CRITICAL SUCCESS FACTOR IN SOLAR ENERGY PROJECT IMPLEMENTATION IN UAE

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DEDICATION

To my family.

ABSTRACT

Energy holds immense significance for individuals and communities across all societal levels. Its pivotal role in human life and societal functioning is undeniable. However, the primary concern lies in the methods employed for energy generation. Traditionally, fossil fuels and natural gas have been the primary sources, contributing to a substantial emission of carbon dioxide (CO2) into the atmosphere. This has raised apprehensions about pollution and global warming, prompting a critical examination of the sustainability of such energy sources. The United Arab Emirates (UAE) has witnessed a steady rise in energy consumption over time, leading to a noteworthy increase in greenhouse gas emissions. This has heightened concerns regarding the sustainability of conventional energy sources. Consequently, there is a pressing need to explore sustainable approaches to curtail CO2 emissions. In the UAE, various renewable energy projects have been initiated, with some still in progress and others successfully completed. Currently, only solar renewable energy is fully operational in the UAE, owing to its substantial potential compared to other renewable sources. Nevertheless, there has been a lack of comprehensive evaluations to assess the efficiency and success of the implemented solar energy initiatives in the UAE. Additionally, the impact of innovation in enhancing the effectiveness and success of solar energy remains unexplored. Thus, this research is aimed to assessing the impact of innovation initiative on effectiveness of sustainable solar energy implementation with a view of proposing a framework for successful renewable solar energy implementation in UAE. Data were collected using survey questionnaire instruments from the sample of 285 stakeholders in the sustainable energy. The collected data was analysed quantitatively using structural equation modelling (SEM). The result shows that the path with the highest positive relationship is between communication factors and sustainable solar energy success (β = .893, t = 50.162, p = .000). The next highest positive relationship is between sustainable solar energy effectiveness and sustainable solar energy success (β = .136, t = 6.668, p = .000). Similarly, the paths Critical success factors for solar energy implementation -> solar energy effectiveness and implementation success; Communication factors -> solar energy effectiveness and implementation success; Communication factors -> solar energy effectiveness and implementation success; Innovation -> solar energy effectiveness and implementation success; and Innovation -> solar energy effectiveness and implementation success all reported positive but weak relationships. On the other hand, the path Organisational factors -> solar energy effectiveness and implementation success reported a weak negative relationship (β = -.023, t = -.876, p = .381). The result implies that only two paths are statistically significant at 5% level of significance. In conclusion, this research underscores the critical role of innovation and effective communication in the successful implementation of sustainable solar energy initiatives in the UAE. The findings highlight the paramount importance of integrating innovative approaches and fostering robust communication strategies to enhance the effectiveness and success of renewable energy projects, thus paving the way for a more sustainable energy future in the region.

FAKTOR KEJAYAAN KRITIKAL DALAM PELAKSANAAN PROJEK TENAGA SOLAR DI UAE

ABSTRAK

Tenaga sangat penting kepada kehidupan dan penghidupan rakyat di semua peringkat. Kepentingan tenaga kepada manusia dan masyarakat tidak boleh dipertikaikan. Walau bagaimanapun, isu utama yang menjadi kebimbangan ialah bagaimana sesebuah tenaga itu dijana. Secara konvensional, tenaga dijana menggunakan bahan api fosil dan gas asli. Sumber tenaga ini mengeluarkan gas karbon dioksida (CO_2) yang ketara ke dalam atmosfera seterusnya menimbulkan kebimbangan terhadap pencemaran dan pemanasan global sekali gus mempersoalkan kemampanan sumber tenaga tersebut. UAE telah meningkatkan penggunaan tenaga selama bertahun-tahun. Perkara ini dengan ketara meningkatkan pelepasan gas rumah hijau. Aktiviti ini membawa kepada kebimbangan kemampanan yang berkaitan dengan sumber tenaga konvensional. Oleh itu, terdapat keperluan untuk meneroka cara yang mampan untuk mengurangkan pelepasan karbon dioksida (CO2). Di UAE, beberapa projek tenaga yang boleh diperbaharui telah dilancarkan. Walaupun ada yang masih dalam pembinaan, sebahagian lagi sudah siap. Hanya tenaga yang boleh diperbaharui dari sumber matahari yang telah dilaksanakan sepenuhnya di UAE. Ini disebabkan potensi tenaga matahari yang tinggi berbanding tenaga lain yang boleh diperbaharui di UAE. Walau bagaimanapun, tiada penilaian yang sewajarnya untuk menentukan keberkesanan dan kejayaan tenaga matahari telah dilaksanakan. Begitu juga, peranan inovasi dalam memacu keberkesanan dan kejayaan tenaga matahari belum dinilai. Oleh itu, penyelidikan ini bertujuan untuk mengukur impak inovasi ke arah pelaksanaan tenaga matahari mampan yang berkesan dengan tujuan mencadangkan rangka kerja bagi kejayaan pelaksanaan tenaga matahari yang boleh diperbaharui di UAE. Data telah dikumpul menggunakan instrumen soal selidik tinjauan daripada pihak berkepentingan dalam tenaga lestari. Hasil kutipan dianalisis secara kuantitatif menggunakan permodelan persamaan struktur (SEM). Keputusan menunjukkan bahawa laluan yang mempunyai hubungan positif tertinggi adalah antara faktor komunikasi dan kejayaan tenaga matahari yang lestari (β = .893, t = 50.162, p = .000). Hubungan positif tertinggi seterusnya ialah antara keberkesanan tenaga matahari yang lestari dan kejayaan tenaga matahari yang lestari (β = .136, t = 6.668, p = .000). Begitu juga, laluan TF -> SSES; OF -> SCES; OF -> SCES; Innovation -> SSEE; dan Innovation -> SSES semuanya melaporkan hubungan positif tetapi lemah. Sebaliknya, laluan EF -> SSES melaporkan hubungan negatif yang lemah (β = -.023, t = -.876, p = .381). Hasilnya menunjukkan bahawa hanya dua laluan adalah signifikan secara statistik pada tahap keertian 5%.

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LIST OF ABBREVIATIONS

AGFI	-	Adjusted Goodness-of-Fit Index
AMOS	-	Analysis of Moment Structure
AVE	-	Average Variance Explained
BEER	-	Building Energy Efficiency Retrofit
CCTV	-	Closed-Circuit Television
CFA	-	Confirmatory Factor Analysis
CFI	-	Comparative Fit Index
CO_2	-	Carbon Dioxide
CR	-	Critical Ratio
EFA	-	Exploratory Factor Analysis
ESD/RERED	-	Energy Services Development/RE for Rural Economic Development
FDI	-	Foreign Direct Investment
GFI	-	Goodness-of-Fit Index
IEA	-	International Energy Agency
MBIPV	-	Malaysia Building Integrated Photovoltaic
ML	-	Maximum Likelihood
NFI	-	Normed Fit Index
NIS	-	National Innovation Strategy
OTEC	-	Other Sustainable Energy Sources
PLS	-	Partial Least Square
REDP	-	Rural Energy Development Programme

RER	-	Renewable Energy Resources
RII	-	Relative Importance Index
RMSEA	-	Root Mean Square Error of Approximation
ROI	-	Return on Investments
SD	-	Sustainable Development
SDG	-	Sustainable Development Goals
SEM	-	Structural Equation Modelling
SHS	-	Solar Home Systems
SPSS	-	Statistical Package for the Social Sciences
SSA	-	Sub-Saharan Africa
UAE	-	United Arab Emirates
UNEPFPI	-	United Nations Environment Program Financing Initiative
WACOSS	-	Western Australia Council of Social Services
WCED	-	World Commission on Environment and Development

LIST OF SYMBOLS

D^2	-	Mahalanobis distance
W	-	weight
A	-	highest weight
N	-	Number of respondents

LIST OF APPENDICES

LIST OF PUBLICATIONS

The followings are the list of publications related to the work on this thesis:

Alahdal, M. A. A., Abd Rahman, M. N., and Mosali, N. A., 2022. Innovative initiatives in influencing the success of solar energy implementation in UAE. *International Journal of Sustainable Construction Engineering and Technology*, 13(4), pp. 205-215.

Alahdal, M. A. A., Abd Rahman, M. N., and Mosali, N. A., 2022. Successful renewable energy implementation model. *International Journal of Sustainable Construction Engineering and Technology*, 13(2), pp. 91-99.

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Project implementation is a pivotal stage in various initiatives, including those in renewable energy, like solar projects. It involves executing plans, managing resources, engaging stakeholders, and adhering to timelines and budgets. Efficient project implementation, emphasized by Meredith et al. (2017), ensures projects are completed on time, within budget, and with high quality. In the context of renewable energy, such as solar projects, effective implementation is essential not only for project success but also for broader environmental sustainability and the transition to clean energy, as highlighted by (Sovacool, 2013). This underscores the global significance of well-executed project implementation in advancing sustainable energy goals.

Globally, energy is inevitably required to power homes, commercial properties, industries, desalination, transportation infrastructures, institutional buildings and day to day running of human lives. The energy comes from the renewable and non-renewable sources. The greatest share of the energy source globally comes for the non-renewable source using fossil fuels such as coals, diesel, natural gas, and others. This energy source emits substantial greenhouse gases that are deleterious to the environment. Several concerns haves been raised on the sustainability of this energy source. There is gradual commitment towards migrating from the non-renewable energy sources to the more sustainable renewable sources. This

concern is also applicable within the context of United Arab Emirate (UAE) energy consideration (Poullikkas et al., 2015).

The UAE is among the top oil and gas producing countries in the world. It has about 98 billion barrels of oil reserve which makes it seventh in the world ranking. It is also ranked seventh in natural gas reserves. The country is among the 10 top oil producing countries in the world. However, despite this oil and natural gas resources of UAE, it is still a net importer natural gas (Poullikkas et al., 2015). This is due to increasing energy demand in the UAE. The UAE has increasing energy consumption over the years. This increasing energy demand has compelled the country to increase the use of the traditional energy generation to non-renewable means. This significantly increased the greenhouse gases emissions (AlFarra and Abu-Hijleh, 2012; Poulikkas et al., 2015). This led to sustainability concern associated with the conventional energy sources. Thus, the need to explore sustainable means to reduce the emission of the Carbon Dioxide (CO_2).

The sustainability concern has made the UAE to consider alternative energy sources to meet the increasing energy demand as well as reduce the emission rates of CO_2. The UAE energy policy considers diversifying the energy source using both the renewable and non-renewable sources. The UAE plan to have up to 44% of the total energy mix from renewable/clean sources by 2050. The energy from non-renewable sources are planned to be reduced to 38 per cent (Alasam Alzaabi and Mezher, 2021). The short-term frame of the policy enacted in 2009 anticipated at least 7 per cent of the energy sources to come from renewable sources (Jamil et al., 2016). The alternative sustainable energy sources include the carbon capture and storage technologies, solar energy, wind energy, wave energy and even nuclear energy (AlFarra and Abu-Hijleh, 2012). These sustainable energy sources

significantly reduce the emission of CO_2 and are renewable thereby not adversely affecting the future generations (Mokri et al., 2013). Of the renewable energy sources, the solar energy has the highest potential (Poullikkas et al., 2015; Salim and Alsyouf, 2020). For instance, the average wind speed in UAE was found to be 5.1 m/s which is not optimally viable due to moderate speed. There are also security concerns and the disposal of the wastewater associated in nuclear energy. The wave energy also has associated concerns of disruption the ecological balances in the oceans (Mokri et al., 2013). Thus, the solar energy overcomes such concerns. With the abundance of solar radiations in UAE the potential of the solar energy in UAE is considered by the UAE government (Jamil et al., 2016). Various solar energy parks have been installed in the UAE and connected to the grid. However, there are limited studies on the effectiveness and success of the solar energy relative to the conventional sources. The role of innovation in enhancing such effectiveness needs to be ascertained.

Every nation in the world agrees that innovation is essential to both social and economic progress. As a result, they are constantly creating national innovation frameworks and initiatives. It is described as the goals that people, corporations, and governments share with regard to advancing quality through the introduction of new goods and services. It is essential for creating job chances. Innovations, including but not limited to technology innovation, are increasingly what power economies. They follow a bottom-up evolution at an accelerating rate, emerging more and more as answers to issues on the ground. In this tendency, Asia is not falling behind. This means that in order to promote innovation, notably in the energy sector, governments and the international community must establish and

strengthen favourable conditions. UAE embraced this invitation and is leading the globe in innovation.

The United Arab Emirates has always been associated with innovation and creativity since 1971, which has improved its social and economic standing and, at an unprecedented rate, transformed it into the world's leading hub for business and talent. Through the UAE Vision 2021, the leadership of the UAE highlights the importance of innovation in all disciplines and believes that it is the future of human investment (Almuraqab, 2016; Ahmad et al., 2019; Amin et al., 2019). Innovation, research, science, and technology are the cornerstones of a knowledge-based, productive, and competitive economy built by entrepreneurs, as well as a business-friendly climate where the public and private sectors may effectively interact.

The UAE is keen to create rich human resources that can meet the country's development aspirations across fields, with strong conviction that human capital construction is far more important than urban development. The UAE has become the number one destination by being ranked the world's No. 1 by attracting Arab talented young people for a better professional and personal life. The UAE's performance over the past few decades has clearly demonstrated its capacity to draw in and keep talent, as evidenced by their ranking of No. 1 in the Middle East and North Asia and No. 36 overall among 143 countries in the 2014 international Innovation Index. A total of 14 billion AED is annually invested in innovation in the UAE, 7 billion of which go toward RandD. UAH Deputy Governor and HH Sheikh Mohammed bin Rashid al Maktoum, ruler of Dubai, uphold the UAE's dominance in the area and are among the most creative leaders in the world. developed a national innovation plan to carry out the goal.

To advance innovation in the UAE, there is a National Innovation Strategy (NIS). There, people, businesses, and governments all share a culture of innovation. It primarily focuses on the priority areas that have been identified as spurring future innovation. The fundamental pillars that make up the NIS framework are as follows:

Figure 1.1 Innovation strategy sector (Ahmad et al., 2019)

Figure 1.1 shows the priority areas for innovation in UAE which renewable and clean energy is part of. Given the rising demand for energy, many countries around the world need to innovate renewable and clean energy. Thus, the global tendency to diversify energy sources and provide access to sustainable energy to future generations ensures that they have a better lifestyle. The UAE has many existing projects related to renewable energy and clean energy, such as Masdar, Mohammed Bin Rashid Al Maktoum Solar Park and Emirates Nuclear Energy Corporation. NIS develop related energy industries within the UAE, promote useful investigation on renewable energy and fresh energy technologies, increase the competence of energy networks and storage, and further shift to distributed energy generation through supply, promote the cleaning of renewable energy, with a tariff program.

Thus, this research will evaluate the effectiveness and success of the sustainable renewable solar energy and determine the impact of innovation to the effectiveness and success or otherwise in UAE.

1.2 Problem Statement

Without energy, the world as we know it today could not have been feasible. Every nation's prosperity and development are greatly influenced by energy. It gave people the essentials they needed to power their homes, vehicles, workplaces, institutions, healthcare facilities, economies, and daily activities. Therefore, energy has an impact on people's lives and way of life at all levels (Jamil et al., 2016). It is undeniable that energy is important to people and society. However, how the energy is produced is the main problem. Traditionally, natural gas and fossil fuels are used to generate the energy. This energy source produces a lot of CO2, which raises concerns about pollution and global warming and calls into question the viability of such energy sources (AlFarra and Abu-Hijleh, 2012; Poullikkas et al., 2015; Alzaabi and Mezher, 2021). Therefore, driving renewable energy as an alternative to non-sustainable energy sources requires innovation.

Innovation has greatly accelerated these alternative renewable energy sources' rapid development in recent years. One of the most important industries is the energy sector, particularly in the UAE. Due to the importance, it has for both each nation's economic development and competitiveness on the global stage, it is given increased prominence.

The UAE is a global leader in the development of renewable energy. The nation's early endorsement of the Sustainable Development Goals (SDG), the United Nations

Environment Program Financing Initiative (UNEPFI), and the Paris Climate Change Agreement 2016 are proof of this. As the agreement serves as a vital international normative cornerstone of its green energy policy, the UAE continues to be committed to maintaining strong institutional capacity in renewable energy. The record-low cost of utility-scale solar energy (less than $ 0.03 per kilowatt hour) has made the UAE evangelists for renewable energy initiatives all over the world.

The development of several techniques and procedures to increase the efficacy of energy is made possible by innovation, which is the secret to this industry's success. Considering how much innovation is used in the UAE, it is clear that this country places a high value on it (Bason, 2010). According to newly released papers, research by Trends Research and Advisory and The Stimson Centre (Washington, DC), UAE energy diplomacy is crucial to strengthening the UAE's position as a leader in this field and the global approach to sustainable development (Dargin, 2015).

Numerous renewable energy projects have been launched in the UAE. Some are finished, while others are still being built. These initiatives include waste to energy renewable energy (WtE, Bee'ah, Al Warsan 2 WtE Plant, Abu Dhabi WtE Plant, and Al Ain WtE Plant), as well as solar renewable energy (Shams 1, Masdar City PV Project, Mohammed bin Rashid Al Maktoum Solar Park [MBR Solar Park], Noor Abu Dhabi, Dubai Rooftop Solar Program, and Abu Dhabi Rooftop Solar Program). Only Sham 1, Masdar City PV Project, Mohammed Bin Rashid Al Maktoum Solar Park Phases 1 and 2, and the Dubai Rooftop Solar Program are all finished of these projects (Salim and Alsyouf, 2020). As a result, only solar renewable energy is entirely utilised in the UAE. Due to its slow speed, wind energy, a different renewable energy source, has a significantly lower potential, making