credit Points for Multi-Residential Buildings	Objectives
SM-R1	Hazardous Materials Elimination	R	Protecting occupants and the environment from the damage of asbestos and eliminate the toxic effects of chromated, copper-arsenate-treated wood.
SM-R2	Basic Construction Waste Management	R	To eliminate the environmental impacts of long-term waste management.

SM-R3	Basic Operational Waste Management	R	To eliminate the environmental impacts of long-term waste operational management.
SM-1	Non-Polluting Materials	3	To promote the selection of materials which do not have long-term negative impacts on human health or pollute natural systems.
SM-2	Design for Materials Reduction	1	To reduce the overall amount of material used in the development of buildings.
SM-3	Design for Flexibility & Adaptability	1	To lengthen the useful life of buildings through designs those are easily adaptable for other program uses.
SM-4	Design for Disassembly	1	To facilitate the future deconstruction and reuse of buildings and their structural and envelope components.
SM-5	Modular Flooring Systems	1	To minimize waste associated with replacement of flooring systems through the use of modular systems.
SM-6	Design for Durability	1	To promote a long-life building by protecting its components from condensation, water ingress, improper drainage and protecting vulnerable areas of the building envelope and surroundings.
SM-7	Building Reuse	2	To encourage the reuse and improvement of the existing building stock, reduce waste and other environmental impacts associated with new materials extraction, manufacturing and transport.
SM-8	Material Reuse	1	To promote the selection of previously used or salvaged materials in order to reduce demand on natural resources and reduce waste.
SM-9	Regional Materials	2	To encourage the selection of building materials that have lower transport impacts and promote regional economies.
SM-10	Recycled Materials	6	To increase the demand for recycled materials to reduce the amount of waste going to disposal.
SM-11	Rapidly Renewable Materials	1	To increase the use of fast growing materials as an alternative to slow growing materials and finite resources.
SM-12	Reused or Certified Timber	2	To encourage the use of timber sourced from legal and sustainable sources.

SM-13	Improved Construction Waste Management	2	To further reduce the long-term environmental impacts associated with construction waste collection, transport, and disposal.
SM-14	Improved Operational Waste Management	2	To further reduce the long-term environmental impacts associated with operational waste collection, transport, and disposal.
SM-15	Improved Organic Waste Management	2	To encourage the recovery and reuse of organic waste from building operations including landscaping and food waste.

Innovating Practice (IP): The Innovative Practice credit is intended to inspire receptive design that achieves innovative solutions which will encourage the development's success and contribute to sustainability in the UAE through addressing the pillars of sustainability through innovative design solutions which are able to be duplicated, providing for feasibility analysis and cost benefit and improving designs that showcase regional practices and culture, while contributing to the environmental performance of the improvement.

Table 13: Innovating Practice (IP): Credit Points and Objectives for Multi- Residential Buildings (PBRS, 2010).

IP	**Innovating Practice**	**Credit Points for Multi-residential Buildings**	**Objectives**
IP-1	Innovative Cultural & Regional Practice	1	Develop designs that showcase cultural and regional practices, while contributing to the environmental performance of the building.
IP-2	Innovating Practice	2	To reward design and construction practices that result in a significant positive impact in relation to any of the four pillars of Estidama.
	Total	**2**	

Impacts and Benefits of Implementing Green Building Procedures at the Al Ghuraibah Project:

Al Ghuraibah villas were selected as a case study on the basis that they represent a sample group which are implementing green building procedures for residential building in Abu Dhabi. It is worthy to mention that Al Ghuraibah villa is represented Estidama mockup villa according to Estidama website (Estidama, 2010).That means Al Ghuraibah villa is the ideal case study that implemented Estidama Pearl Rating System and it provided a good example for the impacts and benefits for the implementation of Estidama Pearl Rating System. Al Ghuraibah villas is located approximately 10km west-south-west of Al Ain city centre. The site is south of the Al Maqam Palace District and is bordered on its southerly side by the Al Ain Wadi separating it from Al Shaabeya District to the south. Al Ghuraibah development is a perfect escape from the hustle and bustle of city life. The community has 600 villas and related community facilities. In addition to the contemporary and Mediterranean architectural styles, the total plot area of 16 millionm^2 will also

include mosques, a school, a neighborhood center, and a wide range of retail outlets, all of which have been designed to meet Estidama "2Pearl" Villa, Building and Community requirements. The total project value is 500 million USD; the cost of the infrastructure work is 88 million USD and the cost of construction work is 224 million USD. Al Ghuraibah villas are designed according to the latest sustainability standards that save energy and water and preserve of the environment. There are two types of design with an area of 480m^2 per villa which meet the residential requirements of the citizen. Al Ghuraibah developer manager stated that design and construction is intended to meet the Estidama guidelines of the Abu Dhabi Urban Planning Council, and earn a "2 Pearl" rating. Al Ghuraibah villas Phase 1 contained 600 villas completed in the first quarter of 2013.Al Ghuraibah villas have an area of 480m^2 for each villa and there are two types of design each of which meets the residential requirements of citizens. Each design has two floors: the ground floor and first floor.

Al Ghuraibah project achieved 33 points for each six main credits and earn a "2 Pearl" rating according to the PVRS (Pearl Villa Rating System); 1 credits point for Integrated Development Process (IDP), 2 credit points for Natural Systems (NS), 11 credit points for Livable Villas (LV), 7 credit points for Precious Water (PW), 5 credit points for Resourceful Energy (RE), and 7 credit points for Stewarding Materials (SM), while no credits were achieved for the seventh credit of Innovating Practice (IP).

The Al Ghuraibah villas project achieved many benefits as a result of Implementing Estidama Pearl Rating System through applying Estidama credits for the Integrated Development Process (IDP), Natural Systems (NS), Livable Villas (LV), Precious Water (PW), Resourceful Energy (RE) and Stewarding Materials (SM) as shown in Table 14.

Table 14: Benefits Achieved by Implementing Estidama Pearl Rating System at Al Ghuraibah Project

SR.No	Achieved Pearl Rating System Credit	Benefits Achieved
1	7 Credits for Precious Water (PW)	Reduce water consumption by 34.6% under the base rate through the installation of sanitary fixtures which provides a low flow of water.
2	5 Credit for Resourceful Energy (RE)	Improve the efficiency of energy consumption further by a reduction of 22.97% below the base rate. The adoption of conditioning systems more efficient in energy consumption, and the installation of solar-powered heating systems to produce about 80% of the total hot water requirements of the residents.
3	7 Credits for Precious Water (PW) &5 Credit for Resourceful Energy (RE)	Improve operational efficiency, reduce operation and maintenance costs resulting from cooling, lighting and water consumption.
4	11 Credits Livable Villas (LV)	Project is located not more than 350m from the nearest social entertainment facility, while enhanced open spaces and shaded lanes encourage the practices of walking and cycling, support greater social interaction and improve public health. Increased the capacity of natural ventilation by 25% above the base rate whilst arranging the temperatures in both the living room and bedrooms to ensure the efficient use of air conditioning and reduce energy consumption. Increased use of natural daylight means that lighting half the spaces or more can be achieved using sunlight during the day.

5	7 Credits for Stewarding Materials (SM)	The quality of indoor air is made healthy by using adhesives, sealants and paints that contain low levels of volatile organic compounds, and the insulating materials used do not contain ozone-depleting substances and so do not significantly contribute to the increase in global warming. Doors and windows with waterproofing and chlorine-free materials for insulating walls and ceilings, 20% of all building materials used come from local sites located within 500 miles of the project site, including concrete blocks, blocks of insulation, ceramic tiles and some paints. more than 50% of construction waste is sent for recycling

III. Method

The research was conceptualized to focus on an exploration of the construction firms in Abu Dhabi. Data collected from the questionnaire was obtained online by using SurveyMethods software. The questionnaire was divided into eight multi-part questions. The interviews and the case study of concerned Al Ghuraibah villas (about 600 villas), which was selected as a case study on the basis that it represented a sample group which was implementing Green Building procedures in residential building in Abu Dhabi through the Estidama Rating System. For selecting the population, simple random sampling was used and the research used a computerized sample size calculator to determine the sample size needed for the population of about 150 individuals. The study used simple random sampling which provides a subset of a statistical population in which each member of the population has an equal probability of being chosen. A simple random sample was meant to be an unbiased representation of a group. An example of a simple random sample would be a group of 25 employees chosen out of a hat from a company of 150 employees. In this case, the population is all 150 employees from 150 firms (consultants and contractors) in Abu Dhabi, the sample of 150 firms is represented 6% of total 2593 construction firms are working in Abu Dhabi according to Abu Dhabi commercial directory which includes all the registered construction firms firm with the Abu Dhabi Chamber of Commerce and Industry (ADCCI) (Abu Dhabi Commercial Directory, 2013). The sample is random because each employee has an equal chance of being chosen.

Table 15: Frequencies and Percentages for Participant Demographics

Demographic		***n***	**%**
Gender			
	Female	30	20
	Male	118	79
Nationality			
	Egyptian	20	13
	Indian	12	8
	Iraqi	5	3
	Jordanian	7	5
	Malaysian	8	5
	Pakistani	6	4
	Filipino	9	6
	Sudanese	33	22
	Other	23	15
Position			
	Architect	15	10
	CEO	2	1

	Director	7	5
	Engineer	65	43
	Manager	36	24
	Other	25	17
Firm type			
	ADM	5	3
	Consultant	54	38
	Contractor	46	31
	Developer	8	5
	Other	29	19
Project location			
	Abu Dhabi	109	73
	Al Ain	6	4
	Al Gharbia	2	1
	Musaffah	3	2
	Other	6	4

The data was collected and extracted from its original raw (questionnaire) and recorded state by using computer software called SurveyMethods. The data was collected as follows: the first section collected details about respondents' knowledge of Green Building and ESTIDAMA. The second section collected details about respondents' practice in implementing Green Building procedures for residential building in Abu Dhabi. The third section collected data about the impacts of implementing Green Building procedures according to the respondents' experiences and projects. The fourth section collected data about the obstacles and challenges facing the implementation of Green Building procedures in residential building in Abu Dhabi and the last section requests respondents' opinions and suggestions for improving the implementation of Green Building procedures in residential building in Abu Dhabi. Exploratory data analysis uses descriptive statistics and graphical forms to analyze data. Descriptive statistics include frequency/percentages and means/standard deviations. Frequency and percentages were calculated for categorical or nominal data. Frequency is the count or number of participants that fall into a particular category; it is also useful to know the percentage of the sample that falls into that category. Means and standard deviations will be calculated for interval/ratio data. The arithmetic mean is defined as the sum of scores divided by the number of scores. Standard deviation measures statistical dispersion, or the spread of values in a data set. If the data points are all close to the mean, then the standard deviation is close to zero. Graphical forms provide a method of organizing data. Examples include frequency distributions, histograms and pie/bar charts (David C. Howell, 1992).

Validity was strengthened through the representative sample, extensive literature review and the dual approach used that allowed the findings to be generalized outside the immediate bounds of the sample. Reliability was gained in the study through the recognition and mitigation of bias, extensive piloting to minimize errors and ambiguity, and through scoping. Since there were both advantages and disadvantages to the nonparametric methods, caution was required in selecting the analytical methods. Finally, exploratory data analysis uses descriptive statistics and graphical forms to analyze data.

IV. Results and Findings

The investigation of current situation for the implementation of Green Building procedures in residential building in Abu Dhabi was measured by different factors. The first factor is the type of procedure that used in Abu Dhabi which is called Estidama Pearl Rating System that was commonly used in the residential building in Abu Dhabi and Al Ghuraibah project case study as illustrated by details on how the Estidama Pearl Rating System implemented to achieve 2 Pearl Rating System.

Also, from the questionnaires findings on all the green building principles includes Environmental design, Sustainable project site location, water efficiency, Energy efficiency, Selection of sustainable material, Develop a construction waste management and Indoor air quality and thermal comfort are commonly used in Abu Dhabi for the residential buildings. The second factor is the knowledge of Green Building and awareness of green building procedure through Estidama for the construction team and firms in Abu Dhabi, A majority of participants (77%) did know about Green Building. Most participants' companies (73%) were aware of Green Building and were also aware of the implementation of Green Building procedure for residential building in Abu Dhabi .A majority of participants' companies (67%) were aware of ESTIDAMA. Over half of the participants' companies (54%) were registered for ESTIDAMA & 46 participants (29%) have ESTIDAMA certification (that means 46 participants are PQP). The third factor is the number of the residential green buildings in Abu Dhabi. Fifty-six percent of participants indicated having contributed to implementation of Green Building procedure in a residential area in Abu Dhabi and most of participants (56%) indicated less than five projects implemented or contributed to Green Building procedures in residential areas of Abu Dhabi.

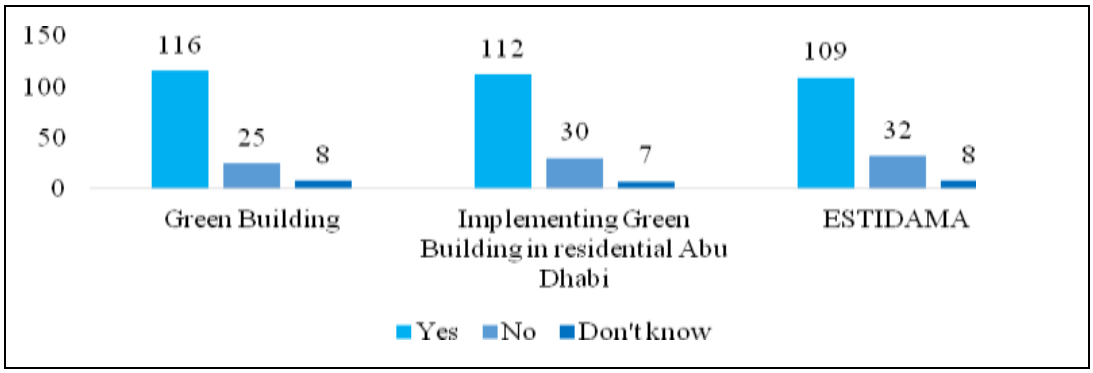

Figure 8: Bar Chart for Company Awareness in Abu Dhabi.

Evaluation of the current situation of implementing Green Building procedures in residential building in Abu Dhabi is ranging between excellent to good which is a great achievement comparing to the recent experience of implementing the green building procedure in Abu Dhabi science 2008. Also , the evaluation of the understanding of green building regulations (ESTIDAMA) for Residential Building in Abu Dhabi by construction firm is ''Medium'' that means the green building procedure (ESTIDAMA) requires more efforts of trainings for the construction firms and more efforts to increase the awareness. Furthermore, there are some obstacles and challenges that facing the implementation of the green building procedure in residential building are Lack in training courses, lack of professional expert Green Building design firms, lack of building material and information, lack of familiarity with Green Building procedures within the building firms, Costly and lack of understanding Estidama Frame Work and regulation.

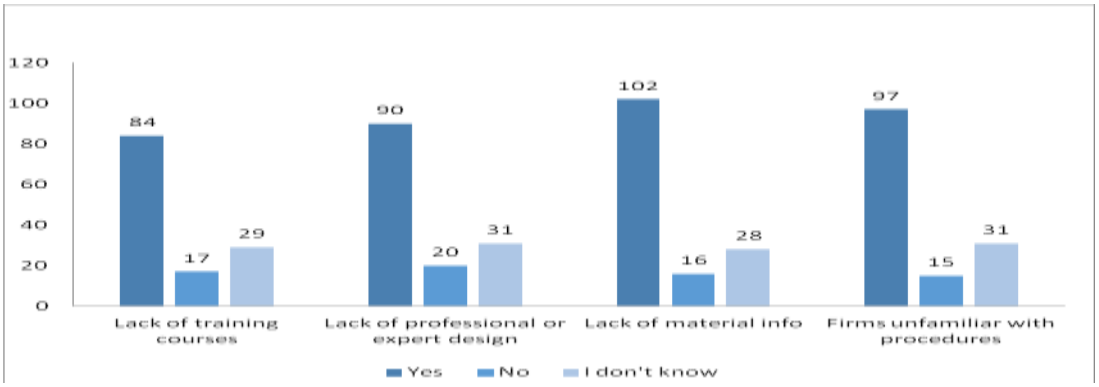

Figure 8: Obstacles and Challenges for Implementing Green Building Procedure in Abu Dhabi

The determination of the impacts and benefits of implementing Green Building procedures in residential building in Abu Dhabi'' are strongly achieved from Al Ghuraibah project case study and it reduce water consumption by 34.6% under the base rate, improve the efficiency of energy consumption further by a reduction of 22.97% below the base rate, improve operational efficiency, reduce operation and maintenance costs resulting from cooling, lighting and water consumption, enhanced open spaces and shaded lanes encourage the practices of walking and cycling, support greater social interaction and improve public health, Increased the capacity of natural ventilation by 25% above the base rate, Increased use of natural daylight, healthy indoor air quality & more than 50% of construction waste is sent for recycling. The impacts and benefits of implementing Green Building procedure in Al Ghuraibah project are similar to findings from the questionnaires. Therefore, 54.86% of participants strongly agreed that reduce the water consumption is a strong impact of implementing green building procedure, 54.11% of participants agreed that reduce the energy consumption is a strong impact of implementing green building procedure, 49.32% of participants agreed that built comfortable and health environment is a strong impact of implementing green building procedure built comfortable and health environment, 46.53% of participants agreed that reduce environment impact is a strong impact of implementing green building procedure, 43.45% of participants agreed that improve indoor air quality is a strong impact of implementing green building procedure, 42.76% of participants agreed that incorporating energy and water efficient technologies is a strong impact of implementing green building procedure, 40.85% of participants agreed that reducing construction and demolition waste is a strong impact of implementing green building procedure, 38.19% of participants agreed that using recycled content material is a strong impact of implementing green building procedure, 37.5% of participants agreed that including renewable energy technology is a strong impact of implementing green building procedure.

Table 16: Rate of the impact of implementing Green Building Procedure assigned by participants

Green Building impacts	Extremely Strong	Strong	Neutral	Weak	Very Weak
Built Comfortable and health environments:	37(25.34%)	72(49.32%)	35(23.97%)	0(0%)	2(1.37%)
Reducing energy consumption:	43(29.45%)	79(54.11%)	17(11.64%)	4(2.74%)	3(2.05%)
Reducing water consumption:	44(30.56%)	79(54.86%)	15(10.42%)	3(2.08%)	3(2.08%)
Reduce cost:	7(4.86%)	25(17.36%)	49(34.03%)	49(34.03%)	14(9.72%)
Reduce construction and demolition waste:	12(8.45%)	58(40.85%)	58(40.85%)	10(7.04%)	4(2.82%)
Include renewable energy technologies:	13(9.03%)	54(37.5%)	65(45.14%)	7(4.86%)	5(3.47%)
Improve indoor air quality:	24(16.55%)	63(43.45%)	53(36.55%)	2(1.38%)	3(2.07%)
Reduce environmental impact:	19(13.19%)	67(46.53%)	53(36.81%)	3(2.08%)	2(1.39%)
Incorporate energy and water efficient technologies:	21(14.48%)	62(42.76%)	54(37.24%)	6(4.14%)	2(1.38%)

Use recycled content materials:	10(6.94%)	55(38.19%)	57(39.58%)	15(10.42%)	7(4.86%)

V. Conclusion & Recommendations

Estidama's target has been to develop Abu Dhabi's cultural character by generating an always-improving quality of life for its residents based on four elements of sustainability: ecological, financial, community and social. The noble benefits of Estidama's target can only be realized if continued studies are put in place to improve the implementation of the Estidama Pearl Rating System in Abu Dhabi. Furthermore many efforts can be done through Abu Dhabi Urban Planning Council, Emirates GBC and Estidama department to improve the implementation of the Estidama Pearl Rating System for the residential building in Abu Dhabi such as:

(i) Program of Green Building award to be establish by Emirates GBC and ESTIDAMA will encourage construction firms to improve implementation of Green Building procedures.
(ii) Abu Dhabi construction industry to adopt Green Building procedures for residential building as a legal term of contract
(iii) All firms need extra improvement & Estidama Training to be compulsory for all construction firms.
(iv) The construction industry to adopt Green Building procedure (Estidama Pearl Rating System)for residential building as a term of contract
(v) Government backing.
(vi) Incentives awarded to the firms which are implementing Green Building procedure (Estidama Pearl Rating System) in their project.
(vii) Increasing awareness through Media program about Estidama.
(viii) Streamlining or making Estidama Pearl Rating System and framework more easily executed.
(ix) Authorities (UPC, Estidama and ADM) to provide flexible services and more coordination for the firms that implementing green building procedure in Abu Dhabi.
(x) Suppliers should provide lists of available green materials and recycled materials.
(xi) Increase the number of the local factories for Estidama products (Materials).
(xii) Green building concept to be educated in schools and colleges.
(xiii) More attention should be given to the waste recycling in Abu Dhabi.
(xiv) Government to support the Estidama products (Materials) to be in a low cost.

Finally, This study has focused on the implementation of Estidama Pearl Rating System for the residential Building only and it is necessary to be extended to incorporate the other type of buildings; Schools, hospital ,commercial building and also infrastructure. This study will provide big picture for the current situation for the implementation of Green Building procedure through Estidama Pearl Rating System in Abu Dhabi and it will give accurate impacts to the four elements of Estidama/sustainability: Environment, economy, community and society in Abu Dhabi. Furthermore, the evaluation for the successful of the Green Building procedure in Abu Dhabi will be validated.This study has addressed the cost saving on Energy consumption and Water consumption during the operation stage. Further study is required to address the ability of the cost saving in the design and construction for the Green Building in Abu Dhabi through the application of the Value Engineering. This recommended study will encourage the construction firm and owners to implement the Green Building Procedure in their project in a low cost budget.

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