



**Title**

**Strategic Pathways in Nuclear Energy: Developing a Universal Framework from UAE Insights**

**By**

**Mohamed Obaid Al-Amimi**

A thesis submitted in partial fulfilment of the requirements for the degree of  
Doctor of Philosophy at the University of Central Lancashire

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## Declaration

### STUDENT DECLARATION FORM

I declare that while registered as a candidate for the research degree, I have not been a registered candidate or enrolled student for another award of the University or other academic or professional institution

**Type of Award**          **Doctor of Philosophy**    

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I declare that no material contained in the thesis has been used in any other submission for an academic award and is solely my own work

## **Abstract**

This thesis, " Strategic Pathways in Nuclear Energy: Developing a Universal Framework from UAE Insights," represents a noble and pioneering effort in addressing the multifaceted dimensions required for the successful implementation of a nuclear energy programme in the UAE. In an era where sustainable and reliable energy sources are paramount, this research stands as a testament to the forward-thinking and innovative approaches needed to navigate the complexities of modern energy challenges.

At its core, the study rigorously examines the critical social, political, and economic factors that are integral to realizing the UAE's ambition to diversify its energy portfolio and ensure a stable energy supply amidst rapid economic growth. The research introduces a ground-breaking conceptual framework, meticulously crafted to cater to the unique regional context of the UAE. This framework synthesizes learnings from previous nuclear programmes globally, while ingeniously integrating factors specific to the UAE's socio-political and economic landscape.

The methodology employed in this study is both comprehensive and robust, utilizing a mixed-methods approach that includes extensive literature review, empirical data collection from key stakeholders, and a pioneering use of modern communication technologies to gauge public acceptance. The research not only confirms critical success factors identified in earlier studies but also innovatively adapts and extends these factors to fit the UAE's distinct context.

The findings of this research are profound. They not only offer a strategic pathway for the UAE to achieve a sustainable and diversified energy future but also address larger global concerns such as environmental sustainability and public acceptance of nuclear energy. This thesis is a significant contribution to the field, providing a strategic framework that can guide not only the UAE but also other nations seeking to embark on a similar journey towards a sustainable nuclear energy future. In its essence, this study is a beacon of innovation and a testament to the power of dedicated research in solving complex, real-world problems.

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## **Dedication**

To the glory of God almighty, who is the maker of heaven and the earth, the Alpha and Omega, the King of all kings, to him, all things are made beautiful in his own time.



## List of Abbreviations

Emirates	United Arab Emirates
CF	Conceptual Framework
EAA	Executive Affairs Authority (UAE)
ENEC	Emirates Nuclear Energy Corporation
ESARDA	European Safeguards Research Association
FANR	Federal Authority for Nuclear Regulation (UAE)
FNC	Federal National Council (UAE)
FSC	Federal Supreme Council
GCC	Gulf Cooperation Council
GNEII	Gulf Nuclear Energy Infrastructure Institute
GSEC	Government Secretariat Executive Council
IAEA	International Atomic Energy Agency
INSEP	International Nuclear Safeguards and Engagement Programmeme
IRSN	Institute of Radiation Protection and Nuclear Safety (France)
KEPCO	Korea Electric Power Corporation
KINS	Korean Institute for Nuclear Safety
MEI	Ministry of Energy and Industry
MOFA	Ministry of Foreign Affairs and International Cooperation (UAE)
MPhil	Master of Philosophy
NEP	Nuclear Energy Policy
NPP	Nuclear Power Plant
NPT	Non-Proliferation Treaty
Ph.D.	Doctor of Philosophy
RPA	Research Programmeme Approval
SPE	Socio-Political Economy
SSS	Safety, Security, and Safeguards
WANO	World Association of Nuclear Operators

## Definitions of terms

The United Arab Emirates, sometimes called the Emirates, is a small country in Western Asia at the southeast end of the Arabian Peninsula on the Persian Gulf, bordering Oman to the east and Saudi Arabia to the south and west, as well as sharing maritime borders with Qatar to the west and Iran to the north.

The Gulf Cooperation Council (GCC) comprises Kuwait, Saudi Arabia, Bahrain, Qatar, Oman, and the Emirates. As a regional organisation, it created multilevel cooperation, which helped its members develop deeper ties, formally and informally—this improved trade, which led to the building of business trust at an international level. The GCC helped to improve overall communication channels via multiple non-governmental bonds, the interdependence of members' relationships based on overall universal benefits, and the reduction of the local military role from significant to minor based on growing trust between members. These interdependent relationships made the policymakers concerned about their joint resources and considered the degree of vulnerability in foreign economic relations. <https://g.co/kgs/4YsPPr>

**Definition of Nuclear Energy:** Different scholars and organisations have advanced many definitions of nuclear energy. The International Atomic Energy Agency (IAEA) described Nuclear Energy as a nuclear power reactor to produce energy by initiating and controlling a sustained nuclear chain reaction [1]. The standard definition for nuclear energy is the energy released by a chain reaction, especially by fission. Nuclear energy uses mined and processed uranium fuel to generate heat, produce steam and generate electricity using steam-driven turbines, as shown in *Figure 2*.



## **Chapter One: Introduction**

### **1.1 Background**

#### 1.1.1 United Arab Emirates (UAE)

Established in 1971, the United Arab Emirates (UAE), a federation of seven emirates with Abu Dhabi as its capital and Dubai as the commercial centre, plays a pivotal role in the Gulf Cooperation Council (GCC). In recent years, the UAE has faced significant challenges in energy generation and consumption, exacerbated by a population surge from 4.11 million in 2005 to 8.28 million in 2010, largely driven by an influx of non-Emirati nationals [2]. This demographic shift has precipitated a doubling in energy demand, presenting critical challenges to the nation's energy infrastructure and policy [3].

#### 1.1.2 Diversification of Energy Sources and Investments

Consequently, the UAE government strategically decided to diversify its energy sources and investments in electricity generation, even though the country possesses abundant oil and gas resources [4]. Nuclear energy is one of those resources the government had planned to give considerable investment [2]. Construction of four civilian nuclear power plants in Barakah in the Emirates started in 2010. The UAE now has three operational units, and unit four is under commissioning [3, 5].

### **1.2 Importance of Nuclear Energy**

#### 1.2.1 Reliable and Low-Impact Source of Electricity

Nuclear generation is widely recognised as one of the most reliable sources of electricity, capable of providing a constant supply of power, known as baseload power while producing minimal greenhouse gas emissions [6, 7]. Compared to other electricity sources, nuclear energy is known to have relatively low environmental impacts on land and natural resources [8]. However, it is essential to acknowledge significant challenges associated with nuclear materials mining and waste management, despite the containment measures in place [9].

#### 1.2.2 Addressing Energy Demand and Economic Growth

Nuclear energy has the potential to address the challenges posed by increased energy demand, reduce strategic vulnerability regarding gas reserves for future generations, decrease dependency on external sources like imported gas, and sustain the current

and future economic growth of the UAE [10]. By providing a reliable baseload power source, nuclear energy enables the government to reduce reliance on combustion and optimise the energy mix [2, 3]. Despite these benefits, the successful implementation of a national nuclear programme comes with various challenges, including establishing regulations, operational readiness, human resource development, and adherence to international obligations related to the safety, security, and non-proliferation of nuclear weapons. Safety, security, nuclear safeguards (SSS), and international laws form the foundation for establishing and succeeding nuclear programmes [11]. These challenges are thoroughly discussed in this research. Without SSS, the social and political landscape would be significantly different. [12]

The context of this research details how a country develops a nuclear energy policy and executes its implementation. Additionally, from a social perspective, the study explores the decision-making processes within nuclear organisations, considering societal views and opinions [13]. It also examines how social acceptance and government commitment to nuclear energy influence these processes. [14]

### **1.3 Research Problem**

The UAE's civil nuclear power programme receives support socially, politically, and economically[15]. However, it initially lacked a robust operational nuclear framework that could establish a clear link between the success factors identified by Sovacool and Valentine[16] and additional factors relevant to the region and industry[17]. Consequently, this research study aims to validate existing success factors and define new elements to draft an operational conceptual framework for the Emirati civil nuclear power programme.

The literature underscores the importance of social, political, and economic factors in successfully implementing a national nuclear energy programme. This is particularly relevant to the UAE as it seeks to diversify its energy sources and ensure a continuous, reliable energy supply for its growing economy [4]. To effectively leverage these factors, this research proposes a tailored conceptual framework considering the UAE's context, including existing regional activities, policies, and priorities. The framework also draws upon the success factors identified by Sovacool and Valentine in national nuclear energy programmes. [18]

By adopting this proposed conceptual framework, the UAE can enhance its approach to implementing the national nuclear energy programme. The framework considers the unique circumstances of the UAE and incorporates lessons learned from successful experiences in the field [19]. It provides a strategic roadmap for addressing social, political, and economic considerations, promoting a seamless and effective implementation of the nuclear energy programme. [16, 20, 21]

Environmental protection and power security are global concerns, including for the UAE government. The UAE aims to achieve significant business developments across various sectors by introducing a commercial nuclear power programme as a new field in power generation within the region [22]. To establish a sustainable and successful nuclear programme, it is crucial to have a conceptual framework that leverages international best practices and addresses local challenges. Literature in Chapter 2 highlights the projected increase in electrical power demand to critical levels, which will impact economic development and growth in the country. Therefore, investing in alternative energy resources such as nuclear power presents a viable solution.

According to the World Nuclear Association's 2022 report [23], the world will require a significantly increased energy supply, remarkably exceptionally clean electricity, in the next two decades[24]. Between 1990 and 2019, electricity demand doubled and is expected to double again by 2050. The total capacity of electricity-producing reactors reached an all-time high of 370 GWe in 2021[23]. The Intergovernmental Panel on Climate Change has emphasised the need for at least 80% of the world's electricity to be low carbon by 2050 to limit global warming to within 2°C of pre-industrial levels. Currently, approximately two-thirds of electricity is generated from fossil fuels. Nuclear power has proven scalable, reliable, and essential for countries aiming to achieve their decarbonisation goals. It is the most environmentally benign method of large-scale electricity production. While renewable energy sources like solar and wind have their advantages, they are costlier per unit of output and intermittent. However, they can complement nuclear power by providing clean power in specific contexts. [24] [23]

The decision to incorporate nuclear energy into a country's energy mix presents numerous social, political, and economic challenges, as discussed earlier [25, 26]. Valentine and Sovacool said, "the interaction between social, economic and political

factors is the major challenge facing the well-experienced and new incomer states to the nuclear industry” [20]. They emphasise the dynamic interplay between the state and society, which shapes the formulation and implementation of a National Energy Programme (NEP). This research aims to bridge the knowledge gap by developing a framework that addresses these challenges and provides guidance for successfully implementing a national nuclear energy programme. By considering the intricate relationship between social, economic, and political factors, the framework can effectively navigate the complexities of incorporating nuclear energy into the energy mix while addressing the specific needs and context of the UAE [22].

#### **1.4 Motivation for the Study**

The UAE wants to establish a sustainable and successful nuclear programme [22]. Sovacool and Valentine have identified social, political, and economic factors as crucial for implementing a nuclear energy programme (examples on [16, 20, 21]). They have developed a conceptual framework that outlines these factors[20]. However, the UAE and the region have unique factors that must be considered for the successful implementation of the nuclear programme by the Emirates government. Therefore, it is necessary to consider both the general success factors proposed by Sovacool and Valentine and the specific factors relevant to Emirates to ensure the programme's success. [22, 27]

According to Sovacool and Valentine, ”the interaction between social, economic and political factors is the major challenge facing the well-experienced and new incomer states to the nuclear industry” [20]. They argue that these factors shape the development and implementation of Nuclear Energy Policy (NEP) through a socio-political economy conceptual framework. Within this framework, they identify six factors present in countries that have successfully developed a nuclear energy programme [16, 20, 21]:

1. Strong state involvement in guiding economic development.
2. Centralisation of national energy planning.
3. Campaigns to link technological progress to national revitalisation.
4. Influence of technocratic ideology on policy decisions.
5. Subordination of challenges to political authority.
6. Low levels of civic activism against nuclear energy.

These factors are considered essential elements in the successful development and implementation of a nuclear energy programme, as outlined by Sovacool and Valentine.

In the current research, the factors identified by Sovacool and Valentine are adopted and extended to understand the implementation of the Nuclear Energy Policy (NEP) in the UAE. These factors are applied while considering other unique aspects specific to the Emirates and the local region [22]. It is essential to recognise that different concepts and circumstances exist among states that wish to establish a nuclear power programme [28]. Therefore, the adopted conceptual framework can be compared to other concepts and tailored to fit the specific circumstances of each state seeking to embark on a nuclear energy programme.

The successful development of a nuclear energy programme can be influenced by various socio-political and economic factors, as identified by Sovacool and Valentine [16, 20, 21]. The following is a conceptual framework that outlines key elements for such success based on the works of Sovacool and Valentine from their research on 50's-70's nuclear programmes. The framework encompasses the following factors [16, 20, 21]:

1. Strong State Involvement in Guiding Economic Development:

The state's strong and active role in guiding economic development is crucial for successfully implementing a nuclear energy programme. This includes providing strategic direction, setting goals, and coordinating various stakeholders. The state's involvement ensures long-term planning, allocation of resources, and regulatory oversight to foster a conducive environment for nuclear energy development. State support can manifest through financial investment, infrastructure development, policy incentives, and partnerships with domestic and international entities.

2. Centralisation of National Energy Planning:

A centralised approach to national energy planning allows for cohesive decision-making and efficient coordination of efforts in the nuclear energy sector. Centralised planning enables the alignment of energy goals with broader national objectives, including economic growth, energy security, and environmental sustainability. It facilitates the integration of nuclear energy into the overall energy mix and ensures a balanced and diversified energy portfolio.

3. Campaigns to Link Technological Progress to National Revitalization:

Promoting nuclear energy as a symbol of technological progress and national revitalisation can help generate public support and garner political will for its development. Government-led campaigns can emphasise the potential benefits of nuclear energy in advancing scientific research, enhancing industrial capabilities, and strengthening national security. Highlighting the contribution of nuclear power to energy independence, job creation, and sustainable development can help shape a positive perception and gain public trust.

4. Influence of Technocratic Ideology on Policy Decisions:

Technocratic ideology emphasises the role of experts and scientific knowledge in policymaking and can significantly shape nuclear energy policy decisions. Expert opinions and scientific evidence should inform the development of regulatory frameworks, safety standards, and risk assessment methodologies. The integration of technocratic principles ensures evidence-based decision-making and fosters public confidence in the safety and reliability of nuclear energy.

5. Subordination of Challenges to Political Authority:

Overcoming challenges associated with nuclear energy development requires the subordination of these challenges to political authority. Political leadership should address potential concerns related to safety, waste management, and proliferation risks by establishing robust regulatory frameworks and implementing stringent safeguards. Political commitment and effective communication are essential to address public apprehensions, dispel misconceptions, and build trust in the nuclear energy programme.

6. Low Levels of Civic Activism against Nuclear Energy:

Low civic activism against nuclear energy provides a conducive environment for its successful development. Limited opposition allows for streamlined decision-making processes and reduces resistance to constructing nuclear power plants. However, it is essential to ensure public engagement, transparency, and public participation in decision-making to address any concerns or doubts that may arise.

Considering these factors within a socio-political economy conceptual framework, a country can successfully create an environment conducive to developing a nuclear

energy programme. This framework emphasises strong state involvement, centralised planning, public campaigns, technocratic influence, political authority, and low civic activism as critical elements for achieving successful outcomes in nuclear energy development. [16, 20, 21]

## **1.5 Significance of Study**

The researcher's motivation for this study stems from the importance of organisational and public support in successfully implementing the nuclear programme. The social aspect of the research delves into the decision-making processes within nuclear organisations and their consideration of stakeholder views [29]. Additionally, the study proposes indicators to measure public acceptance within these organisations and examines how this acceptance influences the decision-making processes [30]. By exploring these dynamics, the research sheds light on the crucial role of stakeholder engagement and public acceptance in shaping the implementation of the nuclear programme [31]. It provides insights into the factors that influence decision-making and highlights the significance of fostering a supportive environment and considering the perspectives of the general public to ensure a successful and sustainable programme implementation. [31]

The civil nuclear programme in the UAE is a recent development. It represents the first implementation of its kind in the Middle East region with recognition and support from the International Atomic Energy Agency (IAEA) [32]. The UAE has been actively developing its nuclear power programme since issuing its first nuclear law, Law Number 6 of 2009 [33]. As part of this effort, the UAE has successfully commissioned three out of four nuclear plants [34]. The government of the UAE has set its sights on developing a civil nuclear programme that adheres to international best practices and aims to achieve a nuclear renaissance (revitalisation) in the country. [22]

This research explores the pillars of successful development in civil nuclear energy programmes. It presents them as a guide for other countries aiming to develop their civil nuclear power programmes. The findings of this research can provide valuable insights and recommendations for implementing protocols within legislative frameworks, particularly those related to non-proliferation initiatives. The study focuses on the UAE's nuclear roadmap and activities, covering various aspects from

policy drafting to achieving successful operation [33]. The research findings and practices outlined align with the success factors identified by Sovacool and Valentine, making them applicable to countries with similar geopolitical structures. [20]

As announced by the UAE's nuclear policy and related verses in the international conference 37, the UAE aims to generate electricity from its planned civil nuclear power programme to meet the national demand and develop its technological capabilities [18, 35, 36]. The UAE's nuclear development relies on the current best practices and procedures. This work discusses those practices, procedures, and regulatory feedback. It adapts them to meet the needs of the UAE's peaceful nuclear power programme, coherent with the success factors that the UAE government already utilises to achieve a successful programme. [18, 35, 36]

This work introduces methods for developing a successful nuclear programme for the UAE, from infrastructure development to operation perspectives. In general, there needed to be more experience in utilising the common success factors of the modern conceptual framework for the nuclear programme in the UAE[37]. This research will therefore assist future nuclear results locally, from expanding existing sites to sustaining the right development path for the UAE and the region [38].

This thesis presents a systematic study to develop a new conceptual framework (CF) [39] to consider known critical success factors and identify and test other factors within the UAE's social, political, economic, and environmental perspectives. The research has developed a conceptual framework based on known and new factors. The pioneering work of Sovacool and Valentine ( i.e. their success factors) was essential to starting and operating a thriving nuclear programme for Emirates [20]. This research verified that these factors and additional aspects of the current national and regional situation led to a new modern operational CF.

This research also discusses the national duties and obligations in generating electricity from advanced nuclear technology in front of the international community. International treaties and international conventions have been reviewed. The ability of a country to comply with the requirements of the international community and maintain international agreements is essential to the success of a new nuclear programme [40]. In this research, those current international requirements are addressed.



The UAE is actively developing and enhancing its institutional and organisational capabilities necessary for the operational phase of nuclear development [41]. This research aims to contribute to understanding sustainable and efficient nuclear energy utilisation by presenting a conceptual framework based on solid and success factors.

Although the UAE is a significant global producer of fossil fuels with abundant oil and gas resources, the country recognises the need to meet the growing energy demand from economic and population growth [42]. In 2008, the UAE issued a Nuclear Energy Policy (NEP). It swiftly established a regulatory infrastructure, forging bilateral agreements with nuclear suppliers, strengthening cooperation with the International Atomic Energy Agency (IAEA), and signing contracts with the Korean contractor KEPCO to construct four nuclear power plants. [2, 43, 44]

As Findlayis has pointed out, “the challenges facing the global energy governance regime can be seen in the case of a promising candidate for nuclear energy, the United Arab Emirates” [44]. The country has received substantial support from the IAEA and other nuclear agencies. The UAE has demonstrated its commitment to nuclear non-proliferation by signing an Additional Protocol to its IAEA safeguards agreement [45] and renouncing any intention to enrich uranium or reprocess plutonium [2]. The UAE has also entered into a 123 Agreement with the United States, providing additional legal assurances, and enabling access to US-origin technologies and expertise [44, 46]. This has facilitated the utilisation of best operational practices and access to classified technologies, benefiting the development of the UAE's civilian nuclear power programme [47].

The concept of "nuclear energy governance" refers to the framework of rules, norms, and actions established to implement a successful nuclear programme, considering the social, political, and economic factors involved. It encompasses the structure of decision-making processes, the accountability mechanisms in place, and the overall management of the nuclear programme. By considering these factors, countries can develop governance frameworks that ensure the safe, secure, and sustainable use of nuclear power while addressing the specific challenges and opportunities associated with its implementation [11, 16, 20, 48].

This research contributes to the UAE's efforts to develop a sustainable and successful nuclear energy programme while adhering to international non-proliferation initiatives and benefiting from global cooperation and expertise.

## **1.6 Research Aim and Objectives**

The research aims to develop, test, and utilise an operational framework to guide the implementation of the Emirates nuclear energy programme. It did so by examining and reflecting on regional activities, policies, and priorities while building upon the success factors identified by Sovacool and Valentine. Other factors relevant to the current national and regional situation were also considered. The modern version of the operational framework served as an extension of the Sovacool and Valentine CF, explicitly tailored for application in the Emirates and the surrounding region.

To achieve this goal, a set of objectives was defined and pursued, including:

1. Defining the factors necessary for developing a new conceptual framework for the UAE in the context of national activities, policies, and priorities.
2. Exploring the evolving socio-political-economic circumstances in the Emirates and applying the new conceptual framework to predict the potential success of commissioning and operating a nuclear power plant within the next ten years.
3. Developing an operational framework for the nuclear programme based on the expanded success factors and considering the socio-political-economic circumstances.
4. Predicting the likely shifts in public perception of nuclear energy in the Emirates as the nuclear plant was commissioned for energy generation through planned fieldwork.
5. To compare the expanded conceptual framework with the actual implementation of plans and operational activities and refine the operational framework based on the findings.

To achieve the first objective, an investigation was conducted into the additional and developing factors influencing the status and situation surrounding nuclear energy in the Emirates.

The second objective was accomplished by examining how the nuclear plan impacted the development of the Emirates Energy Strategy 2050 and how it pertained to the implementation format. This involved understanding:

- a. The method of implementing international agreements and obligations related to nuclear safeguards and export control in the Emirates.
- b. The necessary changes in governance.
- c. How the Emirates overcame barriers, including:
  - I. Ensuring the sustainability and security of diverse energy sources, including business development.
  - II. Considering climate change obligations and their effects on energy planning.
  - III. Providing skilled national staff for the safe operation of a nuclear power plant.

The third objective entailed:

- a. Evaluating the existing operational frameworks utilised for nuclear developments.
- b. Updating the existing operational framework with the new success factors and considering the socio-political-economic circumstances.
- c. Developing a new national nuclear conceptual framework.

To accomplish the fourth objective, the following steps were taken:

- a. Determining how and to what extent the Emirates utilised Sovacool and Valentine's success factors to plan and implement programmes for the post-oil and gas era.
- b. Conducting a critical evaluation of the benefits of establishing a nuclear plant for the Emirates' public.
- c. Identifying the perceived challenges of nuclear energy development in the Emirates and critically exploring the degree of access.

To achieve Objective five, the following steps were taken:

- a. Conduct a thorough analysis of the implementation of plans and operational activities in the Emirates' nuclear energy programme.

- b. Identify any discrepancies between the expanded conceptual framework and the actual implementation.
- c. Assess the framework's effectiveness in guiding the programme's practical implementation.
- d. Evaluate the alignment of operational activities with the principles outlined in the framework.
- e. Identify challenges faced during implementation and their impact on programme success.
- f. Gather feedback from stakeholders involved in implementation and operation.
- g. Compare expected outcomes with achieved progress.
- h. Identify areas for improvement and refine the operational conceptual framework.
- i. Develop recommendations to enhance alignment and support successful implementation.
- j. Ensure the operational framework provides practical guidance tailored to the Emirates' context.

To achieve the fifth objective, implementing plans and operational activities in the nuclear energy programme is thoroughly analysed, identifying discrepancies with the expanded conceptual framework. The framework's effectiveness is assessed, challenges are identified, and stakeholder feedback is gathered to refine and improve the operational framework.

By accomplishing these objectives, the research aims to provide a comprehensive operational framework that effectively guides the UAE's successful nuclear energy programme implementation. This framework considers the unique socio-political-economic circumstances of the Emirates and supports the programme's long-term sustainability and success.

## **1.7 Research Questions**

The research questions proposed for this study are as follows:

1. What factors are necessary to develop a successful and sustainable national nuclear programme?
2. How can the socio-political-economic circumstances in the Emirates contribute to the development of a successful and sustainable nuclear programme?
3. How can a conceptual framework for a nuclear programme be developed based on the extended success factors and socio-political-economic circumstances?
4. How can the UAE government establish and sustain social acceptance and support for the nuclear programme?
5. What discrepancies, challenges, and areas for improvement exist between the expanded conceptual framework and the actual implementation of plans and operational activities in the UAE's nuclear energy programme?

These research questions aim to investigate the essential factors required for a national nuclear programme's successful development and sustainability. They also seek to understand the influence of the socio-political-economic circumstances in the Emirates on the programme's development. Additionally, the research questions focus on the effective development of a conceptual framework that incorporates the extended success factors and aligns with the specific context of the Emirates. Furthermore, the research explores strategies the UAE government can implement to establish and maintain social acceptance and support for the nuclear programme. The fifth research question specifically addresses the identification of discrepancies, challenges, and areas for improvement between the expanded conceptual framework and the actual implementation of plans and operational activities, with the goal of refining and enhancing the operational framework.

## **1.8 Contributions to Knowledge**

This research has made significant contributions in the following areas:

The factors required to develop a successful and sustainable national nuclear programme:

The research has developed a civil nuclear programme conceptual framework incorporating current success factors in the UAE. It draws upon the experiences of successful nuclear states such as France, China, India, Korea, and Japan, considering new conditions and requirements for generating electricity from non-carbon-emitting sources[16, 20, 21]. The UAE demonstrates compliance with international

conventions, implementing guidelines and best practices from renowned nuclear organisations like WANO and INPO.[49]

The Emirates' socio-political-economic circumstances help develop a successful and sustainable nuclear programme:

The research identifies additional factors based on the socio-political-economic circumstances in the Emirates. It emphasises how the UAE government, through the development of nuclear power reactors, contributes to electricity production and carbon emissions reduction [22]. The efficient utilisation of nuclear fuel is ensured through safe, secure, and safeguarded usage of nuclear energy. Government oversight and necessary modifications provide opportunities and support to national private sectors and entrepreneurs, resulting in job creation and economic development. This is an exemplary model for other regions and countries to benefit from nuclear power programmes with public support. [36]

The development of a nuclear programme conceptual framework based on extended success factors and socio-political-economic circumstances:

The research contributes by developing a nuclear programme conceptual framework that incorporates extended success factors and evaluates the current operational framework for the UAE's civil nuclear power programme [44]. It examines and reflects on national activities, policies, and priorities, building upon Sovacool and Valentine's success factors derived from studies on successful nuclear states. The framework addresses the specific national and regional situation, extending the existing framework to create a modern version applicable to the Emirates.

Establishing and maintaining social acceptance and support for the nuclear programme:

The research provides insights into establishing and maintaining social acceptance and support for the civil nuclear programme [13]. It benefits the UAE and other developing countries with similar interests by determining the willingness to align with international regimes, implementing best practices in public engagement, and meeting the expectations and requirements of contracting states. The research includes a comprehensive analysis of face-to-face interviews with prominent nuclear experts in the UAE, ensuring that the decisions made on behalf of the public are informed by the

methods employed by Emirate nuclear organisations to maintain public acceptance and support for the nuclear power programme.

Analysis of discrepancies, challenges, and areas for improvement between the expanded conceptual framework and the actual implementation of plans and operational activities:

The research has thoroughly analysed the implementation of plans and operational activities in the UAE's nuclear energy programme [22]. It has identified discrepancies between the expanded conceptual framework and the actual implementation, the challenges faced during implementation and their impact on programme success. Based on these findings, the research has identified areas for improvement and refinement of the operational framework, contributing to continuous enhancement and effectiveness.

These contributions advance knowledge in the nuclear energy programme implementation field and provide valuable insights for policymakers, industry stakeholders, and researchers interested in developing successful and sustainable national nuclear programmes [50]. The research has not only defined the necessary factors and developed a conceptual framework but has also examined the influence of socio-political-economic circumstances, addressed social acceptance and support, and analysed the implementation to refine the operational framework, ensuring the long-term success of the UAE's nuclear energy programme.

## **1.9 Research Method and Approach**

### **1.9.1 Mix Method**

The research adopts a mixed-methods approach to gather information and data. This approach combines qualitative and quantitative methodologies, including literature reviews, case study analysis, a pilot study, and discussions with key stakeholders. The EU has used this method to analyse the potential increase in renewable energy and nuclear power use in Europe[50]. The data collection involves collecting unstructured data through interviews, document reviews, and structured data through questionnaires.

The researcher has extensive experience in various aspects of the field, including infrastructure development, stakeholder coordination, construction management, and Safeguards and Export Control management. They have also worked closely with

international organisations such as the IAEA, the European Safeguards Research and Development Association (ESARDA) and the Nuclear Suppliers Group (NSG), specifically in the regulatory implementation of nuclear programmes. The researcher's involvement in developing an in-house regulatory compliance programme has further enhanced their skills and knowledge in compliance, verification, and interpretation of regulations. This breadth of experience and expertise provides valuable insights into where and how to collect research data effectively. The researcher draws upon their acquired experiences and knowledge to inform and guide the research process.

### 1.9.2 Literature Reviews, Case Studies, and Interviews

The qualitative aspect of the research involves conducting literature reviews and analysing case studies to understand success factors and best practices in national nuclear programmes [51]. These sources provide a theoretical foundation for the research and real-world examples to inform the analysis. In addition, a pilot study is conducted to test the research methods and instruments [52]. Discussions with key players, such as experts and stakeholders in the nuclear industry, are also held to gain valuable insights and perspectives. The data collection includes interviewing relevant individuals and reviewing organisational documentation in implementing nuclear energy regulation and policy. The goal was to investigate the presence of known success factors in the UAE's nuclear programme and explore any new factors. Internal procedural implementation and management actions were examined through documented evidence within their organisations and external variables such as development plans and international reports to verify the interviewees' claims. This approach helped to identify the factors that influence the programme's success. This qualitative data collection method allows for in-depth understanding and captures rich, contextual information. [53]

### 1.9.3 Structured Data Collection through Questionnaires

Furthermore, structured data is collected using questionnaires. These instruments help gather quantitative data from a larger sample size, enabling statistical analysis and providing additional insights[54]. The researcher dedicates approximately a week to conducting interviews and reviewing the methodology of policy implementation at selected organisations in the Emirates. These organisations were identified and recruited during the earlier stage of the project (MPhil stage). [55]



The research methodology adopts a mixed-methods approach, combining qualitative and quantitative data collection methods. This approach ensures a comprehensive and well-rounded analysis of the subject matter, capturing both in-depth contextual information and statistical insights.[56]

### **1.10 Thesis Outline**

This thesis aims to develop, test, and utilise an operational framework to guide the implementation of the Emirates nuclear energy programme. It builds upon regional activities, policies, and priorities while incorporating additional factors relevant to the national and regional context. The thesis outline, aligned with the research aim and objectives, is as follows:

Chapter One:

- Introduction
  - Scope and Rationale of the Research
  - Research aim, objectives, and the need for a new conceptual framework
  - Research contributions to the body of knowledge
  - Consideration of the UAE's status as a sovereign state and its readiness for nuclear energy

Chapter Two:

- Literature Review
  - Comprehensive analysis of existing literature on the UAE's nuclear programme
  - Assessment of programme feasibility and insights for the research

Chapter Three:

- Research Methodology
  - Explanation of the data gathering, and analysis methods used.
  - Objective to an operational framework aligned with research aims.

Chapters Four and Five:

- Data Gathering and Analysis
  - Summary of the data gathering, and analysis based on the selected methodology.
  - Comparison of the results with the Sovacool and Valentine success factors
  - Comprehensive understanding of the current state of the UAE's nuclear programme

Chapter Six:

- Discussion and Analysis
  - Critical analysis of the findings
  - Development of the refined operational framework based on the findings.
  - Examination of factors influencing social acceptance and support for the nuclear programme

Chapter Seven:

- Conclusion
  - Presentation of recommendations and conclusions based on the study's findings.
  - Consolidation of insights gained throughout the research.
  - Practical guidance for the implementation of a national nuclear energy programme in the UAE

This thesis outline provides a clear structure for the research, guiding the reader through the introduction, literature review, research methodology, data gathering and analysis, discussion and analysis, and conclusion. The chapters work together to develop a comprehensive understanding of the UAE's nuclear programme and to propose a modern conceptual framework for its successful implementation.

## **1.11 Overall**

### **1.11.1 Contributions to Knowledge and Limitations of the Study**

The research explores nuclear energy development in the UAE and makes valuable contributions to knowledge in this field. However, the study has encountered certain limitations. One area for improvement is the need for more research opportunities and studies on developing nuclear programmes in the Middle East and North Africa region, which reduces the availability of prior knowledge and experience. Additionally, the limited availability of research materials focusing on successful nuclear development in the UAE and the MENA region posed challenges to the scope of the investigation. To overcome these limitations, the study relied on structured interviews with selected experts involved in the UAE nuclear development process, emphasising the importance of face-to-face interviews and their analysis as a primary source of information.

### **1.11.2 Need for a New Conceptual Framework for the Nuclear Programme**

The research underscores the need for a new conceptual framework to effectively guide the successful implementation of a national nuclear programme in the UAE. The study highlights the need for an existing unique and practical framework specifically designed for this purpose. It emphasises the importance of developing a framework that integrates success factors from previous nuclear programmes in countries like France, China, India, Korea, and Japan while also considering the unique socio-political-economic circumstances of the UAE and the broader region in the 21st century. This new framework will be a vital tool to support the UAE's nuclear energy programme and contribute to its long-term sustainability and success. [57]

## **Chapter Two: Literature Review**

### **2.1 Introduction**

This chapter offers an in-depth literature review, setting the groundwork for understanding the Emirati nuclear energy programme and the scope of this research. It explores conceptual frameworks, ethical considerations of nuclear resources, and the unique challenges faced by newcomers in establishing nuclear programmes[58]. The evolution of international and domestic nuclear regimes, especially in the civil sector, is examined, alongside a critical analysis of nuclear power generation, touching upon the concept of the nuclear renaissance. The chapter also delves into key management practices and milestones in nuclear power infrastructure development.

The literature review chapter directly contributes to several research objectives. Firstly, it addresses Objective 1 by providing an overview of the factors necessary for developing a conceptual framework for the Emirati nuclear energy programme. It synthesises existing knowledge and identifies the key elements that must be considered in the framework. Objective 1 has been fulfilled in section 2.1.

Secondly, it fulfils Objective 2 by exploring the socio-political-economic circumstances in the Emirates and applying a new conceptual framework to predict the potential success of commissioning and operating a nuclear power plant. This analysis helps to understand the feasibility and viability of the programme within the Emirati context. Objective 2 has been fulfilled in section 2.2. Objective 3 has been addressed in the discussion chapter.

Furthermore, the literature review in section 2.12 partially fulfils Objective 4 by reviewing facts and criticisms related to nuclear power generation and assessing public perception. It provides insights into public opinion and helps anticipate potential shifts in public perception as the nuclear plant is commissioned for energy generation. More information was provided in chapters 4 and 5 to achieve objective 4.

Finally, Objective 5 is addressed by examining relevant literature that compares the expanded conceptual framework with the implementation of plans and operational activities in nuclear energy programmes. This comparative analysis helps identify any discrepancies and challenges during implementation and provides insights for refining the operational framework. This objective has been partially fulfilled in sections 2.3

and 2.5. The discussion chapter provides all the information needed to support Objective 5.

Primary data collection methods, including surveys and interviews, complement the literature review, enhancing the understanding of the Emirati nuclear programme and supporting the research's validity and reliability.

### 2.1.1 The Historical Context of Nuclear Power

The civil nuclear industry has experienced numerous ups and downs throughout its alternating phases of development and decline [59]. With the end of World War II, the nuclear industry grew under the assumption that humanity would benefit from converting a destructive military technology into a peaceful one. By the 1970s, it was widely assumed that nuclear energy was a source of abundant power that could be generated in an environmentally friendly way and at a low-cost [60]. With technology in the hands of a few advanced and wealthy nations, there was little government interference and public scrutiny. These favourable conditions enticed many countries to consider establishing nuclear power plants for the peaceful use of nuclear energy. [20]

However, significant issues arose during the 1970s, including growing public scepticism about the safety of nuclear reactors, a general stagnation in electricity demand, and the Three Mile Island accident (1979) in Pennsylvania [59]. This ended any initial euphoria and brought the dangers of nuclear energy to the forefront. The decline in natural gas prices and the rising technical costs of constructing nuclear power plants further downscaled nuclear programme investments. Public opinion quickly shifted against nuclear power. People began to criticise it for being incompatible with democratic ideology due to nuclear technology's secrecy and centralised nature [61]. Once viewed as world saviours, nuclear institutions were now portrayed as distant and powerful bureaucracies. All of these factors negatively influenced the future of nuclear power facilities across the world [62]. Furthermore, the globe has experienced increased environmental protectionism, which has put nuclear energy production under investigation [63].

In the mid-1980s, the momentum for nuclear programmes had been reawakened. However, the ambitious planning stopped due to the Chernobyl disaster in 1986, which shook public views about nuclear power once more [61]. The tragedy inspired

advancements in reactor technology, safety measures, and increased openness in nuclear plant operations. It was in the current century that interest in nuclear energy investment returned. The Fukushima disaster in Japan, triggered by a major tsunami and earthquake on March 11, 2011, refocused attention on nuclear safety [59]. The incident raised concerns about using nuclear power to preserve the environment and humanity. In the aftermath of these disasters, many countries evaluated the safe, secure, and efficient development and use of nuclear technology to fulfil the demand for power without affecting the environment and maintain public support [64]. However, in recent years the UAE has started to see a return on its nuclear investment [19].

### 2.1.2 The UAE's Governance Structure and Nuclear Programme

The UAE's nuclear programme operates within the framework of its unique governance structure. The UAE comprises seven emirates, each with its internal administration and ruler. However, the Federal Supreme Council, consisting of the seven rulers, governs the federal government [65]. The council is crucial in electing the country's President [57]. Due to their significant economic contributions, Abu Dhabi and Dubai have a greater influence on the administration of the federal lands [66]. The supreme council appoints the prime minister, which holds full authority in managing and selecting ministers for all ministries [67]. To ensure effective decision-making, the Federal Council regularly convenes to draft and agree upon guidelines for national policies [46]. Given the importance of the nuclear programme, the Federal Council needs to be well-informed about its benefits and risks. This knowledge enables them to make informed decisions that shape the UAE's approach to nuclear development [65].

From a researcher's perspective, this governance structure has facilitated support for the nuclear programme and established a robust legal framework to manage and regulate the development and use of nuclear technology for electricity generation.

### 2.1.3 Enhancing Safety Measures in Nuclear Plant Design

During the preparatory phase of the Barakah Nuclear Energy Plant, the Fukushima nuclear incident led to a reassessment of safety measures. As the first unit was constructed, the Barakah plant prioritised safety by conducting a thorough siting process. This process included the IAEA's Siting and External Events Design (SEED)

review, which aimed to identify a suitable location based on favourable geography and seismic history [68]. The goal was to ensure that the chosen site met stringent safety standards to minimise risks associated with external events. This rigorous review process demonstrated the plant's commitment to safety and provided a solid foundation for the subsequent construction and operation stages. [19, 69]

In December 2010, the Emirates Nuclear Energy Corporation (ENEC) submitted the Construction License Application for Units 1&2 of the Barakah Nuclear Energy Plant. The Federal Authority thoroughly reviewed this application for Nuclear Regulation (FANR), the regulatory body responsible for overseeing nuclear activities in the UAE [19]. Recognising the importance of comprehensive safety evaluations, FANR requested ENEC to collaborate with nuclear operators worldwide to conduct extensive reviews of their plant designs. The focus was assessing the designs for severe natural hazards that could exceed the plant's initial design parameters. This collaborative effort aimed to ensure that the Barakah plant's design could effectively mitigate risks associated with extreme natural events, enhancing its overall safety capabilities. [19, 45, 69]

Over nine months, the Emirates Nuclear Energy Corporation (ENEC) conducted an extensive safety design review of the Barakah Nuclear Energy Plant. The findings of this review were submitted to the Federal Authority for Nuclear Regulation (FANR) in December 2011 as part of the Construction License Application [19]. The review confirmed that the plant design exhibited a high level of robustness against natural hazards and demonstrated the ability to effectively manage severe accidents or power loss. Notably, the assessment identified no design deficiencies for the APR1400 reactor and the Barakah site, further validating the plant's safety and resilience. [69, 70]

However, ENEC took advantage of this opportunity to propose additional design enhancements to enhance safety margins even before the commencement of construction at the Barakah Nuclear Energy Plant [70]. In collaboration with the Korea Electric Power Corporation (KEPCO), ENEC put forward several modifications aimed at equipping plant operators with additional measures to mitigate a range of scenarios, including earthquakes, tsunamis, fires, station blackouts, and severe

accidents. These proposed enhancements were intended to further bolster the plant's safety measures and ensure its resilience in the face of potential hazards. [69, 70]

To prioritise the continuous evaluation and improvement of safety standards, the Federal Authority for Nuclear Regulation (FANR) approved 31 design changes for the Barakah Nuclear Energy Plant [71]. These changes aimed to enhance safety measures and ensure compliance with the most up-to-date requirements for earthquake and tsunami safety and aircraft impact resistance. The basis for these enhancements was drawn from industry best practices and the valuable lessons learned from nuclear energy operators worldwide. By implementing these design changes, the Barakah plant further strengthened its safety protocols and incorporated the latest advancements in nuclear safety. [69]

## **2.2 The Conceptual Framework of SPE Enabling Success Factors**

### **2.2.1 The SPE Conceptual Framework by Sovacool and Valentine**

This study adopts Sovacool and Valentine's Socio-Political Economy (SPE) Conceptual Framework as a foundational model for understanding nuclear energy policy implementation in the UAE. This framework is pivotal in examining the socio-cultural, political, and economic conditions that foster nuclear power programme expansion in new entrant countries. Sovacool and Valentine identified six key factors that historically influenced nuclear power development: strong state involvement, centralization of energy policy, linking technology with national revitalization, technocratic influence on policy, subordination of challenges to political authority, and low levels of civic activism. These factors reflect the dynamic interaction between state and society, crucial in shaping nuclear energy policy [16, 20, 21]:

According to Sovacool and Valentine, "the interaction between social, economic and political factors is the major challenge facing the well-experienced and new incomer states to the nuclear industry." [20]. They describe how these factors create a dynamic interplay between the state and society, shaping the formulation and implementation of nuclear energy policy within a Socio-Political Economy Conceptual Framework [16, 20, 21].

### **2.2.2 The Significance of Critical Factors**

So, the literature reveals several critical factors that were perceived to exist during the implementation of previous national nuclear energy programmes, which were

favourable to successful implementation. These factors are also relevant to the UAE as it pursues its ambition of using nuclear energy sources to diversify its energy supply and ensure continuous energy for its growing economy [44]. However, it is essential to assess the instrumental role of these factors and their current relevance in the UAE context. Previous nuclear power establishment took place some years ago [60], and it is possible that other factors now hold a dominant influence in the UAE. These factors may be specific to the local context, such as the need for energy security in an expanding demand (e.g. concerning air-conditioning needs for the elderly) [72]. They could also be time-related, such as the imperative for low-carbon generation to mitigate global temperature rise while meeting the increasing energy demand [42]. This research proposes a new conceptual framework for seamlessly implementing a national nuclear energy programme in the Emirates. [16, 20, 21]

### 2.2.3 Assessing Readiness and Incorporating Societal Concerns

The proposed framework in this current project aims to assess the importance of these established factors while incorporating timely and relevant aspects of public concern, such as reducing carbon emissions and ensuring the safety and well-being of humanity. To achieve this, recognising the constant evolution of society, the influence of societal needs will be considered by examining the impact of popular demand for mitigating global warming while ensuring an uninterrupted and secure energy supply for a safe and high-quality standard of living [72].

The International Atomic Energy Agency (IAEA) plays a significant role in achieving the Sustainable Development Goals (SDGs) established by the United Nations [73]. By providing peaceful nuclear technology, the IAEA supports Member States in areas crucial to sustainable development. Collaborating with organisations like the Food and Agriculture Organisation (FAO), the IAEA assists countries in enhancing food security, improving agriculture, and ensuring food safety through nuclear and isotopic techniques [74]. In health, the IAEA aids nations in comprehensive cancer control, establishes nuclear medicine facilities, and promotes the safe and efficient use of nuclear power to meet energy demands while mitigating climate change. The IAEA also facilitates industrial development through non-destructive testing and irradiation techniques, reducing environmental impact and fostering competitiveness. In addressing climate change, the IAEA's work contributes to greenhouse gas emissions reduction and helps countries adapt to the consequences of climate change [75].



Furthermore, the IAEA promotes the sustainable management of oceans, combatting desertification and land degradation, and engages in knowledge sharing to maximise its impact on sustainable development. These efforts align with the SDGs, including eradicating hunger, improving health and well-being, ensuring access to affordable and clean energy, promoting sustainable industrialisation, mitigating climate change, protecting oceans and marine resources, and supporting sustainable land use and ecosystems. [76]

#### 2.2.4 Proposed Conceptual Framework for the UAE's Nuclear Programme

This research aims to develop and assess the utilisation of an operational framework by which to implement a national nuclear energy programme in the Emirates. The study examines and incorporates regional activities, policies, and priorities, building upon the success factors identified by Sovacool and Valentine [16, 20, 21]. In the social aspect of this study, the researcher explores the decision-making processes of nuclear organisations, considering the views and opinions of the public. The influence of social acceptance of nuclear energy developments on these processes will also be examined. The research will investigate the interaction among social, political, and economic factors as the foundation of a conceptual framework for the Emirates' nuclear programme.

### **2.3 Nuclear Revitalisation: Addressing Constraints and Opportunities**

The global concerns surrounding climate change have increased, prompting the need to reduce greenhouse gas emissions and the reliance on fossil fuels for electricity generation. As a result, nuclear power generation is considered a primary source of energy generation [77]. The World Nuclear Association suggests that the nuclear industry has experienced a potential resurgence, referred to as the nuclear renaissance, since 2001 due to concerns about meeting emission goals and the rising costs of fossil fuels [78]. However, the electricity generated from nuclear power saw a significant decline in 2012 compared to 1999, as more nuclear reactors were decommissioned while fewer new reactors were built. [79]

#### 2.3.1 Constraints on Nuclear Revitalization: Challenges and Emerging Factors

Numerous factors constrain nuclear revitalisation or the nuclear renaissance throughout the lifespan of nuclear power programmes [28]. Key factors include increased nuclear accidents, proliferation, and security concerns. Additionally,

emerging factors in recent years include import and export control restrictions, a lack of expertise and workforce in the nuclear industry, the availability of cheaper alternative energy sources like natural gas, and challenges related to nuclear waste and the use of spent fuel[58]. These factors impact the implementation of nuclear programmes, presenting challenges to the nuclear renaissance and negatively affecting efforts to address climate change [28, 80]. The decline in nuclear power production contradicts the nuclear renaissance's goals and necessitates increased economic resources to generate electricity from fossil fuels. This shift leads to rising energy demand, higher production costs, grid instability, and heightened concerns about climate change [81]. The International Energy Agency (IEA) stated in 2009:

*"A nuclear renaissance is possible but cannot occur overnight. Nuclear projects face significant hurdles, including extended construction periods and related risks, long licensing processes and manpower shortages, plus long-standing issues related to waste disposal, proliferation, and local opposition. Financing new nuclear power plants, especially in liberalised markets, has always been difficult, and the financial crisis seems almost certain to have made it even more so. The huge capital requirements and risks of cost overruns and regulatory uncertainties make investors and lenders very cautious, even when demand growth is robust." [81]*

The IEA highlights that the existence of a nuclear renaissance is still being determined, and its implementation is confronted with numerous challenges. However, based on the progress made in the UAE, particularly in response to the Fukushima accident [82], the researcher asserts that the Emirati nuclear programme is successfully overcoming the challenges mentioned by the IEA. The Emirates Nuclear Energy Corporation (ENEC) has developed comprehensive roadmaps for meeting regulatory requirements, with oversight from both the Federal Authority for Nuclear Regulation (FANR) and the Abu Dhabi Executive Council. The UAE government is actively focused on implementing strategic plans to achieve its nuclear energy goals [83].

The Fukushima nuclear disaster in March 2011 and subsequent shutdowns of nuclear power facilities have contributed to the setback in the nuclear renaissance. Many countries with nuclear programmes initiated reviews and tests of their nuclear facilities to ensure the safety of their reactors and re-evaluate their nuclear expansion plans[84]. The researcher believes that the Fukushima nuclear accidents have prompted plant

design and operations improvements and sparked a renewed interest in the nuclear renaissance movement [28].

### 2.3.2 Opportunities and Challenges for Nuclear Programmes

Countries are always searching for alternative mixed energy sources to overcome the inconsistent price gap and demand for fossil fuels. Considering the additional climate change factor, there is a growing focus on clean, reliable, and efficient sources such as nuclear energy. Nuclear power generation is regarded as the best clean energy source to meet the world's high energy demand, leading many countries to develop or consider developing civil nuclear programmes for electricity generation [85]. New entrant countries are contemplating a nuclear renaissance for their new nuclear programmes [86].

The current nuclear reactors generate between 350 and 1600 GW, depending on the generation. The new generation currently under development is expected to generate 3500 GW, which will be available for implementation by 2060 [87].

Many European countries, including Russia, have announced their plans to expand or develop nuclear power programmes [88]. In addition to generating power from clean sources, these countries aim to phase out their old nuclear reactors, as most have reached the end of their operational lifespan and are in the decommissioning phase [85]. Technical difficulties in maintenance and the high cost of operation contribute to this decision. In the United Kingdom, magnox fuel units have been decommissioned due to the discontinuation of magnox fuel production. However, most new units will be built at the same existing nuclear sites to leverage the available infrastructure. The development or continuation of nuclear programmes will require the subordination of challenges to political authority by the government and strong state involvement in guiding economic development [77]. Therefore, there is a need to develop a new conceptual framework (CF) that considers existing critical success factors and identifies other factors overlooked within the social, political, economic, and environmental perspectives for new nuclear programmes.

### 2.3.3 Driving Forces for Nuclear Power Development

Energy security and climate change are the primary drivers behind the development of nuclear power programmes [89]. In response to the urgent need to address climate change, governments are committed to reducing carbon emissions, leading to the

development or increased reliance on nuclear power programmes [85]. This shift away from carbon-intensive technologies, particularly in electricity generation, will help decrease dependency on fossil fuels and reduce greenhouse gas emissions and their environmental impact. [85, 89]

The growing energy demand necessitates the establishment of an energy security regime. Meeting this demand can be achieved by expanding the development of nuclear power. There is an increase in international and bilateral cooperation in nuclear technology sharing, leading to the growth of nuclear capacity in Asia and Eastern Europe [90]. The global population growth and industrial development across countries, including developing nations, is expected to double the energy demand from 2007 to 2030 [90]. Consequently, the researcher assumes that the UAE has established long-term objectives to generate power from nuclear technologies in response to the increasing energy demand and the issue of energy security. Energy security has become a significant concern for global economies due to the rising price of fossil fuels, geopolitical instability, and recent supply disruptions [89]. These factors have contributed to a shift in international perception towards embracing a nuclear renaissance. [85]

Therefore, the driving forces for nuclear power development include clean, reliable, and efficient energy sources to address climate change, reduce greenhouse gas emissions, ensure energy security, and meet the growing energy demand [85, 88]. These factors have led many countries, including the UAE, to consider or pursue nuclear power programmes as a viable solution. [22]

#### 2.3.4 Phases of the Nuclear Renaissance

The nuclear renaissance encompasses new nuclear programmes and the optimisation of existing ones, considering the life cycle of nuclear power plants and large-scale power generation [28]. Achieving a nuclear renaissance involves two significant phases that work in tandem to advance clean and efficient power generation. The first phase focuses on extending the lifespan of existing nuclear plants and replacing inadequate older facilities [91]. The UAE programme emphasises enhancing the reliability and efficiency of nuclear power generation [22, 91]. By improving existing infrastructure, this phase sets the foundation for a sustainable and robust nuclear power programme. [28]

The second phase marks the initiation of large-scale power generation, aiming to reduce reliance on fossil fuels and lower gas emissions[91]. The UAE plans to commence this phase by 2030, with all four nuclear power plants operating at total capacity as a viable alternative to fossil fuel-based electricity generation [22]. However, the success of this phase hinges on overcoming two critical challenges. The first challenge is addressing the perception that nuclear technology is primarily associated with nuclear weapon proliferation rather than clean power generation. Therefore, any new or expanded nuclear programme must begin with a firm commitment to the International Atomic Energy Agency (IAEA) and the international community, affirming that the development is strictly for civil purposes and characterised by complete transparency [28]. The second challenge pertains to nuclear safety, particularly the safe disposal of nuclear waste and spent fuel. A global standard should be established to ensure the secure handling, storage, disposal, and, if applicable, recycling of nuclear waste [12]. This necessitates a thorough risk assessment for transporting, storing, and managing nuclear waste [7, 91].

Nuclear states and new entrants should heed the recommendations of the IAEA, the global nuclear regulatory body, in devising strategies for waste management and spent fuel handling. The Emirati nuclear programme exemplifies adherence to IAEA recommendations and guidelines, underscoring the importance of aligning with international standards in nuclear programme development.

### 2.3.5 Collaboration with International Atomic Energy Agency

Over a decade, the UAE has fostered extensive collaboration with the International Atomic Energy Agency (IAEA). The UAE has hosted numerous missions, including Site and External Events Design Review Services (SEED), Technical Safety Review (TSR), Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS), Integrated Nuclear Infrastructure Review (INIR), and Integrated Regulatory Review Service (IRRS) missions [82]. These missions have helped the UAE ensure its nuclear power programme's safe and sustainable development and provided valuable support and guidance. The Federal Authority for Nuclear Regulation (FANR), established in 2009, has worked closely with countries with advanced nuclear power programmes during the Barakah Nuclear Power Plant licensing process. Regulatory bodies from the Republic of Korea and technical support organisations (TSOs) in Europe and the United States of America

have provided safety evaluations and technical expertise in reviewing the construction license application [92]. This collaboration has contributed to the rigorous assessment and compliance of the Barakah plant with international safety standards. To enhance transparency and provide information to the public, the Emirates Nuclear Energy Corporation (ENEC) has made an interactive nuclear programme roadmap available on its website. This roadmap offers comprehensive details about the UAE's nuclear implementation programme, ensuring that stakeholders and the public have access to information about the progress and milestones of the nuclear programme [91, 93, 94]

Figure 1 illustrates the extensive collaboration between the UAE and the International Atomic Energy Agency (IAEA) over a decade [28]. The UAE's partnership with the IAEA has played a crucial role in ensuring their nuclear power programme's safe and sustainable development, with various missions and evaluations contributing to implementing international standards and best practices. [94]

### IAEA Milestones Approach

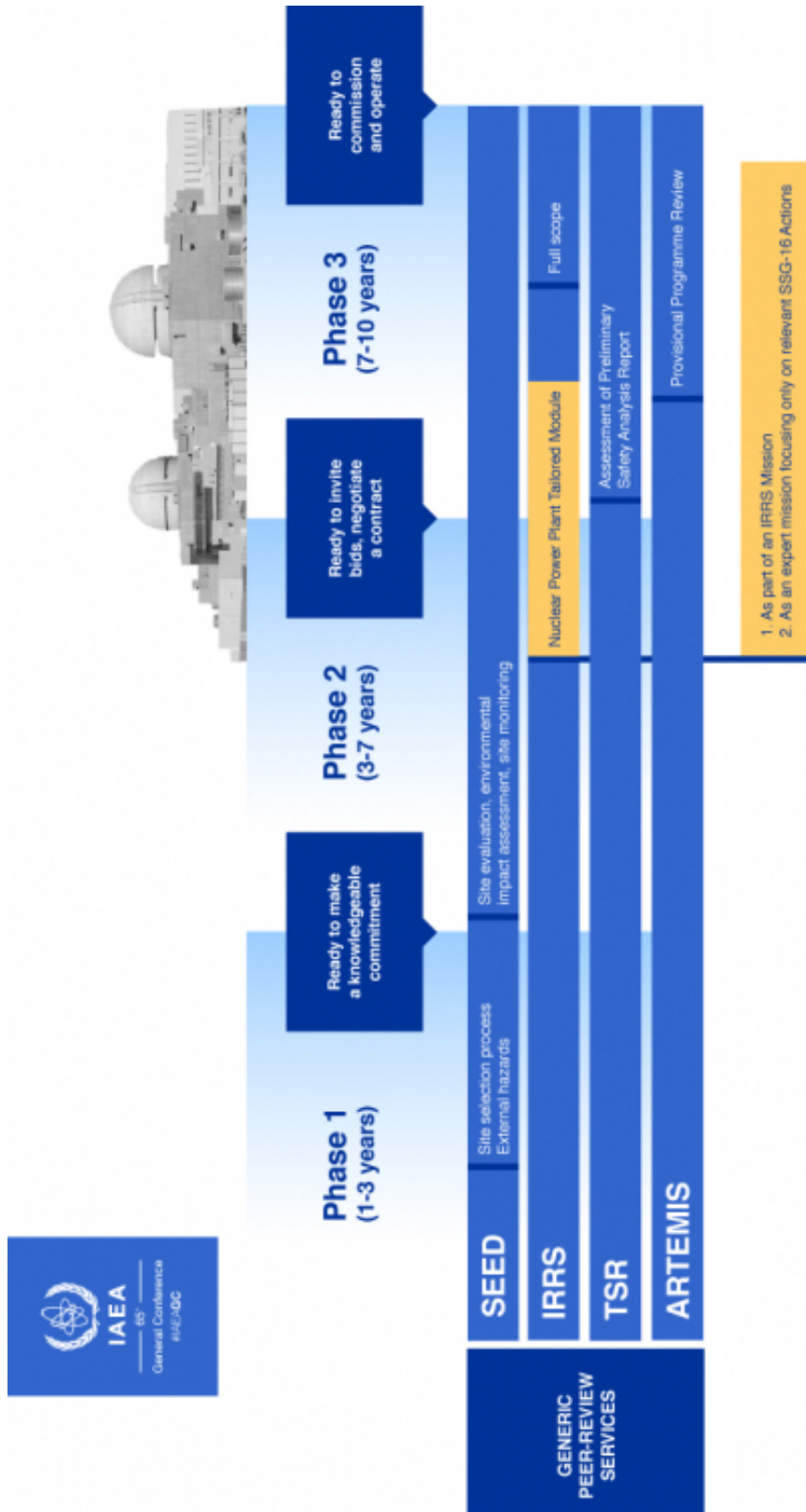


Figure 1: Showing IAEA Milestones Approach [94]

## 2.4 International Nuclear Organisations and Regimes

Since the 1950s, several international organisations have emerged to address the sensitivity of nuclear technology and provide recommendations and guidelines to their members. The Institute of Nuclear Power Operations (INPO) and the World Association of Nuclear Operators (WANO) are two examples. INPO was established in the USA after the Three Mile Island incident. It sets industry-wide performance objectives, criteria, and guidelines to ensure the safe operation of nuclear power plants, promote operational excellence, and share operational experience among plants [64]. WANO was established in 1989 following the Chernobyl nuclear accident. Its mission is to enhance the safety and reliability of commercial nuclear power plants worldwide [95].

Other international organisations, such as the International Atomic Energy Agency (IAEA) and the European Atomic Energy Community (EAEC), have also signed binding agreements with their members to ensure nuclear technology's safe and secure use. The UAE has joined many of these organisations and actively promotes the safe and secure use of nuclear technology. [19]

### 2.4.1 International Atomic Energy Agency

The International Atomic Energy Agency (IAEA) is an autonomous intergovernmental organisation founded in 1957 through a multilateral convention. It holds a particular standing within the United Nations system and is recognised by the UN General Assembly for its leadership role in the peaceful use of nuclear energy [93]. The IAEA's mission is to oversee the developing and implementation of nuclear infrastructure that successfully adopts safe and secure nuclear power. Another fundamental goal of the Agency is to accelerate and broaden the benefits of atomic energy to global peace, health, and prosperity. The Agency's operations are now primarily focused on nuclear safety and security, nuclear research and technology, and nuclear approaches for development and environmental protection [93]. The Treaties and legal frameworks produced by IAEA will be discussed later in the thesis.

The UAE became a member of the IAEA in 1976 and has collaborated effectively with the agency in both nuclear and non-nuclear power aspects. The UAE's nuclear policy, "Policy on the Evaluation and Potential Development of Peaceful Nuclear," published in



2008, strengthened its relationship and collaboration with the IAEA[19]. The policy was designed based on international safety, transparency, and security standards, positioning the UAE as a civil nuclear role model for the world. The IAEA supported the UAE's nuclear development programme to address the increasing power demand in the country. The UAE underwent 12 IAEA-led missions covering various aspects such as nuclear safety, nuclear security, radiation protection, emergency preparedness, capacity building, legal and regulatory systems, and nuclear non-proliferation. This support helped the UAE develop its national nuclear infrastructure [96].

According to Rafael Grossi, Director-General of the IAEA,

*“It was very impressive to visit Barakah and see first-hand what the UAE has achieved over the past decade in becoming the first Arab country to build and operate a nuclear power plant. The UAE’s 100 per cent commitment to introduce a peaceful nuclear power programme safely and securely can serve as a model for other countries considering this clean energy source to help ensure sustainable prosperity for their people. As with other member states introducing or expanding their existing nuclear energy programmes, the IAEA has worked closely with the UAE from the beginning to help it turn this vision into reality, ”[96]*

And according to H.E. Hamad Al Kaabi, Ambassador and Resident Representative of the Permanent Mission of the United Arab Emirates to the IAEA,

*“The visit of the IAEA’s Director-General to the UAE to tour the Barakah Nuclear Power Plant and other key institutions is an important endorsement for the UAE’s being a role model country for nuclear newcomers in building and operating a nuclear power plant. The strong collaboration that binds the UAE and IAEA is a cornerstone for ensuring the delivery of the UAE’s energy needs and maintaining the highest standards of safety, security and non-proliferation, ”[96]*

#### 2.4.2 European Atomic Energy Community (Euratom)

The European Atomic Energy Community (EAEC), also known as Euratom, is an organisation that binds its members through agreements. Founded in 1957, it aims to create a coherent, competitive, secure, and sustainable energy strategy for Europe. Euratom plays a crucial role in maintaining European energy self-sufficiency, with nuclear energy predicted to account for over 30% of power generation in Europe[97]. Euratom aims to establish a common market for nuclear ores and fuel across Europe. It actively promotes nuclear research and sharing nuclear technological know-how among

its member states. Additionally, Euratom is actively involved in creating consistent safety standards and facilitating investments in nuclear energy development. [98]

The Euratom Treaty has demonstrated remarkable resilience over the years, remaining unchanged. It has successfully navigated challenges such as the Three Mile Island incident, the oil crisis of the 1970s, the Chernobyl disaster, and the Fukushima incident. Despite attempts to change or modify the treaty, these efforts have yet to be successful [97]. In 1977, the Euratom Treaty established the "Euratom Loans" initiative to finance the development and expansion of nuclear programmes. However, due to the failure of the loan system, the "Euratom Loan" mechanism was cancelled in the 1980s. One criticism faced by the Euratom Treaty is the decision-making process and perceived lack of democracy. The treaty created two committees to address these concerns: the Scientific and Technical Committee and the European Economic and Social Committee (EESC). The member states nominate the members of these committees, and their roles include providing recommendations and consultations to the European Parliament. These committees serve as mechanisms to address criticism and enhance transparency and democratic processes within Euratom. [98]

## **2.5 Nuclear Revitalisation Challenges**

### **2.5.1 Regulatory Challenges**

Nuclear plants, whether existing, under development, or planned, face a multitude of challenges. Key issues include site selection, cost overruns, construction delays, grid integration, and nuclear waste management [53]. Furthermore, external challenges like climate change and evolving technological requirements pose additional risks to nuclear safety [9, 99].

Despite these hurdles, nuclear energy is seen as a viable solution to meet growing energy demands, reduce dependency on gas reserves, and sustain economic growth [10]. Nuclear power provides a stable baseload, aiding governments in diversifying their energy sources and reducing reliance on fossil fuels [2, 3].

However, establishing a national nuclear program is not without its challenges. It demands rigorous regulatory compliance, operational readiness, skilled human resources, and adherence to international safety, security, and non-proliferation standards [9, 99].

Ensuring the principles of safety, security, and safeguards (SSS) is crucial for the success and credibility of a nuclear program [11].

### 2.5.2 Technical Challenges

The limited availability of nuclear technology and raw materials is a concern for the sustainability of nuclear programs. The sector also faces a shortage of experienced professionals, which is critical for safety and operational efficiency [99]. Decommissioning of aging nuclear plants and the management of public perception, which can impact policy decisions, add to these challenges [30].

Addressing these technical challenges requires investment in training and education for nuclear professionals, including maintaining nuclear-related academic programs. Public outreach is pivotal to increase awareness about nuclear safety, its civil use, and environmental protection [100].

New challenges will emerge with the expansion of nuclear programs. These include securing a sustainable supply of nuclear fuel [30], as many fuel recycling plants are nearing decommissioning, affecting fuel availability and the management of nuclear waste [101]. Improving nuclear plant designs to meet growing energy demands is also crucial, ensuring facilities are capable of long-life operation, efficient decommissioning, and potential rebuilding at existing sites [102].

Additionally, the increasing number of nuclear units worldwide necessitates a larger workforce of skilled operators and safety inspectors. Training young professionals is essential for the continuation of safe and efficient nuclear power generation [25].

## 2.6 Nuclear Power Milestones

### 2.6.1 Milestones for Successful Nuclear Power Infrastructure Development

Developing a nuclear power programme requires careful planning, budgeting, scheduling, and preparation, including licensing and human resources. It also necessitates a legal framework, specialised organisations like regulators, and adequate procedures for handling nuclear material and technologies. These requirements ensure the safe and secure use of nuclear material for peaceful purposes. Member states aspiring to establish a nuclear programme should meet these prerequisites [103]. The International Atomic

Energy Agency (IAEA) has set 19 milestones that states should aim to achieve for successful nuclear power infrastructure development: [104, 105]

1. Management.
2. National Position.
3. Regulatory Framework.
4. Legislative Framework.
5. The site and Supporting Facilities.
6. Stakeholder Involvement.
7. Nuclear Fuel Cycle.
8. Environmental Protection.
9. Procurement and Industrial Involvement.
10. Safeguards.
11. Nuclear Safety.
12. Electrical Grid.
13. Radiation Protection.
14. Emergency Planning.
15. Human Resources Development.
16. Radioactive Waste.
17. Security and Physical Protection.
18. Role of Government (Leadership/Commitment, Institution Building and Legal Framework and Rule of Law).
19. Funding and Financing.

These elements should be further detailed into four categories to ensure effective implementation [103]. Firstly, all elements should be applied comprehensively without compromising any aspect, particularly the availability of nuclear fuel. Secondly, external infrastructure, such as the electrical grid, should be considered essential for a functioning nuclear power programme. Thirdly, sufficient funding should be allocated to address all aspects of the programme. Lastly, all responsible parties should have explicit scopes and levels of responsibilities. Ultimately, the government has overall responsibility (to neighbouring states and to civilians within the UAE) for oversight of activities intended to reduce risk to a 3<sup>rd</sup> party from all nuclear activities in the UAE.[104]

### 2.6.2 Success Factors in the UAE's Nuclear Power Programme

The UAE has successfully established its nuclear power programme, supported by a robust legal framework, which has contributed to the safe and secure operation of its nuclear plants. Public engagement and awareness, environmental protection, the development of safety and security procedures, and building a skilled workforce have also played crucial roles in the success of the UAE's nuclear programme [106]. These factors were evaluated during the Integrated Nuclear Infrastructure Review (INIR) mission conducted by the IAEA in 2018. The IAEA reported that the UAE's nuclear programme demonstrated "good practices" in implementing the 19 nuclear infrastructure milestones established by the IAEA[107]. Also, during the mission, the World nuclear News interviewed Hamad Alkaabi, the country's permanent representative at the IAEA, and he said:

*"The UAE is rapidly moving forward with developing its peaceful nuclear energy sector. The successful conclusion of the Phase 3 INIR mission is a testament to the UAE's commitment to upholding the highest international standards of safety, security, and transparency as we approach the commissioning of the nation's first nuclear energy plant,".* [107]

The UAE's achievements in implementing a successful nuclear power programme are attributed to its adherence to international standards, comprehensive planning, and commitment to safety and transparency. [107]

### 2.6.3 Establishing Sustainable & Comprehensive Infrastructure

The complexity of nuclear power programmes necessitates a solid commitment to building a sustainable national infrastructure that provides continuous support throughout the programme's lifespan [106]. This infrastructure should encompass governmental services, independent regulatory bodies, a robust legal framework, well-structured organisations, technological assistance, human resources development, and industrial infrastructure [105]. International support is also crucial, involving establishing trust within the international community through implementing rigorous nuclear safety standards, suitable security measures, and compliance with the International Atomic Energy Agency's Comprehensive Safeguards Agreements. The UAE demonstrated its

commitment to these principles from the early stages of its nuclear programme, incorporating them into its policies, laws, and plans [18].

Operating a nuclear power plant requires comprehensive facilities that offer continuous automated services. The management of plant operations should consider several key factors to ensure uninterrupted functioning [105, 108]:

1. A capable and experienced workforce to carry out operational activities: Adequate training and qualifications are essential to ensure nuclear power plants safe and efficient operation. Continuous professional development programmes and knowledge transfer initiatives help maintain a skilled workforce.
2. Sufficient budget allocation to cover all expenses: Proper financial planning and allocation of resources are vital to ensure the availability of necessary funds throughout the lifecycle of the nuclear power programme. Adequate budgeting allows for the timely completion of tasks and the fulfilment of operational requirements.
3. Regulatory services to ensure compliance and business continuity: Independent regulatory bodies are crucial in overseeing and enforcing safety and security regulations. These regulatory services ensure that nuclear power plants comply with established standards, minimising risks and ensuring business continuity.
4. Adequate radioactive waste management facilities: Safe and efficient management of radioactive waste is essential for the long-term sustainability of a nuclear power programme. Developing appropriate waste management facilities, including storage, treatment, and disposal, is crucial to minimise environmental impact and ensure public safety.
5. Effective plant management: A well-defined management structure and robust operational procedures are necessary for nuclear power plants' effective and efficient operation. Clear roles, responsibilities, effective communication channels, and proactive maintenance programmes contribute to reliable plant management.
6. Well-established supply chain and material transportation processes: A secure and well-organized supply chain is crucial for procuring and transporting materials required for nuclear power plant operations. Stringent controls and monitoring measures help prevent unauthorised access and ensure the integrity of the supply chain.

7. **Reliable grid connection and power supply:** A stable and reliable grid connection is essential for efficiently integrating nuclear power into the electricity grid. Continuous power supply, both on-site and off-site, ensures the availability of electricity for plant operations and contributes to overall grid stability.

The UAE has successfully maintained these services through its project plan, which encompasses all operational and management activities of nuclear power plants [19]. The UAE has laid a solid foundation for successfully implementing and operating its nuclear power programme by prioritising establishing a comprehensive and sustainable infrastructure.

#### 2.6.4 Considerations for New Entrant States

When developing or expanding a nuclear programme, countries need to establish a national infrastructure that provides essential services through specialised organisations with the assistance of multiple stakeholders. Learning from the best practices of professional nuclear organisations and states can help new entrant states efficiently establish and expand their nuclear programmes. Through its regulator and operator, the UAE implemented a clear plan with milestones that enabled the country to become a capable and thriving state with a nuclear power programme [19].

For new entrant states, certain factors need to be considered [105, 109]:

**Social stability:** Ensuring social stability within the country is essential for a nuclear programme's successful development and operation. A stable society fosters public confidence, support, and acceptance of nuclear energy, which is crucial for long-term sustainability.

**Economic stability:** Economic stability provides financial resources and investment capabilities to establish and sustain a nuclear programme. A sound economic foundation allows for allocating funds required for infrastructure development, regulatory frameworks, human resource training, and the implementation of safety and security measures.

**Political stability:** Political stability and a positive reputation are crucial for gaining support and trust from international nuclear organisations. A stable political environment fosters international cooperation, facilitates the establishment of international agreements

and partnerships, and ensures the country's adherence to global nuclear non-proliferation norms and regulations.

In addition to stability considerations, the safe and secure use of nuclear materials and technologies is paramount for the international community and the well-being of the country's citizens. A robust safety and security framework is necessary to promote the efficient development of a nuclear programme [105]. This framework includes stringent regulatory oversight, establishing adequate safeguards, implementing physical protection measures, and a strong safety culture throughout all nuclear programme levels. [109]

By considering these factors, prioritising social, economic, and political stability, and a robust safety and security framework, new entrant states can lay the groundwork for a successful and sustainable nuclear programme. Drawing upon the experiences and lessons learned from established nuclear organisations and states can further facilitate their programmes' efficient and responsible development.

#### 2.6.5 Developing Facts and Criticisms on BNPP

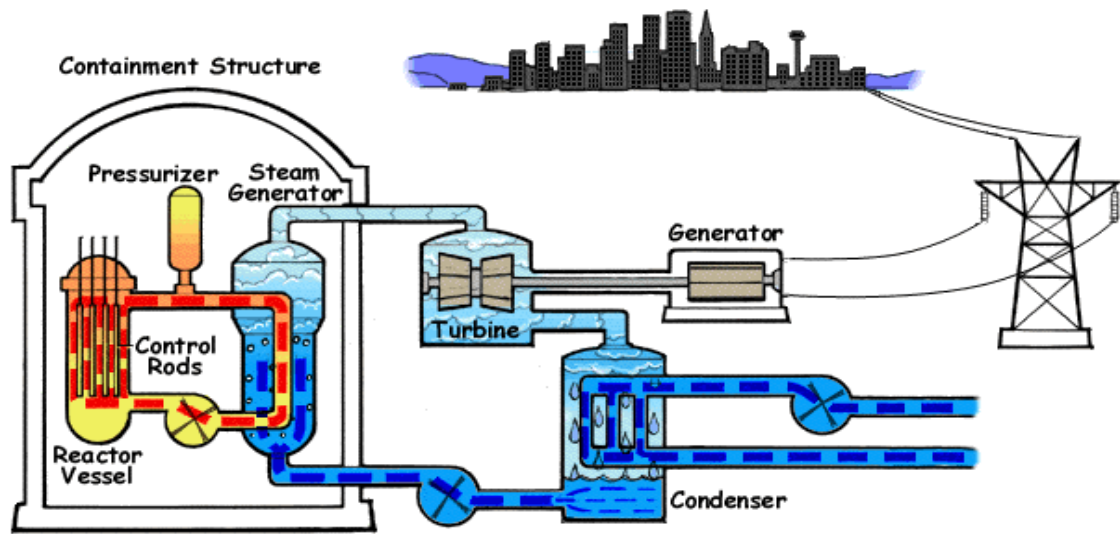
There are both positive and opposing views concerning the Emirati nuclear power programme that people are concerned about. This section will delve into these details and outline how the UAE government, through its organisation, addresses various factors and requirements. It will analyse and provide details on the emerging facts regarding BNPP power production. Increased awareness of these facts will help mitigate the risks and potential harm associated with nuclear programmes for the public and stakeholders.

#### 2.6.6 Understanding Nuclear Energy and Power Generation

The Nuclear Energy Institute (NEI) explained that Nuclear Energy "comes from splitting atoms in a reactor to heat water into steam, turn a turbine and generate electricity" [110]. Nuclear fission is a subdivision of heavy atomic nuclei, such as uranium or plutonium, into two fragments of roughly equal mass [111]. Therefore, nuclear fission occurs at nuclear plant reactors to generate heat. The heat will generate steam to run a steam turbine, rotating the shaft at the electrical generator to produce electricity. Figure 2 illustrates this method.



## Pressurised Water Reactor



*Figure 2: Showing the Pressurized Water Reactor (PWR) [112]*

### 2.6.7 Benefits and Considerations of Nuclear Energy

Many countries such as England, France, China, and Korea use nuclear energy as a base load and main energy supply [113]. Many states know the potential benefits of nuclear energy, which will help meet the continuous increase in power demand [114]. With the development and expansion of industries and economies, there is a substantial rise in energy requirements [113]. Many countries, particularly in the Middle East and North Africa, are considering using nuclear technology for electricity generation [114]. The growing power demand is driven by efforts to improve living standards and the economic development of these nations. Developing nuclear power will enable the UAE's thriving economy to meet the power demands of its infrastructure and socio-political economy diversities. [22]

### 2.6.8 Policy and Planning for Nuclear Power in the UAE

The UAE government conducted a comprehensive evaluation of its current and projected power demand and recognised the potential of nuclear technologies to meet its energy requirements. To establish nuclear plants as peaceful nuclear programmes for electricity generation, the UAE government issued the "Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy". This policy reflects several key commitments and principles, including [18, 22]:

1. Commitment to complete operational transparency.

The UAE government is dedicated to ensuring transparency in all aspects of its nuclear energy programme, providing open access to information, and fostering public awareness and engagement.

2. Commitment to the highest standards of non-proliferation.

The UAE is committed to strictly adhering to non-proliferation standards and safeguards, as outlined by international agreements and organisations such as the International Atomic Energy Agency (IAEA). This commitment helps to establish trust and build strong international partnerships.

3. Commitment to the highest standards of safety and security.

The UAE recognises the importance of safety and security in operating nuclear power plants. Stringent measures and regulations are implemented to ensure the highest levels of protection for the public, workers, and the environment.

4. Collaboration with the International Atomic Energy Agency (IAEA) and adherence to its standards for evaluating and potentially establishing a peaceful nuclear energy programme.

The UAE actively collaborates with the IAEA, benefiting from its expertise and guidance in evaluating and potentially establishing a peaceful nuclear energy programme. By aligning with international standards, the UAE ensures the development of a safe and responsible nuclear programme.

5. Desire to develop peaceful domestic nuclear power capability through partnerships with responsible nations and firms, along with the assistance of expert organisations.

The UAE seeks to develop its domestic nuclear power capability through partnerships with responsible nations and firms. Collaboration with expert organisations allows for the transfer of knowledge and expertise, fostering the growth of a skilled workforce within the UAE.

6. Approach any nuclear power programme with a focus on long-term sustainability.

The UAE's nuclear energy programme is approached with a focus on long-term sustainability. This includes considering the environmental impact, waste management, and the efficient utilisation of resources, ensuring the programme's viability for future generations.

The "Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy" is the guiding framework for the UAE government's nuclear energy programme. It outlines the initial structure and implementation plan initiated in 2008 [18]. The main objective of the policy is to develop a civil nuclear power programme that can generate electricity for all emirates while also fostering the development of regulatory and operational organisations using Emirati citizens [66, 115, 116]. This policy provides a clear direction and strategic roadmap for the UAE's nuclear energy programme, ensuring its successful and sustainable development.

#### 2.6.9 Implementation and Partnerships in the UAE's Nuclear Programme

KEPCO (Korea Electric Power Corporation) was awarded the international bidding contract to design, build, and start the Emirati Nuclear Power Programme, overseen by the Emirates Nuclear Energy Corporation [117]. KEPCO's selection was based on factors such as project management performance, technical evaluation, human capital development, and affordability compared to other bidders. Before bidding, site selection, environmental assessments, and safety evaluations for the programme were completed within two years [66, 115]. South Korea provided technical and financial assistance to the UAE to expedite the development of the programme [116]. The Emirate of Abu Dhabi has taken the lead in nuclear development to address the country's electricity needs [116].

#### 2.6.10 Justification for Nuclear Power in the UAE

The justification for establishing a civil nuclear power programme is to address the anticipated power supply shortage and meet the increasing future demand. Economic analyses for the UAE's future development projects predict a more than two-fold increase in power demand to 40 GW by 2020 [66]. Therefore, the government aims to increase the power supply by 9% annually [116]. This study considers future scenarios, including the possibility of a drop in oil and gas prices. Many significant projects in the UAE require a substantial power supply, as reflected in the country's portfolio [22, 66].

The UAE currently produces 1.7% of the world's gas production and consumes 2% of global output. It imports 2 billion cubic feet of gas from Qatar and has a long-term contract to export 600 million cubic feet of gas to Japan [66]. The UAE imports Qatari gas through a pipeline to reduce the cost of importing gas overseas. However, according to the nuclear policy, more than the current gas production rate will be required to meet future demand

[18]. The UAE government also recognises that relying on petroleum or coal for power generation is insufficient and environmentally harmful [66, 116]. In contrast, the UAE has implemented wind farm and solar power projects, more than they alone will be required to meet the annual increase in power demand [66]. Hence, the UAE has decided to introduce nuclear power generation to its energy mix to meet future demand [22, 117].

By understanding these facts and considerations, stakeholders and the public can better understand the UAE's nuclear power programme and its rationale. This knowledge helps to address concerns, mitigate risks, and promote transparency in nuclear programmes.

## **2.7 Challenges to the Creation of the Emirates Nuclear Programme**

Establishing the Emirates nuclear programme in the UAE has its fair share of challenges. However, the UAE has proactively addressed these challenges by implementing key policies and strategies. In 2008, the UAE issued the "Policy of the UAE on the Evaluation and Potential Development of Peaceful Nuclear Energy," laying the foundation for the nuclear programme. Additionally, the UAE Energy Strategy 2050, introduced in 2015, sets ambitious targets for reducing carbon dioxide emissions by 70%, increasing clean energy (including nuclear and renewables) by 50%, and improving energy efficiency by 40% by the middle of the century. These goals contribute to mitigating climate change and offer substantial economic benefits, with projected savings of AED 700 billion. By setting clear objectives and aligning with global clean energy trends, the UAE is committed to building a sustainable and environmentally friendly energy sector for the future. [2, 19, 22, 32, 42, 43, 118]

Incorporating nuclear energy into the UAE's energy mix is challenging and can affect various government areas. However, despite the surrounding region's political unrest, the UAE is the most stable country in the Middle East. It has taken on the monumental task of executing the most extensive single-site nuclear construction programme, setting an example as a role model for other emerging nuclear projects in the Middle East. The UAE's commitment to nuclear energy demonstrates its dedication to diversifying its energy sources, ensuring energy security, and advancing sustainable development in the region. This ambitious undertaking highlights the UAE's determination to overcome

challenges and establish itself as a leader in the global nuclear energy landscape. [19, 22, 25, 26, 32, 118]

### 2.7.1 Regulatory Challenges

As a new nuclear state, the Emirates faces regulatory challenges due to the need for operating experience in nuclear power plants [19, 118]. Hussain Alkathéri highlighted these challenges from the Federal Authority for Nuclear Regulation (FANR) during a programme update at the International Atomic Energy Agency (IAEA) on 5/12/2014 [30]. The main regulatory challenges include the development of a trained and competent workforce, familiarising with the new organisational structure, establishing dosimetry services, and developing an adequate emergency preparedness system. These challenges require proactive measures to address them and ensure the safe and effective regulation of the Emirates' nuclear programme. [118]

To address the challenges in developing the Emirates' nuclear programme, the Federal Authority for Nuclear Regulation (FANR) collaborated with various stakeholders and implemented several measures. FANR worked closely with state stakeholders to overcome training challenges and ensure the availability of skilled expertise [30]. They established a scholarship programme in partnership with the Ministry of Higher Education, sending students to nuclear institutes for education [119]. FANR also collaborated with international institutions such as the Korean Institute for Nuclear Safety (KINS), the US Nuclear Regulatory Commission (NRC), and Khalifa University to establish the Gulf Nuclear Energy Infrastructure Institute (GNEII) [120]. To meet radiation protection requirements, FANR contracted the French Institute de radioprotection et de sûreté nucléaire (IRSN). Furthermore, FANR engaged with international organisations like the International Atomic Energy Agency (IAEA) and participated in the International Nuclear Safeguards Engagement Programme (INSEP) to enhance their safeguards programme. These collaborative efforts and engagements demonstrate FANR's commitment to building expertise, knowledge sharing, and ensuring regulatory excellence in the Emirates' nuclear programme. [19, 118, 121]

To address the challenges related to radiation protection, FANR hired experienced staff with diverse regulatory approaches to develop a conventional approach. This approach ensures effective communication and cultural awareness in implementing radiation

protection measures [30]. FANR also established an adequate management system for dosimetry services and enforced it through the licenses granted, thereby ensuring accurate and reliable monitoring of the radiation exposure [30]. Regarding emergency preparedness, FANR collaborated with relevant national entities and established an off-site emergency centre integrated with the Emirates Nuclear Energy Corporation (ENEC). This centre serves as a hub for coordinating emergency response efforts.

Additionally, FANR implemented a training programme for nominated staff from each relevant authority, enhancing their preparedness and response capabilities in emergencies. These initiatives demonstrate FANR's commitment to ensuring robust safety measures and effective emergency management in the Emirates' nuclear programme. [19, 25, 30]

To benefit from international expertise and promote safe and secure operations, the Emirates Nuclear Energy Corporation (ENEC) became a member of the World Association of Nuclear Operators (WANO) in October 2010 [122-124]. This membership provides ENEC access to global best practices and valuable lessons learned from operating nuclear plants worldwide. By collaborating with WANO, ENEC can enhance their operational practices, prioritise safety and security measures, and improve the efficiency and profitability of their nuclear programme. This commitment to learning from international experiences demonstrates ENEC's dedication to maintaining high standards in the Emirates' nuclear industry. [2]

These measures demonstrate the Emirates' commitment to developing a robust and competent nuclear programme by leveraging global knowledge and expertise.

### 2.7.2 Geopolitical Challenges

The Emirates faces political and regional challenges in its nuclear programme. One challenge is the reliance on gas imports from Qatar via a pipeline, despite the ongoing conflict between the two countries [125]. Another challenge is the dependence on the Strait of Hormuz for sea access to international transportation, including oil, gas, and nuclear material and equipment shipment. The political conflicts with Iran, which controls the Strait, pose a potential risk of disrupting sea traffic [2, 19, 118].

To overcome these challenges, the Emirates has undertaken bold initiatives in the country's eastern region, specifically on the Arabian Sea, to establish alternative transport

facilities that are not reliant on the Strait of Hormuz. This includes diversifying gas imports from other sources [118, 126].

Regarding non-proliferation, the Emirates has had a complex relationship with the non-proliferation regime due to the activities of AbdulQadeer Khan, who used Dubai as a transit hub for nuclear technology smuggling to various countries. Khan exploited the previously lax regulations and lack of internal coordination in the Emirates, using local companies as fronts for his operations. This drew scrutiny from policymakers in the West when the A.Q. Khan Network was exposed in 2004 [2, 118].

The Emirates recognises the importance of implementing adequate safety, security, and safeguards (SSS), including export control measures, in their nuclear programme to address these challenges. This requires a robust institutional structure and coordination between regulatory and operator organisations to ensure nuclear plants' safe and secure operation while meeting international SSS standards [2, 19, 118].

### 2.7.3 Climate Change Challenges

The global reliance on fossil fuels has led to a significant increase in CO<sub>2</sub> emissions, prompting international efforts to reduce these emissions. The 2011 UN Climate Change Conference of the Parties (COP17) aimed to establish a new treaty to limit carbon emissions, and the majority of attending government representatives made common decisions regarding climate change issues [127, 128]. However, weak international regulation addressing climate change has resulted in a general reluctance to invest heavily in renewable technologies and transition away from fossil fuels and traditional energy sources [127]. Despite expressing a desire to tackle climate change, significant countries face persistent challenges in taking effective action due to weak energy governance at the national level. As a result, several countries, including the Emirates, view nuclear energy as a low-carbon solution that can help achieve carbon emissions reduction targets and consider it a preferred energy option [22, 128, 129].

The 2015 UN COP21, also known as the Paris Agreement, called on governments to submit mid-century strategies outlining their plans to achieve deep decarbonisation goals [130]. These strategies rely on energy-economy-climate models to ensure high-quality implementation at the national level [128, 130]. However, to be feasible, many of these

strategies require significant policy changes, particularly in sectors such as industry. Governments have jurisdiction over various choices related to these strategies, including the level of societal participation, technical modelling approaches, and the translation of strategy into policy. Unfortunately, there is a temptation for governments to prioritise 'short-term' interests, such as the next election, at the expense of 'long-term' considerations. [22, 42, 128, 130, 131]

#### 2.7.4 Decarbonisation Challenges

Governments face significant challenges in decarbonising their economies and achieving ambitious decarbonisation goals. The strategies proposed by governments, including those outlined in 'Mid-Century Strategies,' underscore the need for substantial new policies to drive the necessary reduction in carbon emissions [128, 130]. There needs to be more adequate policies to tackle the magnitude of the decarbonisation task at hand. Decarbonisation requires a transition to a sustainable economic system that effectively reduces and compensates for carbon dioxide (CO<sub>2</sub>) emissions, aiming to achieve a carbon-free global economy. This transition necessitates transformative changes in critical sectors such as energy production, transportation, industry, and agriculture, through the widespread adoption of renewable energy sources, energy efficiency measures, carbon capture and storage technologies, and sustainable land use practices. Governments must prioritise research, innovation, international cooperation, and the development of comprehensive policy frameworks to overcome the complex challenges and drive the transition towards a decarbonised future [22, 128, 132].

Decarbonising industrialised societies presents complex and long-term policy challenges from distributive politics, time-inconsistency issues, and uncertainties over time. Addressing these challenges requires governance pathways considering long-term and short-term concerns by analysing the political, administrative, and legal structures for effective climate policies. Coordinating policies and investments across related sectors is crucial, especially in the industrial sector, which currently needs a viable decarbonisation policy [128, 130, 131]. Technological and financial barriers impede the implementation of decarbonisation policies in the industrial sector, necessitating further global research and development efforts to overcome these challenges and reduce costs [133]. Enhanced



worldwide research and development in the industrial sector will contribute to developing more effective decarbonisation solutions and drive down the associated costs. [128, 130]

#### 2.7.5 Societal Participation Policymaking

Public input and societal participation in policymaking can have positive and negative effects, representing a double-edged sword. On the positive side, involving the public enhance strategies' durability by building political support, increasing transparency, and fostering trust and accountability. It allows for considering diverse perspectives, leading to more robust and sustainable long-term policies. However, public participation can also mobilise opposition and create conflicting interests, making consensus challenging. Societal limited involvement and a robust governmental agreement can facilitate efficient decision-making but may need more checks and balances provided by broader public participation. Governments often need help maintaining consistent and credible long-term policies due to changing societal preferences and political dynamics. Achieving a balance between public input and societal participation while ensuring continuity and credibility requires careful governance and effective mechanisms for decision-making [22, 134].

#### 2.7.6 Environmental Protection and Energy Transition in the Emirates

In the Emirates, there has been a significant focus on environmental protection, resulting in the implementation of a Strategic Programme to transition from non-renewable to renewable energy sources. This transition has led to decreased use and production of kerosene. However, the Emirates still exhibits higher per capita energy consumption and carbon emissions than other Middle Eastern countries [128]. There has been a significant increase in energy consumption in the Emirates between 1994 and 2005, with an average annual growth rate of 12%, surpassing the population growth rate. In 2007, the registered vehicles were 1.5 million. In 2011, the share of transportation in the total energy sector Greenhouse Gas (GHG) emissions was 15.87%. To address these challenges, the Emirates has made commitments under the Intended Nationally Determined Contribution (INDC) to the United Nations Framework Convention on Climate Change (UNFCCC), including an increase in clean energy to 24% of the total energy mix by 2021. This commitment is expected to reduce greenhouse gas emissions from the energy sector by approximately 20.4% in 2020. Nuclear energy is considered a viable solution to help achieve these targets. [22, 135]

## **2.8 Emirate Energy Sector and Greenhouse Gas Emissions (GHG)**

Power demand, energy security, and climate change are pressing concerns central to the discussions among societies, scholars, and policymakers. These issues give rise to various uncertainties, including electricity shortages, economic instability, and the impact of global warming, which provide a crucial context for governments and civil authorities to address [128]. Transitioning to carbon-free and sustainable energy sources has become a global governance priority, leading to increased political cooperation among transnational actors to negotiate and implement measures to reduce associated risks [11, 44]. In alignment with this global concern, the Emirates have recognised the importance of nuclear power as a sustainable solution for meeting power demand and generating baseload electricity while prioritising environmental sustainability [22, 128, 135, 136].

### **2.8.1 Energy Sector and GHG Emissions**

In 1991, the annual petroleum and natural gas consumption in the Emirates was 110 million and 118 million barrels, respectively. By 2013, these figures had increased to 225 million and 395 million barrels due to the high dependence on natural gas for 99% of electricity generation. The energy sector in the Emirates accounts for over 90% of greenhouse gas (GHG) emissions. The electricity generation capacity has grown significantly, rising from 3.7547 GWh in 2000 to 9.79 GWh in 2011. Based on a simple linear regression model, it is projected to reach a specific GWh value by 2020. To meet the required electricity generation capacity, Abu Dhabi plans to privatise its power generation, resulting in lower-cost production and more resources available for other services [128]. This transition would require effective policies and legislation to ensure low GHG emissions. The major industries contributing to energy consumption and GHG emissions include cement, iron, steel, aluminium, road transport, oil, and power/desalination plants. Nuclear power has been considered a primary energy source for these industries to reduce emissions and meet the energy demands [22, 128, 137].

### **2.8.2 Actions to Reduce GHG Emissions**

The Emirates has implemented various measures across sectors to reduce greenhouse gas (GHG) emissions and promote sustainable energy practices. These actions encompass various vital industries and demonstrate a comprehensive environmental mitigation approach. Some notable activities include [22, 128, 137, 138]:

1. Switching to less carbon-intensive fuels and implementing measures such as using dry kilns (for cement production) without leaks and capturing CO<sub>2</sub>.
2. Utilising large-scale solar power plants, nuclear power plants, solar photovoltaic plants, wind power, and waste-to-energy technology.
3. Improving vehicle efficiency and public transportation, using environmentally friendly fuels, and reducing travel demand through policies.

These actions demonstrate a comprehensive approach to reducing GHG emissions in the Emirates. The Emirates is actively pursuing a sustainable path that aligns with global efforts to combat climate change by addressing key sectors such as industry, energy generation, and transportation. These measures reduce environmental impact and position the Emirates as leaders in adopting clean energy technologies and promoting sustainable development. [128]

### 2.8.3 Emirates' Initiatives for Sustainable Development

The Emirates has established goals related to sustainable development in its Vision 2021. Implementing green growth and national innovation strategies, along with other relevant plans, policies, and programmes, has resulted in establishing a national clean energy target [137, 138]. This has led to various initiatives, including [22, 128, 137]:

#### 1. Tariff reform:

One significant initiative is tariff reform, which involves restructuring electricity pricing to incentivise energy efficiency and using renewable energy sources. By adjusting tariffs, Emirates encourages consumers to adopt more sustainable energy practices and reduce their overall energy consumption.

#### 2. Developing building and efficiency standards:

The Emirates has developed building and efficiency standards to promote energy efficiency in buildings. These standards focus on optimising the design and construction of buildings to minimise energy consumption and maximise resource efficiency. By implementing these standards, Emirates aims to reduce the environmental impact of the construction and operation of buildings.

#### 3. Demand management:

Demand management strategies have also been implemented to manage and regulate energy consumption effectively. These strategies involve load balancing, peak shaving, and demand response programmes, which aim to optimise energy usage and reduce strain on the power grid during periods of high demand.

4. District cooling:

District cooling is another key initiative in the Emirates' sustainable development agenda. District cooling systems provide centralised cooling services to multiple buildings, allowing for more efficient energy use and reduced environmental impact compared to individual cooling units. This initiative contributes to lowering energy consumption and GHG emissions associated with cooling.

5. Appliance efficiency standards:

Appliance efficiency standards have been implemented to ensure that energy-consuming appliances meet specified energy efficiency requirements. These standards help reduce electricity consumption and promote using more energy-efficient appliances, contributing to energy conservation efforts.

6. Mass transit development:

The Emirates recognises the importance of sustainable transportation and has prioritised mass transit development as part of its initiatives. By investing in expanding and improving public transportation systems, Emirates aims to reduce reliance on private vehicles, decrease traffic congestion, and lower emissions from the transportation sector.

7. Use of compressed natural gas:

Compressed Natural Gas (CNG) as a cleaner alternative to conventional fuels is also being promoted in the Emirates. By encouraging the adoption of CNG vehicles, Emirates aims to reduce emissions from the transportation sector and enhance air quality.

8. Investing in renewable energy and R&D:

In line with its commitment to clean energy, the Emirates has significantly invested in renewable energy and research and development (R&D). These investments support developing and deploying renewable energy technologies, fostering the transition to a more sustainable and diversified energy mix. The allocation of over \$270 million in subsidies for the power sector demonstrates the Emirates' dedication to driving the growth of clean energy sources and reducing dependence on fossil fuels [137, 139].

By implementing these initiatives and investing in sustainable development, Emirates aims to achieve a balanced and sustainable economy with a high standard of living. These efforts align with their long-term strategy to diversify from an oil-based economy to a service-based one. Through regulatory measures, financial incentives, and research and development, the Emirates are actively working towards a future characterised by sustainable practices, reduced environmental impact, and enhanced quality of life for their residents. [128]

#### 2.8.4 Emirate-Level Strategies and Policies

In the UAE, strategies and policies are implemented at the emirate and federal levels to reduce greenhouse gas (GHG) emissions. Each emirate has its own set of initiatives and targets, aligned with the national objective of transitioning towards sustainable energy practices and mitigating GHG emissions. [22, 128, 137, 139]

Abu Dhabi, for example, has set a specific target to generate 7% of its total electricity demand from renewable sources by 2020. The government has launched a solar roof plan to install 500 MW of photovoltaic power capacity to achieve this target over 20 years. This initiative promotes the adoption of solar energy and contributes to reducing the reliance on fossil fuels for electricity generation. [22, 128, 137, 139]

In 2011, Abu Dhabi introduced an agriculture and food safety policy that includes measures to reduce water usage and GHG emissions in the agricultural sector. By implementing sustainable practices and promoting efficient water management, the policy minimises the environmental impact of agricultural activities. [22, 128, 137, 139]

The Vision 2030 of Abu Dhabi strongly emphasises sustainable transport and land use planning. The goal is to shift from private modes of transportation to public methods, such as public transit systems, to reduce GHG emissions from the transport sector. This initiative aligns with the broader objective of promoting sustainable urban development and reducing carbon emissions. [22, 128, 137, 139]

The Dubai Electricity and Water Authority (DEWA) has implemented educational programmes to raise awareness about energy conservation and the importance of sustainable practices. These programmes promote behavioural change and encourage individuals and businesses to adopt energy-efficient measures. [128, 137, 139]

These initiatives demonstrate the commitment of the Emirates to mitigating GHG emissions and transitioning towards sustainable energy practices. However, several challenges need to be addressed in the development of renewable energy resources: [22, 128, 137, 139]

1. The conflict between maintaining subsidies and sustaining exports:

Balancing the need for subsidies to meet domestic energy demands while considering the potential reduction in revenue from decreased exports due to rising populations and increased energy demand. Finding a sustainable balance is crucial to ensure economic stability and promote renewable energy adoption.

2. Reorientation in energy sectors:

Shifting towards renewable energy requires consistent strategies and policies that may take medium to long-term efforts to achieve meaningful reforms. The transition from traditional energy sources to renewables involves systemic changes that require careful planning and coordination.

3. Competitiveness of renewable energy:

Renewable energy sources often face challenges competing with fossil fuels regarding cost-effectiveness from an end-user perspective. Addressing this challenge involves developing innovative financing mechanisms and technological advancements that reduce the cost of renewable energy generation.

4. Lack of legal policy framework and strategies:

The Gulf Cooperation Council (GCC) needs a comprehensive legal policy framework and strategies for deploying renewable energy sources. Clear guidelines and regulations hinder attracting investments in the renewable energy sector. A supportive legal and policy framework is essential to create an enabling environment for renewable energy deployment.

To overcome these challenges, developing a supportive legal and policy framework that provides long-term stability and promotes investment in renewable energy projects is crucial. Long-term planning is necessary to effectively integrate renewable energy sources into the energy mix. Additionally, measures to improve the competitiveness of renewable energy, such as research and development investments and technological

innovation, are essential for accelerating the adoption of clean energy technologies and achieving sustainability goals in the Emirates.

#### 2.8.5 Promoting Renewable Energy and Mitigating GHG Emissions

The development and changes in policies, regulatory frameworks, and establishing institutions are crucial in overcoming these structural weaknesses and promoting the wide-scale deployment of renewable energy sources [140]. Renewable Energy Sources (RES) refer to energy derived from natural sources that are replenished at a higher rate than consumed. Power Purchase Agreements (PPAs), in which governments partner with renewable energy project developers, have provided equal opportunities for renewable energy sources to compete with heavily subsidised conventional energy sources. As the Emirates heavily depends on petroleum resources, the high energy and electricity consumption, population growth, and economic development have prompted policymakers to adopt renewable and alternative energy sources to ensure energy security and mitigate GHG emissions [26, 128, 136, 137].

To effectively mitigate greenhouse gas (GHG) emissions, the Emirates should prioritise the following steps [22, 128, 137]:

1. Conduct a comprehensive national GHG emission inventory:

Gathering accurate data on GHG emissions across various sectors is crucial to identify the primary sources and determining emission reduction targets.

2. Investigate the dynamics of the energy sector's contribution to national GHG emissions:

Understanding the specific role of the energy sector in GHG emissions is essential for formulating targeted policies and strategies. This analysis can identify areas where emission reduction efforts can be most effective.

3. Establish future energy outlook scenarios and assess their implications:

Developing scenarios that outline the potential pathways for the country's energy future allows policymakers to evaluate the impact of different strategies. This analysis helps identify opportunities for integrating renewable energy sources, improving energy efficiency, and reducing emissions.

4. Select appropriate policy measures to mitigate GHG emissions:

Based on the findings from the previous steps, Emirates should design and implement policy measures tailored to their specific context. This may include setting renewable energy targets, implementing carbon pricing mechanisms, promoting energy efficiency programmes, and supporting research and development of clean technologies.

5. Consider increasing tariffs to encourage efficient energy use:

Adjusting tariffs to reflect the actual costs of energy consumption can incentivise individuals and businesses to adopt more energy-efficient practices. Higher tariffs for excessive energy consumption or carbon-intensive fuels can drive behavioural changes and promote a shift towards cleaner energy sources.

By implementing these measures, the Emirates can make significant progress in promoting renewable energy sources, reducing GHG emissions, and ensuring a sustainable and environmentally friendly energy future. These actions will contribute to global efforts to address climate change and establish a low-carbon economy [22, 128].

#### 2.8.6 Energy Awareness and Tariff Structure

However, tariff increases should be accompanied by awareness and educational programmes highlighting the potential benefits of energy efficiency to consumers [42]. The Regulation and Supervision Bureau (RSB) declared a tariff structure on 1st January 2015 [141], wherein higher energy consumers are charged more. The future deployment of renewable and alternative energy resources for electricity and heat generation will significantly impact national GHG emission outlooks. Nonetheless, energy awareness and training plans, policies, and programmes will also considerably shape future GHG emission scenarios [22, 128, 137].

## 2.9 Recent Energy Policy in the Emirates

After signing the COP21 agreement, the Emirates are committed to the United Nations Framework Convention on Climate Change and are actively negotiating to finalise a protocol or legal instrument applicable to all parties [129]. As part of their commitment, the Emirates aims to increase clean energy's share to 24% of the total energy mix by 2021 [42, 137]. Despite these commitments and ongoing mega energy infrastructure programmes, the Emirates still needs a specific energy policy mandated by the federal



constitution. Instead, each emirate has its energy plan, with Abu Dhabi, holding 94% of the crude oil reserves, taking the lead in the energy planning [126]. The current nuclear energy policy of the Emirates is outlined in the 2050 Strategy, developed in 2015 [41]. This strategy aims to achieve an energy mix that combines renewables, nuclear power, and clean energy sources to meet the Emirates' economic and environmental goals [22, 41, 128]:

1. Clean energy: 44%.
2. Gas: 38%.
3. Clean coal: 12%.
4. Nuclear: 6%.

### 2.9.1 2050-Strategy and Energy Goals

The 2050 Strategy and Energy Goals are crucial in shaping the Emirates' energy policy and pursuing a sustainable energy future. However, there have been notable adjustments in the nuclear power contribution, which decreased from the initial target of 25% to 6%. This change raises concerns about the implications for stakeholders, including the public [42]. The implementation of the 2050-Strategy revolves around three key themes [22, 41, 42, 128, 136]:

1. A quick transition towards power consumption efficiency, diversification of energy sources, and ensuring supply security:

This theme emphasises the importance of improving energy efficiency, exploring a variety of energy sources, and ensuring a stable and reliable energy supply. By prioritising efficiency and diversification, Emirates aims to reduce dependence on traditional energy sources and enhance energy security.

2. Exploring new solutions that complement power and transportation systems:

This theme focuses on identifying innovative solutions that can effectively integrate with power and transportation systems. The Emirates recognises the need to explore emerging technologies and strategies that can enhance the efficiency and sustainability of its energy infrastructure, supporting its goal of a more diversified and resilient energy sector.

3. Ensuring energy sustainability through research, development, and innovation:

The Emirates acknowledges the significance of continuous research, development, and innovation in achieving long-term energy sustainability. By investing in research and fostering innovation, they aim to develop advanced technologies and practices that can contribute to a more sustainable energy landscape.

These themes serve as guiding principles for the Emirates' energy goals and their broader energy policy. Through a concerted effort to promote efficiency, diversify energy sources, and prioritise sustainability, the Emirates are taking proactive steps towards achieving their energy targets and advancing their overall energy strategy.

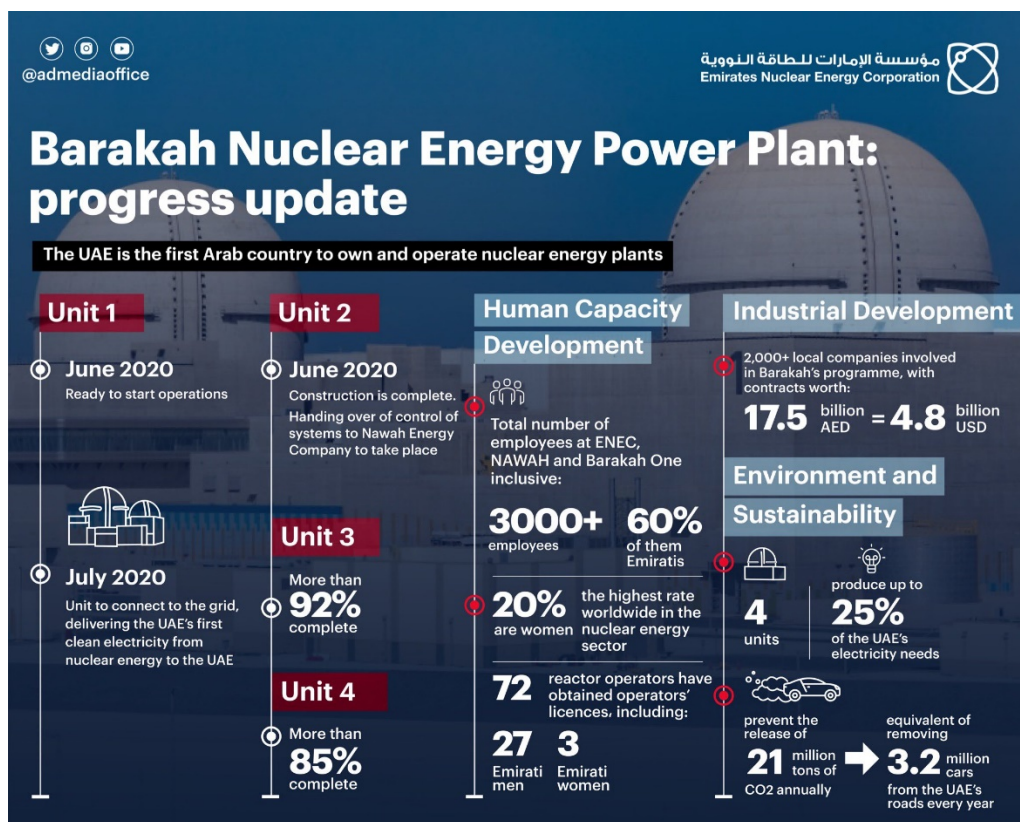


Figure 3: BNPP progress [139]

2.9.2 Progress on Planning of Nuclear Energy

The Ministry of Energy and ENEC has summarised the progress in planning the Barakah Nuclear Power Plant (BNPP). Figure 3 illustrates the BNPP progress. [139]

In preparation for the commissioning milestone, the Emirates Nuclear Energy Corporation (ENEC) obtained a fuel storage license from the Federal Authority for Nuclear Regulation (FANR) and stored the fuel at the BNPP site, following the

recommendation of the International Atomic Energy Agency (IAEA). Based on a comprehensive operational readiness review, the Fuel Load milestone is expected to be completed by early 2020, which will contribute to achieving the operational milestone by 2021 [22, 139].

Currently, three out of the four units of the BNPP are in operation and connected to the grid [142]. This indicates significant progress in implementing the nuclear energy programme in the Emirates.

## **2.10 Socio-Political Economy Conceptual Framework**

In recent years, many countries, including approximately 60 states, have expressed their interest in introducing nuclear power as part of their national energy mix, as reported to the International Atomic Energy Agency (IAEA) [44]. The growing interest in nuclear power from emerging nations can impact market dynamics, industry costs, the global energy mix, climate change initiatives, and international security dynamics. However, countries pursuing nuclear power face various sociocultural, economic, and political challenges [16, 44, 143]. While there needs to be more data available to compare the Emirates' nuclear development directly, the researcher is considering case studies of nuclear development in France and Japan [20, 144].

### **2.10.1 Sovacool and Valentine's Framework**

According to Sovacool and Valentine," the interaction between social, economic and political factors is the major challenge facing the well-experienced and new incomer states to the nuclear industry" [20]. They described how these factors form a dynamic force of state and society that influences the method of drafting and implementing Nuclear Energy Policy (NEP) as a Socio-political economy conceptual framework. This socio-political economy conceptual framework (CF) identifies six factors present when a country successfully develops a nuclear energy programme, as shown below [20, 21].

1. Strong state involvement in guiding economic development.
2. Centralisation of national energy planning.
3. Campaigns to link technological progress to national revitalisation.
4. Influence of technocratic ideology on policy decisions.
5. Subordination of challenges to political authority.
6. Low levels of civic activism against nuclear energy.

### 2.10.2 Extension of the Framework for the Emirates

In the current research, this socio-political economy conceptual framework is adopted to understand the implementation of Nuclear Energy Policy (NEP) in the Emirates. However, the framework is extended and tailored to consider the unique aspects of the Emirates and the local region. It is important to note that different contexts and circumstances exist among states interested in starting a nuclear power programme.

The current research aims to develop, test, and utilise a modern conceptual framework tailored explicitly for implementing a national nuclear energy programme in the Emirates. This framework will incorporate regional activities, policies, priorities, and the success factors identified by Sovacool and Valentine. The Emirates, with its significant nuclear construction project in a politically unstable region like the Middle East, presents an attractive research opportunity, as the area has yet to be extensively studied in the socio-political economy (SPE) conceptual framework literature. [16, 20, 21, 32]

Developing a conceptual framework for the Emirates based on the works of Sovacool and Valentine will contribute an original perspective to the existing literature. The framework will be built upon the six factors identified by Sovacool and Valentine, which have proven significant in successful nuclear energy programmes. This research opportunity is particularly relevant for the Emirates, a newly emergent state undergoing massive nuclear development and experiencing significant SPE changes in the coming decades. There is a strong justification for creating a new conceptual framework to guide the successful implementation of a national nuclear programme in the Emirates. However, to the best knowledge of the researcher, there is currently a lack of an existing unique and practical operational framework for Emirates' nuclear energy programme. Therefore, the factors identified by Sovacool and Valentine were verified based on the causal properties of nuclear energy development, specifically focusing on the world's most significant nuclear construction project [145]. The framework will be validated by considering the unique status of the Emirates' socio-political economy before, during, and after the decision to pursue nuclear energy. This will consider factors such as government structure, governance implementation methodology, and public engagement, demonstrating the primary methodological dimension of this research [26]. [16, 20, 21, 32]

In comparison to Sovacool and Valentine's success factors, the development situation in the Emirates is unique in the Middle East region, which is characterised by political unrest affecting many countries. The Emirates' uniqueness can be attributed to wise and modern leadership. Each Emirate has its development plan, designed to align with the federal strategic plan, demonstrating the utilisation of the "strong state involvement in guiding economic development" and "centralisation of national energy planning". The Emirates has invested in and developed an advanced education system to support the idea of modernisation and has become a model of development in the Middle East. This successful vision has led to campaigns that link technological progress to national revitalisation and have resulted in low levels of civic activism against nuclear energy. The Emirates government has also actively engaged with international nuclear organisations and signed Memoranda of Understanding (MOUs) with member countries of the Nuclear Suppliers Group (NSG), allowing them to influence technocratic ideology on policy decisions and support national political authorities. From this perspective, the Emirates has effectively utilised factors similar to those observed in France and Japan [16, 20, 21, 32].

#### 2.10.3 Comparison to France and Japan

This research focuses on examining and reflecting on regional activities, policies, and priorities while building upon the success factors identified by Sovacool and Valentine in their studies on successful nuclear states like France, China, India, Korea, and Japan. The Sovacool and Valentine success factors are crucial for establishing and operating a successful nuclear programme in the Emirates. In addition to these factors, the research incorporates additional factors related to the current national and regional situation, resulting in an operational framework based on the Sovacool and Valentine conceptual framework. [16, 20, 21, 32]

#### 2.10.4 Operational Framework for the Emirates

The operational framework developed in this research is a modern version tailored explicitly to the Emirates' civil nuclear programme. It contributes original insights to the conceptual framework of the UAE's nuclear development by considering the success factors observed in countries such as France, China, India, Korea, and Japan. This framework considers the unique conditions and requirements of the Emirates in

generating electricity with minimal gas emissions to protect the environment. [16, 20, 21, 32, 128]

The UAE actively complies with international conventions and adopts guidelines, best practices, and lessons learned from participating in international nuclear organisations like WANO and INPO. The research utilises the six factors identified by Sovacool and Valentine to understand and explore the decision-making processes of nuclear organisations and incorporate public views and opinions through governmental representation. It also examines the influence of social acceptance of nuclear energy development on these processes. [20, 128]

By assessing the socio-political economy challenges and conditions associated with the Emirates' nuclear energy programme, this research contributes to the existing literature. It enhances our understanding of decision-making processes, public acceptance, and nuclear governance. Data obtained from ENEC websites provide valuable insights into the implications of public acceptance of nuclear energy and the legitimacy of decision-making conducted by nuclear organisations. This research also has implications for nuclear governance, including implementing strategies to ensure compliance with national regulations and international requirements. [22, 26, 128]

This research provides valuable insights into the socio-political economy challenges and conditions related to developing a nuclear energy programme in the Emirates, contributing to the existing literature, and guiding decision-making, public acceptance, and effective nuclear governance.

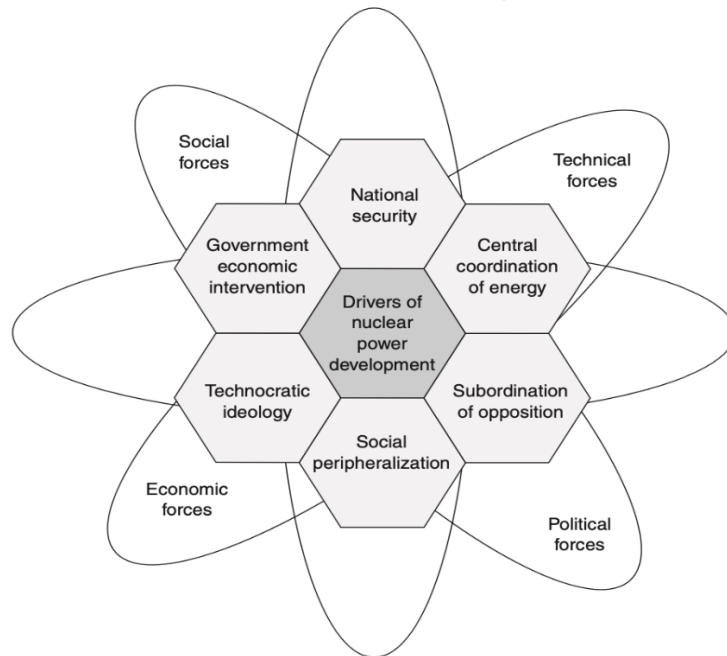
## **2.11 Established Conceptual Framework in Modern PEST Environment**

### **2.11.1 Drivers of Nuclear Power Programme Development**

Sovacool and Valentine's framework, when aligned with PEST influences, forms the "Nuclear Social-Political Economy Framework." This framework, derived from case studies in countries like the US, France, Russia, South Korea, Canada, China, and India, identifies six critical drivers for the development of nuclear power programmes [16, 20, 21, 32]. These drivers have historically been pivotal for the success of commercial nuclear power [146] (refer to **Figure 4**):

1. **Pro-Nuclear Society:** Societies with policymakers and politicians favouring nuclear power for enhancing national security.
2. **Technocratic Ideology:** Societies where policy discourse is influenced by a technocratic approach, prioritizing technological progress and modernization.
3. **Economic Intervention by Government:** Governments playing a significant role in the economic aspects of national development.
4. **Centralized Energy Policy Control:** Nations with central control over energy policy are more adept at implementing nuclear power programmes.
5. **Governmental Insulation from Criticism:** Governments that can shield themselves from challenges tend to support nuclear power development.
6. **Limited Public Involvement:** Societies with minimal public participation in energy policy decisions are more conducive to nuclear power development.

### Nuclear Social-Political Economy Framework



**Figure 4:** Showing Nuclear Social-Political Economy Framework [146]

#### 2.11.2 Influence of PEST Environment

The PEST environment, particularly influenced by climate change and the Fukushima disaster, has dramatically affected the nuclear industry [77, 144]. Climate change has emerged as a catalyst for nuclear power development in many countries as "nuclear renaissance.", leading to plans for adopting or enhancing nuclear programmes as part of climate change mitigation strategies [16, 20, 21, 32]. Conversely, the Fukushima disaster

has significantly impacted political and social support for nuclear power, questioning the industry's safety claims and technological advancements [86, 91, 146].

2.11.3 Evidence and Validation

While the eight case studies provide a strong basis for the framework (Figure 4.), they also indicate that the strength of these drivers can diminish over time, affecting the industry's growth. The case studies show that these drivers are essential for catalysing nuclear power development but can also weaken or evolve. This necessitates continuous examination of the socio-political and economic dynamics influencing nuclear power development in different national contexts [146]. Refer to (Table 1) for historical and current drivers for nuclear power development in the eight case studies. [16, 20, 21, 32]

**Nuclear Drivers**

		National security	Technocratic	Economy support	Stakeholders Coordination	Government support	Social support
US	past	Strong	Strong	Strong	Strong	Strong	Strong
	Now	Weaker	Weaker	Weaker	Weaker	Weaker	Weaker
France	Past	Strong	Strong	Strong	Strong	Strong	Strong
	Now	Weaker	Strong	Strong	Strong	Weaker	Weaker
JAPAN	Past	Strong	Strong	Strong	Strong	Strong	Strong
	Now	Weaker	Weaker	Weaker	Weaker	Weaker	Weaker
Soviet Union	Past	Strong	Strong	Strong	Strong	Strong	Strong
	Now	Weaker	Weaker	Weaker	Strong	Weaker	Weaker
South Korea	Past	Strong	Strong	Strong	Strong	Strong	Strong
	Now	Weaker	Strong	Strong	Strong	Weaker	Weaker
Canada	Past	Strong	Strong	Strong	Strong	Strong	Strong
	Now	Weaker	Weaker	Weaker	Weaker	Weaker	Weaker
China	Past	Strong	Strong	Strong	Strong	Strong	Strong
	Now	Weaker	Weaker	Weaker	Weaker	Weaker	Weaker
India	Past	Strong	Strong	Strong	Strong	Strong	Strong
	Now	Strong	Weaker	Strong	Strong	Weaker	Weaker

**Table 1:**Historical and current drivers for nuclear development in the eight case[146]



## **2.12 Nuclear Governance within Emirates' Conceptual Framework**

### **2.12.1 Concept of Nuclear Governance**

While 'Nuclear Governance' lacks a universally standardized definition, it generally pertains to compliance and adherence to international instruments and internal state arrangements [11, 44]. In the Emirates, nuclear governance initially focused on policy compliance and implementation. By combining academic perspectives with Emirates' arrangements, an appropriate definition is developed, informed by various studies on nuclear policy governance [16, 20-22, 32, 128].

#### ***Social Aspect***

Early public engagement is crucial in nuclear decision-making. In the Emirates, exploring the extent of public influence and incorporation of societal views in nuclear organisations is key [147]. Understanding this aspect is vital for sustaining public trust and support for nuclear development. [22, 128, 143]

#### ***Political Aspect***

Distinct from Western models, the Emirates' governance does not mandate formal public consultations for nuclear development. However, it maintains compliance with international standards through the Federal Authority for Nuclear Regulation (FANR) and its interaction with the IAEA [22, 26, 128].

#### ***Economic Aspect.***

The development and adoption of nuclear projects require substantial financial resources. [22, 128, 148]. The development and adoption of nuclear projects require substantial financial resources. Cost and time overruns, common in global nuclear projects, influence electricity pricing policies and necessitate a balance between economic benefits, energy security, and environmental considerations. [2, 22, 128]

#### ***Nuclear Culture***

The emphasis on safety in nuclear policy is evident in the UAE [82]. FANR, aligning with IAEA's safety standards, and ENEC's role in promoting nuclear technology as a safe energy source, are central to cultivating a strong nuclear safety culture. This focus has garnered significant public trust and support for the nuclear programme. [22, 128, 149]

These dedicated efforts have yielded remarkable public trust and support for the Emirates' nuclear programme. National polls have consistently indicated a growing favourability towards the Emirates Nuclear Energy Programme, with 85 per cent of respondents expressing support in 2018, up from 83 per cent in 2017. The polls also reveal that 78 per cent of Emiratis believe that the benefits of nuclear energy outweigh its risks. Additionally, an overwhelming 91 per cent of Emirate residents reported placing their trust in ENEC, with an astonishing 98 per cent of residents believing that ENEC always prioritises safety. [149]

### 2.12.2 Drivers for Nuclear Development in the UAE

The UAE government effectively utilizes all six drivers identified by Sovacool and Valentine [22, 128]:

- **Energy Security:** Strong emphasis on securing a stable energy supply.
- **Technocratic Ideology:** A focus on technological progress and modernisation.
- **Economic Interventionism:** State involvement in guiding economic development related to nuclear energy.
- **Central Planning:** Coordinated approach in energy policy and nuclear programme development.
- **Subordination to Authority:** Compliance with regulatory standards and international commitments.
- **Social Acceptance:** Building and maintaining public trust and support for nuclear development.

According to the literature review and the comparison with the UAE's drivers for nuclear power development, the UAE government effectively utilises all six drivers, as illustrated in **Table 2**. These strong drivers support the development of the UAE's nuclear programme.

**Drivers for nuclear power development**

UAE BNPP	Energy security	Technocratic ideology	Economic interventionism	Central planning	Subordination to authority	Social acceptance
status	Strong	Strong	Strong	Strong	Strong	Strong

**Table 2:** Current drivers for nuclear power development in the UAE. Source: The Author

### 2.12.3 Enhancing the Framework

To adapt to current challenges like climate change, the Nuclear Social-Political Economy Framework requires enhancements. Research into energy security, political, economic, social, and technological influences, and maintaining public support is crucial for evolving the framework. This approach will enable a comprehensive evaluation of the UAE's nuclear programme for sustainable development and operation. [146]

## 2.13 Meta-Theoretical Framework

### 2.13.1 Concept and Perspectives

The meta-theoretical framework for energy transitions acknowledges the multi-faceted influences on energy policy, such as economic development, technological innovation, and policy evolution. This framework considers global challenges like climate change and the dynamic interplay between different factors impacting energy transitions<sup>1</sup> [150]. Within this framework, three key perspectives are identified:

1. **Techno-economic Perspective:** Focuses on the relationship between technology and economics in energy systems.
2. **Socio-technical Perspective:** Examines the social and technical elements of energy transitions, influenced by sociology and evolutionary economics.
3. **Political Perspective:** Investigates the impact of political factors and institutions on shaping energy transitions.

These perspectives help to understand the complexities of energy transitions and their interconnectedness with economic, technological, and political dynamics[27]. On the other hand, the “socio-political economy” is defined as the dynamic forces of state and society which influence the nuclear power industry [16]. The socio-political economy conceptual framework plays a significant role in shaping the nuclear power industry and is interconnected with energy transitions, low-carbon transitions, and sociotechnical change [150].

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<sup>1</sup> “Britain is legally required to reduce its emissions of greenhouse gases by 12.5% by 2012 as part of the Kyoto Protocol. Britain is also subject to the 2008 Climate Act which mandates that Britain reduce its carbon emissions by 80% by 2050.”

### 2.13.2 National Energy Transitions

Energy transitions are understood as the co-evolution of three interconnected systems: energy flows and markets, energy technologies, and energy-related policies. However, the literature on this framework shows inconsistency in theories and methods, making comparative analysis challenging [27, 43]. The transitions involve a variety of scopes and methods, from historical accounts to citation analysis and problem structure deduction [27, 151].

### 2.13.3 Policy Change in Energy Transitions

Energy transitions encompass more than technological shifts; they represent a transformation of the entire energy system. While such transitions can contribute to clean, modern, low-carbon energy systems, their primary drivers are their scale and depth, not specific outcomes. These transitions involve significant policy changes and require comprehensive frameworks to effectively steer energy systems towards sustainability [22, 26, 128, 152].

National energy transitions are characterized by episodes that respond to domestic economies, laws, natural resources, and infrastructure. They involve changes in energy flows and markets, energy technologies, and energy-related policies. These transitions are influenced by international pressures, domestic political factors, and bureaucratic processes [22, 27, 128, 153].

### 2.13.4 Addressing Barriers to Energy Efficiency

The UAE State of Energy Report 2017 identifies barriers to energy and water efficiency, such as perceived high costs, market accessibility, and subsidies. To overcome these barriers, initiatives like developing science-based standards, establishing financing initiatives, reforming energy tariffs, and developing evidence-based policies are suggested [22, 42, 128].

### 2.13.5 Meta-Theoretical Framework Application

The Meta-Theoretical framework, as illustrated in Figure 5 and Table 3 by Sovacool [27], offers a holistic view of the factors influencing energy transitions, crucial for policymakers and stakeholders. It emphasizes the importance of considering the changing economic, technological, and policy-related aspects in the operational version of the conceptual framework. This approach aids in developing informed strategies to address climate change and energy transition challenges effectively.

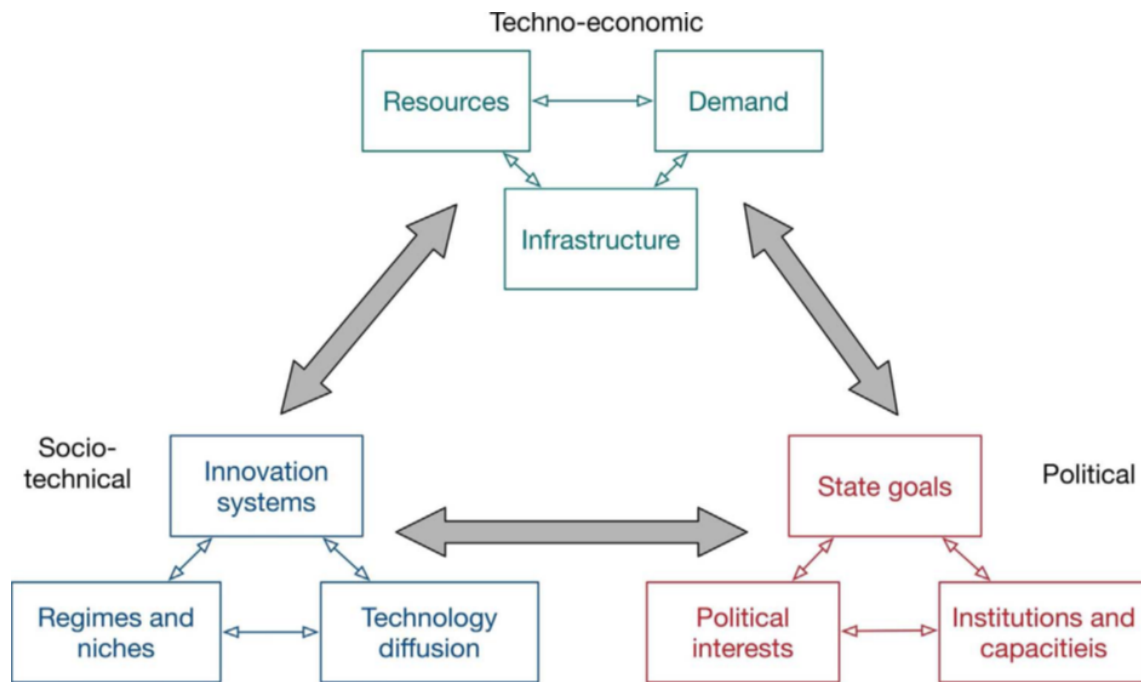


Figure 5: Top-level variables in a meta-theoretical framework[27].

Perspective	Disciplinary roots	Systemic focus	Examples of concepts and variables	Examples of theories	Examples of models and applications	Limitations
Techno-economic	Economic history, neoclassical, evolutionary, ecological economics; energy systems analysis	Energy flows and markets	Energy resources, energy services, energy demand, energy infrastructure, energy prices	Supply-demand balance, market equilibrium, demand convergence, energy ladder, peak resource	IAMS and long-term climate-energy scenarios	Poor representation of technology inertia, innovation, and policy change
Socio-technical	Sociology and history of technology, STS, evolutionary economics	Energy technologies embedded in socio-technical systems	Socio-technical regimes, niches, landscapes, innovation systems, core and periphery	Technological lock-in, learning, diffusion, MLP	Transition management, innovation policies	Excessive focus on novelty, strive for "seamless web"
Political	Political science, political economy, policy studies, international relations	Political actions and energy policies	National interests, policy paradigms, constitutional systems, special interests, voters' preferences, institutional capacities	Punctuated equilibrium, multiple streams, ACF, policy learning and diffusion	Design of international regimes and domestic policies	Poor representation of material factors

Table 3: Three perspectives on national energy transitions [27].

## **2.14 Mixed Methods Research**

In this section, please refer to sections 3.1 and 3.3 in Chapter 3, 'Methodology', for a comprehensive review of the mixed methods research approach adopted in this study.

## **2.15 Successful Nuclear Programme Conceptual Framework**

The successful implementation of a civil nuclear energy programme requires a comprehensive understanding of the critical elements and considerations involved. This section presents a refined conceptual framework that outlines these factors, drawing upon an extensive literature review encompassing global nuclear power programmes while considering the unique context of the United Arab Emirates (UAE). [22, 128]

By comprehensively addressing these key factors, policymakers and stakeholders can navigate the complexities of nuclear energy development, ensuring safety, security, and sustainability. The conceptual framework encompasses seven interconnected dimensions: policy and governance, socio-political factors, economic considerations, technological advancements, safety and security measures, international cooperation, and compliance, as well as environmental concerns. It provides a holistic perspective, emphasising the need for a comprehensive approach to achieving a successful civil nuclear energy programme. [22, 128]

This conceptual framework, derived from our Literature Review, outlines the necessary ingredients for a successful civil nuclear energy programme. Firstly, it stresses the importance of clear policy goals and objectives and a robust governance and regulatory structure that guarantees safety, security, and non-proliferation. Furthermore, it highlights the necessity of transparent decision-making processes and engaging the public effectively.

Secondly, socio-political factors play a significant role in garnering social acceptance and public trust through proactive engagement and effective dissemination of information. Also, a supportive political environment and the government's strong commitment to nuclear energy are integral to the process. Efficient communication and education campaigns are needed to address and allay public apprehensions.

Thirdly, it emphasises the need for sufficient financial resources and investments to support the development and operation of nuclear power plants. In addition, nuclear energy's cost-effectiveness and financial viability must be evaluated against alternative energy sources. Integrating nuclear energy into the broader energy market and grid system is also crucial.

Technological factors, forming the fourth dimension, involve access to cutting-edge and safe nuclear reactor technologies, a skilled workforce, and technological expertise for nuclear power plant operation and maintenance. It also accentuates the need for robust research and development capabilities for continuous improvement and innovation.

Safety and security, the fifth dimension, requires a strong culture of safety, adherence to international safety standards and regulations, and comprehensive security measures to prevent unauthorised access to nuclear facilities and materials. Emergency preparedness and response plans are also necessary to handle potential accidents or incidents.

The sixth dimension, international cooperation and compliance, involves partnerships with international organisations, such as the International Atomic Energy Agency (IAEA), for technical assistance and guidance. Compliance with non-proliferation obligations, international treaties, and adherence to global standards and best practices for nuclear energy development are also emphasised.

Finally, environmental considerations form the seventh dimension. It highlights the importance of integrating nuclear energy as a clean, low-carbon source to combat climate change. Appropriate waste management and disposal strategies for nuclear waste are vital, along with efforts to minimise environmental impacts throughout the lifecycle of the nuclear energy programme.

This conceptual framework provides an exhaustive overview of the critical factors contributing to successfully implementing a civil nuclear energy programme. A nation can establish a sustainable and successful civil nuclear energy programme by conscientiously addressing and balancing these seven dimensions—policy and governance, socio-political factors, economic considerations, technological factors, safety and security, international cooperation and compliance, and environmental concerns.

## **2.16 Critical Factors for Successful Implementation**

Chapter 2 provides a comprehensive literature review on critical factors for successfully implementing national nuclear energy programmes, specifically focusing on their relevance to the UAE's context. It examines these factors' evolving significance and applicability, considering local considerations such as specific energy needs and security. The chapter also recognises the importance of addressing time-related factors, including the increasing demand for low-carbon generation in the UAE.

Objective 1 is accomplished through the literature review in Section 2.1, which offers an overview of the necessary factors for developing a conceptual framework tailored to the Emirati nuclear energy programme. By synthesising existing knowledge and identifying key elements for consideration, the review lays the foundation for a customised conceptual framework that aligns with regional activities, policies, and priorities, while incorporating the success factors identified by Sovacool and Valentine [21].

The research adopts the Socio-Political Economy Conceptual Framework developed by Sovacool and Valentine to build this framework. This framework serves as a foundational tool for understanding the implementation of nuclear energy policy in the UAE. It compares the modern Emirates with the six catalysts identified for new-entrant nuclear powers. The research identifies six influential factors by analysing the sociocultural, political, and economic conditions prevalent during the establishment of nuclear power programmes in new-entrant countries.

Objective 2 is addressed in Section 2.2, which explores the socio-political-economic circumstances in the Emirates and applies the new conceptual framework to predict the potential success of commissioning and operating a nuclear power plant. This analysis aids in understanding the feasibility and viability of the programme within the Emirati context.

Objective 3 is further discussed in the subsequent chapters as the operational framework is developed based on the expanded success factors and considerations of the socio-political-economic circumstances. By comprehensively addressing regional dynamics, existing activities, policies, priorities, and the success factors identified in the literature, the operational framework



strongly emphasises social aspects, including public opinion and societal acceptance of nuclear energy.

Section 2.12 partially fulfils Objective 4, reviewing facts and criticisms about nuclear power generation and assessing public perception. However, further information will be provided in later chapters (4 and 5) to address Objective 4 fully. [18]

Objective 5 compares the expanded conceptual framework with implementing plans and operational activities in nuclear energy programmes. This analysis is conducted in Sections 2.3 and 2.5, enabling the identification of discrepancies, challenges, and lessons learned during implementation. By aligning the theoretical framework with real-world practices and addressing potential gaps, this process ensures that the operational framework is robust and adaptable to the specific context of the UAE's nuclear programme, contributing to its overall success.

The research recognises the significant challenge posed by the interaction between the nuclear industry's social, economic, and political factors. By assessing the importance of these factors and incorporating contemporary concerns such as carbon emissions reduction and safety, the proposed conceptual framework provides valuable insights into how these factors can shape the successful implementation of the UAE's nuclear energy programme. [21]

The UAE's Policy on Peaceful Nuclear Energy is crucial in implementing nuclear energy. The "Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy" articulates the UAE government's commitment to utilising nuclear energy for peaceful purposes, particularly electricity generation. Guided by principles of operational transparency, non-proliferation, safety, collaboration with the IAEA, partnership with responsible entities, and long-term sustainability, the policy defines the strategies and standards that the UAE government will follow as it continues to assess the potential use of nuclear energy to meet its growing energy demand [20]. Emphasising operational transparency, safety, and non-proliferation, the UAE aims to set a new standard and validate its peaceful intentions in exploring the application of civil nuclear energy in the country. [18]

This chapter emphasises the importance of efficient electricity generation through nuclear power programmes in nuclear revitalisation or renaissance. It discusses the need for technological

advancements, infrastructure upgrades, best practices, and robust legal frameworks. By prioritising efficient electricity generation and upholding stringent safety and environmental standards, the UAE aims to ensure the responsible use of nuclear energy. This information aligns with understanding the critical factors for successful implementation.

Chapter 2 establishes a robust foundation for subsequent analysis by providing a comprehensive overview of the UAE's nuclear energy programme. It covers various aspects such as the research scope, conceptual frameworks, ethical considerations, challenges faced by newcomers in the nuclear industry, the evolution of international and domestic nuclear regimes, the concept of a nuclear renaissance, and critical milestones in developing nuclear power infrastructure.

The chapter emphasises the necessity of developing a tailored conceptual framework that accounts for the unique socio-political-economic circumstances of the UAE. Synthesising relevant literature, addressing ethical considerations, and identifying critical success factors establish a solid basis for the research. Additionally, it highlights the UAE's policy on peaceful nuclear energy, focusing on transparency, safety, collaboration with international bodies, partnership with responsible entities, and long-term sustainability.

Moving forward, the next chapter will delve into the research methodology, providing a detailed explanation of the methods and approaches employed in the study. Subsequent analysis chapters will explore the research findings and insights, contributing to a comprehensive understanding of the critical factors for implementing national nuclear energy programmes in the UAE. These findings will further refine and enhance the operational framework, providing valuable insights and recommendations for the UAE's nuclear energy programme.

## **Chapter Three: Research Methodology**

### **3 Introduction**

This research was conducted in the United Arab Emirates (UAE), a pioneering nation in Middle Eastern nuclear energy development. The UAE's nuclear programme, a pioneer for regional nuclear initiatives, serves as an exemplary model for emerging nuclear projects in the Middle East. This study's focus on the UAE offers a unique opportunity to explore a nascent yet rapidly advancing nuclear program in a geopolitically stable context. [2, 3, 25, 32]

The methodology employed a comprehensive mixed-method approach [155], integrating both qualitative and quantitative techniques [55]. This multifaceted strategy was carefully chosen to ensure a thorough investigation of the UAE's nuclear program, focusing on identifying established and emerging success factors. The qualitative component involved conducting semi-structured interviews with professionals from organizations pivotal in shaping nuclear energy regulation and policy. This allowed for an in-depth exploration of internal procedural implementations, decision-making processes, and management actions. Additionally, the review of organizational documentation and external reports such as development plans and international analyses provided a platform for cross-verifying the data obtained from interviews. [55]

Reflecting the study's motivation outlined in Chapter 2, this research aims to unravel the intricacies of decision-making processes within nuclear organizations, particularly how these decisions align with public acceptance and contribute to the overall success of the UAE's nuclear program.

A distinctive feature of this research was the utilization of the author's professional networks and knowledge, enabling access to senior-level experts in the field. This access enriched the research with nuanced insights and expert opinions that would otherwise have been challenging to obtain. In parallel, the quantitative aspect of the study involved structured questionnaires designed to complement and enhance the qualitative findings. These questionnaires were dynamically adjusted based on preliminary data to ensure relevance and depth. Following the collection of survey responses, face-to-face interviews were conducted, allowing for a deeper exploration of policy issues and the integration of questionnaire findings into broader discussions.

A crucial element of the methodology was the triangulation of data sources. This process involved cross-referencing interview responses with questionnaire data, organizational documents, relevant literature, and inputs from professionals outside the nuclear industry in the UAE. Such a comprehensive approach was instrumental in validating the research findings and ensuring the accuracy of the conclusions drawn.

By leveraging a mix of data collection methods and engaging in rigorous data triangulation, this study offers a rich, multi-dimensional understanding of the factors that underpin the success of the UAE's nuclear program. The insights gleaned from this research are composed to contribute significantly to the development of an effective operational framework for the UAE's nuclear programme and provide a valuable reference for other countries embarking on similar nuclear ventures.

### **3.1 Research Design and Approach**

The methodological approach of this research is grounded in a comprehensive set of principles and procedures that form the backbone of our investigative strategy [156, 157]. This research utilises a mixed-methods approach, combining qualitative and quantitative data to offer a multi-faceted perspective on nuclear energy development in the UAE [156, 157]. This technique aligns with the established methodologies in fields such as foreign policy analysis and cross-national studies of best practices [155]. It echoes the approach used in examining Agile management adoption in Saudi Arabia's industrial sector, reflecting its adaptability and efficacy in varied contexts [158].

As explained by Louise Doyle [160], the mixed methods data collection approach is “an approach in which the researcher collects, analyses and interprets both quantitative and qualitative data, integrates the two approaches in various ways and frames the study within a specific design”. The methods for this research are the systematic tools used to find, collect, analyse and interpret the collected data [55]. Data collection is gathering and measuring information on variables of interest. It is done through interviews, surveys, and reviewing organisations' documentation [55] [161] [162, 163].

Verification was partially achieved by comparing interviewees' claims and questionnaire data with documented evidence from within organisations and in context. The paradigm definition is

the belief about the nature of knowledge, a methodology and criteria for validity [163]. Since the interviewees and documents are well placed within the nuclear industry to corroborate each other, triangulation is taken from the non-nuclear sector too. [160]

A critical starting point for establishing knowledge was the work of Sovacool and Valentine, and numerous commentaries followed it. Sovacool and Valentine showed that six 'Social-Political Economy' (SPE) factors were present when other states developed a civil nuclear power programme. These are collectively known as success factors. Sovacool and Valentine used the Comparative case study approach [16, 20, 21]. Comparative research aims to identify similarities and differences between social entities and refers to research comparing nation-states, societies, or cultures. The case study method investigates a contemporary phenomenon within its real-life context to explore causation. That is to find underlying principles for factors that catalyse nuclear power development. [16, 20, 21, 164, 165]

The disadvantage of Sovacool and Valentine's method to establish underlying causation is that analysing experiences in different countries takes time and effort. Also, they evaluated nuclear programmes that were initially developed back in the '50s & the '60s. There was weak consideration of current international requirements and circumstances, especially after Fukushima. They did not account for the current public perception of nuclear. They also did not evaluate countries that phased out their nuclear power programme. There was no strong emphasis on climate change's impact on their success factor development in 2010 [20] and validation in 2014 [21]. Their production of 6 critical success factors did not consider the modern development upheaval of SPE significant. But they did provide the seminal work in the area that accounted for the success in the 50s and 60s.

In this research, the impact of climate change as an external factor has been focused on. The processes by which nuclear organisations conduct decision-making and consider the views and opinions of civil society have been explored. This is also very different from developments in the 50s and 60s; in as much as modern communication systems, the opportunity to educate and persuade public opinion has significantly evolved. The traditional background of the state is also different from the nuclear civil powers of the 20<sup>th</sup> century, but what has stayed the same is the relative economic power of the state evolving its civil nuclear programme. The degree to which

social acceptance of, and government commitment to, nuclear energy, influence these processes has been investigated in the UAE. The original six critical success factors are also checked to ensure they remain essential in developing civil nuclear power in the UAE.

### 3.1.1 Justifications for the Research Approach Chosen

The research approach chosen for this study is a mixed-methods approach, which combines qualitative and quantitative data collection and analysis. This approach is justified for the following reasons:

1. **Comprehensive Understanding:** A mixed-methods approach allows for a complete and holistic understanding of the research topic by incorporating qualitative interviews and quantitative data collection. This combination enables a more robust exploration of the factors influencing the success of the UAE's nuclear programme.
2. **Literature Review:** A literature review, including organisational documents, policies, and articles, adds rigour to the research by providing valuable information to corroborate interview findings and gain a deeper understanding of the programme's implementation, regulatory compliance, and strategic planning. This approach ensures the inclusion of official and documented perspectives.
3. **Quantitative Data Collection:** Including quantitative data collection, such as structured questionnaires, is justified as it provides numerical data that can be statistically analysed. This allows for identifying trends, patterns, and statistical relationships within the data, complementing the qualitative findings and providing a more comprehensive understanding of the research topic.
4. **Qualitative Interviews:** Conducting face-to-face interviews with key personnel and stakeholders involved in the UAE's nuclear programme is justified as it enables in-depth exploration of their perspectives, experiences, and insights. These interviews provide rich qualitative data that captures nuances, contextual information, and subjective viewpoints, enhancing the overall understanding of the research topic.
5. **Explanatory Sequential Design:** Including an Explanatory Sequential Design is justified as it follows a sequential process, where qualitative data collection and analysis are conducted first, followed by quantitative data collection and analysis. This design allows for the initial

exploration of qualitative data to inform the development of quantitative measures, providing deeper insights into the research topic.

6. **Triangulation:** The use of triangulation, comparing interview responses with questionnaire data, organisational documents, literature, and perspectives from individuals outside the nuclear industry, enhances the validity and reliability of the findings. Triangulation helps identify consistencies, discrepancies, and convergence of evidence from different sources, strengthening the overall research conclusions.

Note: refer to Methodology workflow at Appendix.

### **Examples Used:**

The following examples are used to support the justification of the research approach chosen:

1. **Comparative Case Studies:** Sovacool and Valentine's work on success factors in nuclear power development is a foundation for this research, demonstrating the relevance of comparative case studies in identifying underlying principles and success factors in nuclear programmes.
2. **Agile Management Adoption:** Research on adopting Agile management in Saudi's industrial sector illustrates the effectiveness of a mixed-methods design, combining semi-structured interviews and questionnaires to gather quantitative and qualitative data for analysis.
3. **Hydro-Power Resource Utilization in Pakistan:** Research on hydro-power resource utilisation in Pakistan uses a mixed-methods approach, combining qualitative interviews with stakeholders and quantitative analysis of energy production data to assess success factors and challenges.
4. **Exploration of Public Perceptions of Nuclear Energy in Thailand and Vietnam:** Research exploring public perceptions of nuclear energy in different cultural contexts highlights using a mixed-methods approach, incorporating surveys and in-depth interviews, to gain insights into general attitudes.

### **Why Expecting the Approaches to Work:**

The chosen research approaches are expected to work based on the following reasons:

1. **Comprehensive Understanding:** The combination of qualitative and quantitative data collection methods is expected to provide a comprehensive understanding of the factors

influencing the success of the UAE's nuclear programme. By incorporating multiple data sources and methods, the research aims to explore various perspectives and dimensions, leading to a more robust operational framework.

2. **Validation & Triangulation:** Triangulation and comparison of data from different sources aim to validate and corroborate findings, enhancing the credibility and reliability of the research outcomes by identifying consistencies and discrepancies in the data. Triangulation helps to strengthen the overall research conclusions.
3. **In-Depth Insights:** Using qualitative interviews and document reviews is expected to yield in-depth insights and nuanced perspectives from key stakeholders. These methods enable a deeper understanding of decision-making processes, public acceptance, and policy considerations in the nuclear programme, providing valuable insights into the research topic.

**Risks and Mitigation Strategies:**

The following risks may be associated with the chosen research approaches, along with mitigation strategies:

1. **Time-Consuming Process:** Conducting interviews, reviewing documents, and analysing data can be time-consuming. To mitigate this risk, careful planning, setting realistic timelines, and employing efficient data management techniques can help streamline the research process and ensure timely completion.
2. **Limited Accessibility:** Gaining access to organisations and individuals involved in the nuclear programme may pose challenges. To mitigate this risk, building rapport, establishing professional networks, and leveraging the researcher's professional status and knowledge can facilitate access and cooperation.
3. **Bias and Subjectivity:** The qualitative nature of the research methods may introduce bias and subjectivity. To mitigate this risk, employing rigorous data analysis techniques, involving multiple resources for data coding and analysis, maintaining an audit trail of decision-making processes, and engaging in critical reflexivity can help minimise biases and enhance the validity of findings.
4. **Reliance on Self-Reporting:** The research relies on self-reporting through interviews and questionnaires, which may be influenced by social desirability bias or selective memory. To



mitigate this risk, ensuring confidentiality and anonymity, designing structured questionnaires, cross-verifying information through document reviews, and triangulating data from multiple sources can enhance the reliability of the data.

5. Impact of COVID-19: The ongoing COVID-19 pandemic may pose challenges in terms of limited access to in-person interviews, restricted movement, and potential disruptions in data collection. Alternative methods, such as virtual interviews, online surveys, and remote access to documents and resources, can mitigate this risk. Flexibility in research plans, adapting to changing circumstances, and adhering to safety guidelines and regulations will be crucial in mitigating the impact of COVID-19 on the research process.

By considering these justifications, examples, expectations, and risks, the chosen research approaches can be effectively executed, and potential challenges, including the impact of COVID-19, can be addressed to ensure the validity and reliability of the research outcomes.

### 3.1.2 Explanatory Sequential Design

The explanatory sequential design has been used, and, it started with a quantitative data collection phase (prepared by a trial study) followed by an extensive qualitative phase. The aim of this is to follow up and explain the qualitative results. Data collection and analysis usually occurred sequentially—the impact of the quantitative phase fed into the development of the qualitative phase. The qualitative step is dominant. The following Table 4 used for this research illustrated.

The advantage of this design is that it is relatively straightforward, with distinct sequential phases of data collection, making it possible for a lone researcher to complete this approach used by [166] to define strengths and weaknesses in nuclear development. The challenges are that the first phase must come to start the second phase [167]. Another challenge is the time-consuming process, which is mitigated to some extent by the researcher due to his arrangement and agreement with the nuclear organisation. [168]

The following **Table 4** shows the sequential design in a pictorial arrangement of action taken:

Phase 1	Phase 2	Phase 3	Phase 4
Quantitative data collection (and state of the art review). <sup>2</sup>	Collecting documentation (part of qualitative phase) <sup>3</sup>	face-to-face interview (part of qualitative phase)	Triangulation and Interpretation for Framework development <sup>4</sup>
To get an early indication of cultural support for the interview. Identify the strength of opinion on the influence of climate change and new energy policy on the nuclear programme and establish current knowledge, iterative design to questionnaires and pilot study, then survey. Analysis of results from the quantitative survey. Checking the result of Quantitative to add and adjust the interview topics.	<ul style="list-style-type: none"> <li>i. public opinion.</li> <li>ii. Protecting the public.</li> <li>iii. Taking advantage of 6 known and suggested additional catalysts.</li> </ul>	<p>Understand their practices and defined the gap. (e.g., Gap between documents claim and actual practice).</p> <p>This relation to developing SPE circumstances (e.g., Energy policy)</p>	To ensure the claims are reasonable in context of wider opinion; hence to triangulate the industry with external view (e.g., Newspaper, local authority, etc.); ensure robust evidence; Fulfilling the objectives.

**Table 4:** Phases. Source: The Author

<sup>2</sup> Phase one includes an iterative approach to use of literature review to identify the state of the art in new entrant development for the UAE and piloting questions, discussion with supervisor etc....

<sup>3</sup> This is documentation available to the author which includes that available through identify contacts.

<sup>4</sup> This also include documentation made available to the author as a result of interviews.

### 3.1.3 Quantitative Research Design

The research design for data gathering and analysis followed a specific order, including the following components:

#### *Pilot Study*

A pilot study technique allowed the questionnaire to be iteratively designed and empowered using personnel from ENEC, as recommended [169]. This pilot study aims to ensure the research method's effectiveness during data gathering by checking participants' understanding and adapting the research design methodology and question phrasing. The pilot study was conducted with experienced staff in the nuclear field.

This allowed the research method to be very effective during data gathering. This is due to checking research participants' thinking and understanding to adapt the research design methodology [170] and phrasing of questions. It helped to identify barriers to success encountered in the programme's last ten years and to reveal historical and current issues affecting the success of implementing nuclear energy policy in the UAE. The data from the pilot study were analysed to finalise the questionnaire and interview topics. This enabled the criteria for success, gaps, and weaknesses in implementation to be identified and questions generated to explore. These findings also compared Sovacool and Valentine's CF to the Emirates' nuclear development programme. This also informed the CF of the unique context of the Emirates to facilitate this study. This clarified the government process and how to utilise the conditions of factors to achieve an economic development plan.

#### *Participants*

The eventual participants were drawn from organisations within or related to the nuclear industry. The 'nuclear organisations' can be classified as regulators, owners and operators, and specialised service providers. The selected interviewees are decision-makers, experts, and management-level personnel of these classes' main and representative bodies, regulatory agencies, and organisations in the Emirates' nuclear industry. These organisations have a clear scope in terms of nuclear development and implementation. The 'major stakeholders' are varied regarding involvement and scope of work. The 'other stakeholders' are the organisation who are adequately experienced by nuclear programmes or have personnel who used to work within nuclear industries. There

were relevant official approvals from each organisation/entity towards empowering and facilitating the study. The organisations recruited to support this project are in **Table 6**.

### ***Sample Size***

The sample size for this research included fifty individuals representing thirty organisations across all three classes (regulators, owners and operators, and specialised service providers). The questionnaire was distributed to all selected organisations, and the responses were collected from the participants. Additionally, interviews were conducted with a sufficient number of nominated participants from the selected organisations, including representatives from the nuclear industry's private and public sectors. The responses were compared with 'other stakeholders' who are effective in the process of nuclear programme implementation, such as the Ministry of Defence. Notably, this sample size compares favourably with the reference study on "Factors affecting Agile adoption," which had a sample size of 16 participants [158].

### ***Quantitative Data Collection***

The primary data collection phase commenced after analysing the pilot study results, questionnaires, and interview topics. The researcher utilised a questionnaire tool (MS FORMS) to collect data that aligns with the research questions from 'nuclear organisations', 'major stakeholders' and 'other stakeholders'. This helped to gather more about the research topic. The questionnaire was identified and subjected to the ethical approval process to ensure compliance with ethical guidelines. The structured questionnaires were distributed to the interviewees, who filled out the form containing concise and research-related questions. This process was conducted before the face-to-face discussions to gain insights into their perspectives.

### ***Questionnaires Design***

The questionnaire was designed with eight sections, each focused on specific aspects of the research topic. Here is a breakdown of each section:

#### **Section 1: Personal Details and Assessment**

This consisted of seven questions to collect personal details and assess the respondents, including which respondent organisation they belong to. Respondents were required to select from a list of options in the questions. The section required respondents to choose

from a list of options; the focus of their organisation, its stakeholders, the respondent's job responsibility, nationality, and age.

**Section 2: Strong State Involvement in Guiding Economic Development**

Four questions in this section focused on issues related to the UAE government's contributions and its involvement in guiding economic development; the drivers of those contributions that respondent organisations have made; and a question regarding specifically what contribution each department within a respondent organisation has made towards the implementation of the Nuclear energy policy. Additional questions explored important characteristics in developing the Barakah Nuclear power programme, contributions to feasibility studies, and decisions to support the government's economic development plan associated with the Barakah Nuclear plant.

**Section 3: Centralisation of National energy planning, development, and implementation**

This section included six questions concerning implementation methods to ensure compliance with national regulations and international commitments. Additionally, within the section, questions were asked about how organisations contribute to the development of the national economy by supporting nuclear energy as a primary energy source, particularly in the context of centralised national energy planning.

**Section 4: Campaigns to Link Technological Progress to National Revitalisation**

Respondents were asked questions related to known challenges in achieving organisational objectives, how these challenges were overcome, how campaigns were created to link technological progress to national revitalisation, and how organisations monitor and analyse the public acceptance of nuclear energy.

**Section 5: Influence of Technocratic Ideology on policy decisions**

Respondents were asked about a technocratic ideology's influence on policy decisions. This is important because only some countries have successfully introduced civil nuclear power in the modern context. Previous success was generally in the mid to late 20<sup>th</sup> Century. In contrast, UAE is attempting to raise new civil nuclear power when concern and interest have heightened concerning both advances in technology and climate change, as well as their future impact on UAE stability; and this is at a time when UAE has had to respond to the covid pandemic and plan for the next COP28.

**Section 6:** Subordination of Challenges to political authority

This section examined challenges related to subordination to political authority and how such challenges can be mitigated internally within organisations.

**Section 7:** Low levels of civic activism were influential factors in supporting the nuclear programme.

Questions in this section focused on the low level of civic activism affecting the introduction of civil nuclear power. Respondents were asked about the presence of recognisable civic activism in the UAE, how the government deals with it (both pro and anti-programme), and how social acceptance is maintained within the context of nuclear energy development. Civic activism can be a force to be harnessed, but the target of this section is to consider civic activism as a possible problem for new nuclear programmes.

**Section 8:** Promoting Environmental Protection and Public Health for Current and Future Generations

This final section addressed concerns about promoting environmental protection and public health for current and future generations. Questions were generated based on current/recent circumstances within the UAE, testing the perceived impact of these concerns on introducing nuclear power. It also considered the development of UAE society, including economics, living standards, and technological development.

The questionnaire aimed to gather comprehensive data on various aspects of implementing nuclear energy in the UAE, covering individual and organisational perspectives.

***Questionnaires Interaction***

Participants who work with an organisation directly and indirectly linked to the energy sector in the UAE, particularly the Nuclear and renewable industry, were invited as part of the sample size. Additionally, they were selected based on their roles and contributions at high-level Cabinet positions, Management, Technical contributions, and operations within their sector and organisations. They can be split into three types of organisations based on their roles concerning the programme. That's 'nuclear organisations, 'major stakeholders' and 'other stakeholders.

The MS Form survey link was communicated to each organisation's focal point to facilitate the questionnaire interaction. Within the organisation, the association was shared with individuals who were able to respond to the survey questions. The survey link was also sent to individuals who provided their responses anonymously.

This approach ensured that participants from various levels and sectors within the nuclear and renewable industry had the opportunity to participate in the study, providing a comprehensive perspective on the research topic.

### ***Questionnaire Instrument***

The questionnaire used in this study was designed to gather relevant data by directing respondents to provide information aligned with the research objectives. A structured set of questions was employed to ensure efficiency, minimise bias, and facilitate data analysis. The development of the questionnaire was informed by the literature review, discussion with the research supervisor and other pertinent materials, which allowed for the evaluation of critical constructs in the study.

The questionnaire encompassed various areas related to nuclear energy development in the UAE. It explored the UAE's vision for nuclear energy, the complex interdependencies at regional and international levels, geopolitical considerations, and social, political, and economic factors associated with nuclear energy development. Specific topics included the centralisation of planning, media campaigns, the influence of technocratic ideology, and the levels of civil activism and social acceptance of civil nuclear power.

Using a structured questionnaire, the study aimed to save respondents and researchers time and effort while maintaining the data's integrity. The results from the questionnaire also provided insights and guidance for conducting personal interviews, ensuring a comprehensive understanding of the research topic.

The questionnaire instrument played a crucial role in collecting data from respondents, enabling the analysis and interpretation of survey results. The findings derived from the questionnaire and subsequent interviews form the basis for the analysis and discussion presented in the following sections of this chapter.

## **3.2 Questionnaire Design**

### **3.2.1 Questionnaire Structure**

The questionnaire was structured into eight sections, each addressing specific aspects of the research topic. The sections and their corresponding content were as follows:

Personal Details (section 1): This section comprised seven questions aimed at collecting personal details and assessing respondents' variety and credibility, including which respondent organisation each belonged to. Respondents were required to select from a list of options to indicate their responses. For example, the respondents chose from a list of options to reveal the focus of their organisation, its stakeholders, the respondent's job responsibility, nationality, and age.

State Involvement in Guiding Economic Development (section 2): This section consisted of four questions asked on issues relating to the UAE government's contribution to the development of civil nuclear power, its involvement in guiding economic development, the drivers of that respondent organisation's contribution and a question regarding specifically what contribution each department within a respondent organisation has made towards the implementation of the Nuclear energy policy. Additional relevant questions were raised on important characteristics in developing the Barakah Nuclear power programme, contributions to feasibility studies, and decisions made towards aiding the government to achieve the economic development plan associated with the Barakah Nuclear plant.

Centralisation of National Energy Planning (section 3): This section included six questions on implementation methods to ensure compliance with national regulations and international commitments. Additionally, within the section, questions about how organisations contribute to developing the national economy (by supporting Nuclear energy as a primary energy source) were asked as centralisation of national energy planning.

Campaigns to link Technological Progress to National Revitalisation (section 4): respondents were asked questions relating to known challenges: how these challenges were overcome, how campaigns were created to link technological progress to national



revitalisation, and how organisations monitor and analyse nuclear energy acceptance by the public.

Influence of Technocratic Ideology (section 5): respondents were asked about technocratic ideology's impact on policy decisions. This is important because few countries have successfully introduced civil nuclear power in the modern context. Previous success was generally in the mid to late 20<sup>th</sup> Century. In contrast, UAE is attempting to introduce new civil nuclear power when concern and interest have heightened concerning both advances in technology and climate change, as well as their future impact on UAE stability; and this, at a time when UAE has had to respond to the covid pandemic and plan for the next COP, which is COP 28.

Subordination of Challenges to Political Authority (section 6): questions were focused on challenges related to the subordination of nuclear energy development to political authority. Respondents were asked about the nature of these challenges and how they can be mitigated internally within organisations.

Low Levels of Civic Activism (section 7): questions related to the low level of civic activism affecting the introduction of civil nuclear power. Respondents were asked if there is a recognisable form of civic activism in the UAE, including how social acceptance is maintained within the context of nuclear energy development. Civic activism can be a force to be harnessed, but the target of this section is to consider civic activism as a possible problem for new nuclear programmes.

State contribution to lower global warming initiative (section 8): The final section addressed questions about promoting environmental protection and public health for current and future generations. It explored the measures and considerations organisations took to ensure the safety and well-being of the environment and the public.

The questionnaire structure enabled the collection of comprehensive data on various dimensions of nuclear energy development in the UAE. The responses obtained from the questionnaire were further analysed and discussed concerning the research objectives and the existing literature.

### ***Scaling of Measurement***

The measurement scale used in the questionnaire varied depending on the section. In section 1, respondents were provided with a simple options list and were required to select the option that applied to them. In sections 2-8, questions have an options list or a five-point Likert scale for respondents to answer. For data interpretation, the descriptive phrases for the primary side of the five-point scale are (1) “Strongly agree”, (2) “Agree”, (3) “Neutral”, and (4) “Disagree”, and (5) “Strongly disagree”.

### ***Questionnaire- Pre-Testing***

Before the questionnaire was officially distributed, it underwent a pre-testing phase to ensure its effectiveness. The pre-testing was conducted in two stages. Firstly, the supervisor reviewed the questionnaire to validate its content. Secondly, a group of selected UAE nationals, academics, and nuclear professionals participated in the pre-testing process—the pre-testing aimed to gather input on the questionnaire's comprehension, language, and design.

The pre-test was designed with the following objectives:

- i. Validating the questionnaire's content: The participants in the pre-testing phase assessed the relevance and appropriateness of the questionnaire's content. They provided feedback on the clarity of the questions and the extent to which they addressed the research objectives.
- ii. Checking for completeness, syntax errors, and general layout: The pre-test allowed for the identification of any missing or incomplete questions and syntax errors or formatting issues. This ensured that the questionnaire was comprehensive and well-structured.
- iii. Ensuring correct comprehension and interpretation of questions by survey completers: The participants' feedback during pre-testing helped to identify potential issues related to comprehension and interpretation of the questionnaire. It allowed for revisions to enhance clarity and ensure respondents would understand and answer the questions accurately.

Overall, the pre-testing phase was crucial in refining the questionnaire and ensuring its validity and effectiveness in gathering the required data. The process was developed in

compliance with the University of Central Lancashire's ethics committee requirements to uphold ethical standards in research.

#### ***Screening and Checking Data***

Data was carefully reviewed and analysed for errors before entering the system to ensure data integrity and accuracy. This step was crucial to prevent potential issues affecting the analysis.

The questionnaire was created using Microsoft Forms, and the data and the interview transcript were entered into NVivo. Microsoft Forms provided automatic questionnaire rendering and data rendering functions, enabling the researcher to obtain high-quality chart visualisations for data analysis. [171]

#### ***Identification and Selection of Participants***

Participants were invited to represent an organisation directly and indirectly linked to the energy sector in the UAE, particularly the Nuclear and renewable industry. Additionally, they were selected based on their roles and contributions in Cabinet positions, Senior Management, Technical contributions, and operations management within their sector and organisations. They can be split into three types of organisations based on their roles concerning the programme. However, when progressing to follow-up interviews, the degree of insight sought meant that only a few people could provide it. Most were in very senior roles within the same or related organisations. This led to some careful anonymising of comments being necessary and the use of software to identify trends and patterns without compromising the interviewees.

#### **3.2.2 Generation of Survey Questions**

Questions for the survey were generated by reference to known situations (i.e., literature review).

The following are some examples of questions in the questionnaire to illustrate the style used. The complete questionnaire is in Chapter 4.

**Sample Questions**

Which of the following is the most important driver(s) of the contribution that your department (within the organisation) has made to the implementation of the Nuclear Policy by your organisation?

You can select more than one option

- Reduce gas emission and focus on environment (Climate Change).
  - Securing power resources and meet power demand increase.
  - Improving businesses opportunities and provide jobs.
  - Focusing on safety, security, safeguards and other related international treaties.
  - Evaluating public input and considering their opinion.
  - Regulatory services.
  -
- Other

*Extract 1: Showing sample questions from the questionnaire Source: The Author.*

To what extent do you agree with the following statements about the UAE government strong contributions and involvement:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
In guiding economic development.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
In guiding the energy planning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
In guiding the expansion of nuclear energy.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The development of nuclear industry under an independent regulator	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

*Extract 2: Showing sample questions from the questionnaire Source: The Author.*

To what extent do you think the following characteristics were important in developing the Barakah Nuclear Power Program?

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Clean energy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Economical Competitive advantage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alternative energy resource	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Job opportunity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
International recognition	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

*Extract 3: Showing sample questions from the questionnaire Source: The Author.*

### 3.2.3 Participants and Sample Selection

The research focused on the energy sector in the UAE, with a specific emphasis on the nuclear industry. Due to practical constraints, it was not feasible to include every stakeholder organisation in the industry as participants in the study. Factors such as the reluctance of organisations to participate, time limitations, and resource constraints made it impractical to invite every organisation.

To address this, purposive selective sampling was employed to select and construct the research sample of respondents and interviewees. Purposive selective sampling is a non-probability sampling method where researchers intentionally choose individuals or groups based on specific criteria to participate in surveys or interviews. In this case, the selection was based on individuals from the UAE's energy sector, government organisations, and related industries, focusing on the nuclear sector [172].

The goal of purposive selective sampling was to ensure that participants had relevant knowledge, expertise, and experience in nuclear energy and policy, allowing for in-depth

insights and meaningful contributions to the research. The research aimed to gather valuable data and perspectives from key stakeholders in the UAE's energy sector by selecting participants directly involved in the industry.

### **3.3 Qualitative Research Design**

#### **3.3.1 Qualitative Method**

The qualitative method has been used to answer some research questions by conducting a face-to-face interview to discuss related topics from ‘nuclear organisations, ‘major stakeholders’ and ‘other stakeholders’. Before the face-to-face interview, a review was conducted on organisational policies and documents related to nuclear compliance, supporting documents for nuclear policy implementation and plans for Emirates’ 2050-Strategy [41]. That was done to understand how the government utilises the available supportive factors. Due to their accuracy, the most valuable documents are executive reports and the audit report on policy in the organisation’s compliance. The structured questionnaire responses were also reviewed to amend or supplement the interview topics. The interviews were recorded after obtaining acceptance from the interviewees.

#### ***Interview Design***

A semi-structured interview approach was employed. In the Interview, the questions related to (i) nuclear policy and the scope of each respondent organisation’s activity about “Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy”, (ii) government planning apparent in the UAE Vision 2021 & Energy Strategy 2050; and (iii) how organisations stay in line with the government’s planning and direction. Additional interview questions included how respondent organisations coordinate & cooperate with their stakeholders to ensure efficient implementation of their role.

Other questions include the methods used for overcoming regulatory challenges, how the UAE organisations benefit from international organisations and questions targeted at public support issues, how the organisation achieved and maintained social acceptance of nuclear energy development. Lastly, questions on success factors were asked based on the interaction between social, economic, and political factors (as significant challenges/strengths when facing the well-experienced and newcomer states to the nuclear industry). Covid protocol was mandatory and applied during the face-to-face interview. It

is also considered during access to different organisations. However, the fact that the interviews were held during the pandemic seems not to have affected the results.

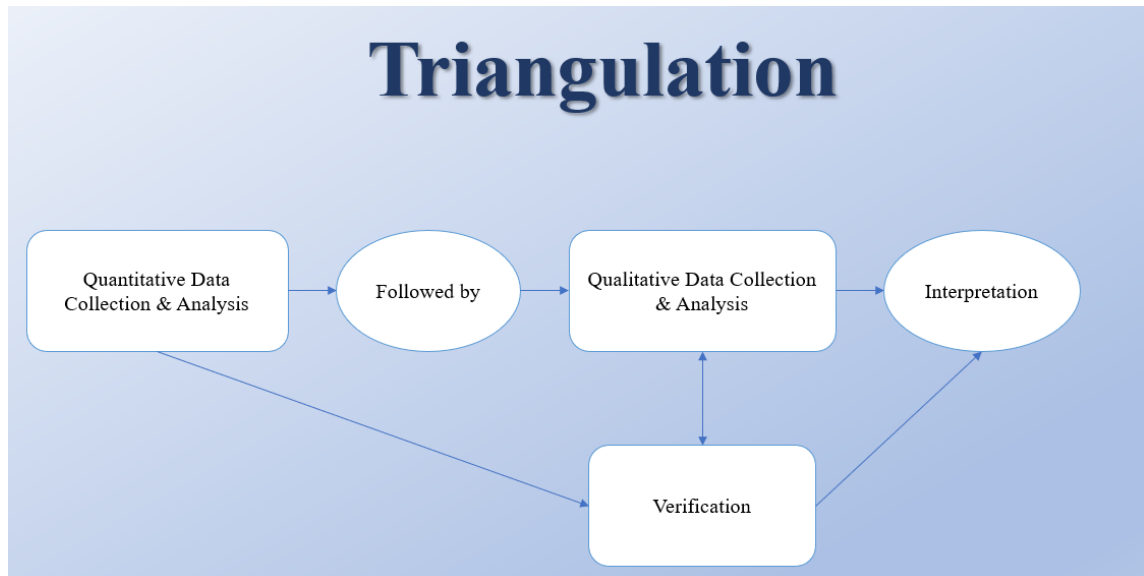
#### ***Interview Interaction***

Participants were selected based on their specialist knowledge and position within their organisations. In other words, only a semi-structured interview technique with very few people of a similar ilk could elicit the insight and experience necessary for the study. The same is true of the questionnaire, where only a small number of organisations (and only a limited selection of their employees) could respond with answers based on the authentic and sufficient experience and knowledge sought. However, it is the interviews where greater freedom was afforded the interviewees to ramble into contextual and related matters to draw out expert, first-hand knowledge. This gives more freedom to comment on topics such as centralisation of national energy planning, development and implementation, campaigns on national revitalisation, the influence of technocratic ideology on policy decisions, subordination of challenges to political authority, low levels of civic activism as influential factors in supporting nuclear programme, promoting environmental protection and public health for current and future generations.

#### ***Verification***

After the Face-to-Face interview with the ‘nuclear organisation’ and ‘major stakeholders’, ‘other stakeholders’ were interviewed, including the local municipality near the BNPP site, to verify the interview result. The ‘other stakeholders’ represent the people and organisations who can be used to check that claims are accurate. For the few cases where the verification outcome is not in line with face-to-face interviews, clarification was requested from the nuclear organisation interviewee. The method is called triangulation. Methodological triangulation involves multiple methods to gain diverse perspectives on the studied topic. It can be applied within a single method by incorporating numerous viewpoints or between different methods by employing various research approaches [173]. By combining different data types, such as interviews and observations, methodological triangulation enhances the depth and quality of research by providing a broader understanding of the phenomenon under investigation [173]. Triangulation between different methods in a mixed methods study helps strengthen the conclusions drawn and adds rigour and depth to the research [160], as shown in **Figure 6**. The

triangulation approach has been used to investigate policy solutions for fuel poverty and energy vulnerability by Kimberley O'Sullivan and Philippa Howden-Chapman [160].



*Figure 6: Triangulation [167]. Source: The Author*

### ***Data Analysis***

The main aim of data collection and analysing is to find common challenges, ways to overcome these challenges and success factors. A computer-aided qualitative data analysis tool (NVivo) has been used and imported into spreadsheets analysis software to analyse collected data and interpret the evidence. The adoption of mathematical analysis software follows a similar successful use of mathematical analysis software to analyse the barriers to hydro-power resource utilisation in Pakistan by [161] and, in the exploration of public perceptions of benefits and risks, trust, and acceptance of nuclear energy in Thailand and Vietnam [162]. The data was analysed using thematic analysis of the interview data; this was achieved by transcribing the interview data and grouping the participant responses to each question. The themes have been identified within the data to make sense of the data and extract supporting evidence to see the connections between themes and analytical insights. Additionally, comparisons between participants' responses that align with the outcomes of the overall research design have been made. That helped to fulfil research objectives and deliver the aim of the research.



### 3.3.2 Questionnaire Analysis

NVivo and Microsoft Forms were used to analyse the collected data, which provides a data analysis feature on the backend that feeds information immediately. The researcher created sophisticated, high-end visual representations in the form of tables and charts [171].

#### *Interview Analysis*

The UK Data Archive's instructions and suggestions for transcription conventions to transcribe and create data from the Interview session's audio recording and format them have been used [174]. The audio data were transcribed and encoded by computer-assisted qualitative data analysis software (CAQDAS), and recurring themes and patterns were discovered.

In NVIVO, the most critical phases in qualitative data analysis are extraction, labelling, and classifying as coding. These processes enable to structure of the content of the transcribed data and identify patterns that would otherwise be invisible or undetectable if the text or audio were read or listened to. For interpretation, the data was coded, categorised, and tagged.

NVIVO was used to classify the interview data. Furthermore, NVIVO aided in the identification of relevant patterns within the data [175]. Where questionnaire data were insufficient, the researcher consulted the interview data [176].

## **3.4 Questions Focus**

The interviews focused on various aspects related to nuclear policy and the scope of activities of each respondent organisation. The questions addressed the "Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy" [2] and how it aligns with government planning as outlined in the "UAE Vision 2021" and "Energy Strategy 2050" documents. The interviews also explored how organisations coordinate and cooperate with stakeholders to ensure the efficient implementation of their roles. Regulatory challenges, the benefits derived from international organisations, and achieving and maintaining social acceptance of nuclear energy development were also key topics of discussion (refer to section 2.8).

Furthermore, the interviews aimed to identify success factors based on the interaction between social, economic, and political factors that pose significant challenges and strengths for both experienced and newcomer states in the nuclear industry. The semi-structured nature of the interviews allowed for flexibility, encouraging interviewees to elaborate and discuss points with the researcher, thereby enabling fresh insights and considerations on various topics to emerge. The interviews also explored how respondent organisations coordinate and cooperate with stakeholders, *methodologies* used to overcome regulatory challenges, benefits derived from international organisations, and strategies for achieving and maintaining social acceptance of nuclear energy development.

To provide transparency and context, the specific interview questions that formed the main structure of the discussions can be found in Table 5: interview questions, reproduced here for the reader's reference. The semi-structured approach aimed to facilitate in-depth exploration and allow for the emergence of valuable insights during the interviews.

### 3.5 Example of Questions

Here is an example of the structure of the interview questions:

Introductory	Questions
<b>Intro Question</b>	1. On Nuclear policy: What is your organisation scope in relation to: “Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy”
<b>Main Questions</b>	2. On Government Planning from UAE Vision 2021 & Energy Strategy 2050. How does your organisation stay in line with the government’s planning and direction? 3. On Stakeholders. How does your organisation coordinate & cooperate with its stakeholders to ensure efficient implementation of its roles? 4. Overcome Methodology: What are the regulatory challenges during nuclear programme planning, implementation, commissioning, and operation? 5. On International Organisations: How does your organisation benefit from international organisations to efficiently implement nuclear requirements? 6. Public Support: How did the government (through your organisation) achieve and maintain social acceptance of nuclear energy development?
<b>Closing Questions</b>	7. On Success Factors: from this statement, “The interaction between social, economic and political factors are the major challenge/strength facing the well-experienced and newcomer states to the nuclear industry” <ul style="list-style-type: none"> <li>• What are the factors utilized by the UAE government to achieve a successful nuclear power programme?</li> </ul> 8. Based on our discussion, would you like to add any point contributed to this research?

*Table 5: interview questions. Source: The Author*

These questions were structured to guide the interview and encourage the interviewee to elaborate on various topics. The goal was to gather insights and perspectives on nuclear policy, government planning, stakeholder coordination, regulatory challenges, international cooperation, public support, and success factors.

### **3.6 Research and Social Environment**

The research investigated the social, political, and economic challenges and conditions in developing the Emirati's nuclear energy programme. The conceptual framework of Socio-Political Economy developed by Sovacool and Valentine was adopted to understand the implementation of the Emirati programme about the six catalysts proposed by the authors' [16, 20, 21]. To facilitate this study, the unique context of the Emirati's programme has adopted the conceptual framework. As part of the social aspect of this study, the 'nuclear organisations' processes have been explored, including how they conduct decision-making and now consider the views and opinions of civil society. It also evaluated the influence of social acceptance of nuclear energy developments on these processes.

The 'socio-political economy' conceptual framework identifies six catalysts that are present when a country develops a nuclear energy programme, shown below: [16, 20, 21]

1. Strong state involvement in guiding economic development.
2. Centralisation of national energy planning.
3. Influence of technocratic ideology on policy decisions.
4. Campaigns to link technological progress to a national revitalisation.
5. Low levels of civic activism against nuclear energy.
6. Subordination of challenges to political authority.

This current study shows that the six critical factors for the success of nuclear energy programme development, as identified in [16, 20], validated in [21] and critically evaluated in [17, 166, 177], have been and remain present in the Emirates during its nuclear programme development. These factors occurred in France, Japan, and other nuclear states when their civil nuclear programme development was highly successful in the 20th century. One of the limitations of Sovacool and Valentine's work is that it needs to cover the recent international development of a need for nuclear in the 20<sup>th</sup> century. Another area for improvement with their work is that more than these factors may be needed. There should be other factors that should have been studied, as mentioned by [166]. Most Sovacool and Valentine works were done in Japan, Korea, China, India, and France; and have only been done in specific fields and time, which show some limitations in terms of numbers. There are limits to how far their works can be taken as a guide to

nuclear energy development in a new-entrant country due to limited research on the 'socio-political economy' conceptual framework since 2014.[21]

Concerning Stephen Tromans [17], France has a robust national framework that helped to have a strong state involvement in guiding economic development and centralising national energy planning [17, 178, 179]. France is also considered a technocratic state. However, it needs to deliver the continued strength in nuclear power which characterised its history. Strong state involvement drove nuclear companies through government policies rather than commercial considerations (such as EDF). That has resulted in high-cost overrun and significant delays to Flamanville 3 in France and Olkiluoto in Finland [17, 148]. Stephen Tromans and Sylvan Brouard Field [177] disagree with Sovacool and Valentine that these six factors still support the French nuclear industry in the current decade[17]. For example, the French government invested heavily in the new third-generation European Pressurized Reactor (EPR) and started the construction of Flamanville 3 partly to preserve French expertise and competencies. Due to the rigid French nuclear governance system, EDF suffered significant delays in Flamanville and couldn't synchronise with other nuclear governance requirements outside France (such as Finland)[17]. These delays led to missing the granting of the Barakah nuclear power project in the UAE, which affected French confidence. That's led to tightening nuclear governance to support commercial industry structure for expansion and export[17, 166]. French official statement was made as [17, 177]

*“The new industrial battle of civil nuclear power is now so important that it requires states to invest, sometimes by abandoning their traditional positions, arguing strongly and at the highest level of business development of its major firms and increasing intergovernmental agreements.”*

The research examined the socio-political and economic aspects of the Emirati nuclear energy programme, adopting the Socio-Political Economy conceptual framework. The study found that the six identified catalysts were present in the Emirates' programme, but limitations and other factors must be considered. The case of France highlighted the challenges and developments in its nuclear industry, which influenced the approach to nuclear governance.

### 3.6.1 Technocratic Ideology

Technocratic ideology can have advantages and constraints regarding policy decisions in the context of nuclear energy. While it can provide efficiency and expertise, it can also lead to potential constraints when safety-related requirements are overlooked [180].

In Japan, the influence of technocratic ideology is evident in the centralised nuclear regulatory system, which is under the control of the government [166]. The responsibilities for overseeing and managing nuclear activities are divided among various ministries and authorities based on their respective authorities. As the Nuclear Regulatory Authority explained, the responsibility for using and overseeing nuclear activities was divided by jurisdiction between several authorises and organisations based on the form of use, as shown in Figure 7. [180, 181]

The Fukushima disaster in Japan revealed a need for coordination and communication between nuclear operators, regulators, and the government. This failure hindered the ability of political parties to mediate between civil society and the state, resulting in a disconnect between the public and those responsible for the Nuclear Energy Programme (NEP) [166]. Consequently, public trust in nuclear energy was eroded, leading to civil solid society activism opposing nuclear power development [63, 127]. In response, the Japanese government established the Nuclear Regulation Authority in September 2012. This new independent regulatory body regulates and licenses nuclear activities, including nuclear safety, security, and safeguards, as shown in Figure 7. Its mandate is based on international commitments, best practices, and national requirements, to rebuild public trust in the nuclear industry. [20, 63, 127, 181]

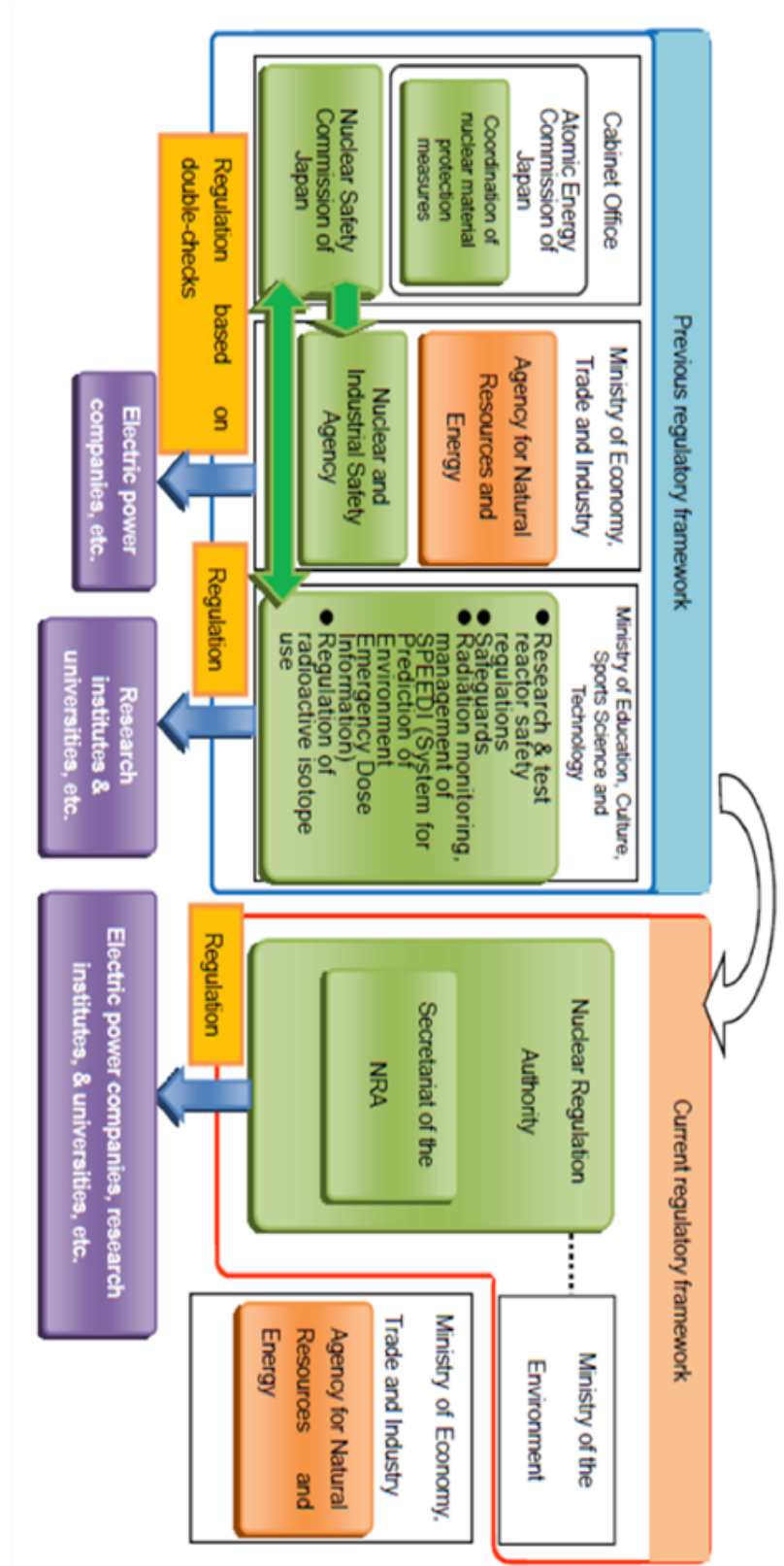


Figure 7: Japanese Nuclear Regulator Before & After Fukushima [181].

Overall, the case of Japan illustrates the importance of a well-functioning regulatory framework and the need for effective communication and engagement between the government, regulators, operators, and civil society to address safety concerns and maintain public trust in nuclear energy.

### 3.6.2 National Revitalisation

The successful linkage of technological progress to national revitalisation has played a significant role in mitigating civic activism against nuclear energy development. Three Miles Island, Chernobyl and Fukushima incidents changed public perception of towered nuclear [182]. Due to public protest, the TMI incident stopped building new nuclear plants and led to the freezing many under-constructions nuclear plants in the USA. Some of these plants were at 60% completion. The Chernobyl accident stopped almost all planned nuclear power plants for over a decade. The Fukushima incident affected Japan's nuclear industry and led to Germany's phase-out of all nuclear power plants. That proves that no matter how the public support nuclear, any nuclear accident will change the public perception of the worldwide nuclear [183].

However, it is worth noting that anecdotal evidence suggests that the stress tests implemented in the UK and Europe following the Fukushima incident, along with expert appearances on television, helped stabilise public support for nuclear energy in the UK. This highlights the impact that nuclear accidents can have on public perception globally, regardless of previous levels of support. [184]

Another reason, which might affect public perception, is related to construction risk due to long overrun. Another risk is financial due to the high cost of capital. Also, the market risk is due to the price of electricity. The UAE is facing significant delays and cost overruns in the BNPP project. The nuclear power contribution went down from 25% to 6%. Changing the plan will raise questions on the investment outcome from relevant stakeholders, including the public. [2, 42, 180, 182, 183, 185]

Things change, and that change might weaken the influence and the six catalysts. A new catalyst needs to be considered: the influence of catastrophe/environment on the six existing motivations. Another (as will be shown here) is the recent effect of climate change and energy policy on public opinion and hence, on the six known catalysts.



Recognising that the evolving social and environmental landscape, including climate change and energy policy, can affect public opinion and weaken the influence of the six catalysts identified in the socio-political economy framework is essential. Therefore, it is crucial to consider the impact of catastrophes, environmental factors, and the current effects of climate change and energy policies on public opinion and the six known catalysts for nuclear energy development.

### 3.6.3 Participant Organisations

Barakah Nuclear Power Plant is located 270 km west of the capital Abu Dhabi, and the nearest city is Ruwais, 60 km away. There is no direct interaction between the site and the public due to distance restrictions and an authorised buffer area for such sensitive facilities. Therefore, the research was conducted mainly in Abu Dhabi, where most government HQs (decision-makers) are located, and at local municipal offices of the Emirates' Western Region. All the interviews were conducted virtually due to Covid restrictions while the interviewees were at their offices. The interviewees also shared some organisation documents related to national energy strategy.

The study aimed to gain comprehensive knowledge and understanding of the UAE's nuclear energy programme and broader energy strategy by conducting research in Abu Dhabi and collaborating with key decision-makers and government entities.

The researcher was among the pioneering engineering team working in the nuclear industry from the early stage of the project, precisely when signing the contract with prime contractor KEPCO. The researcher's experience in the field extends from infrastructure development, stakeholder coordination, and construction management to Safeguards and Export Control manager. This is in addition to coordinating with international organisations such as the IAEA, the European Safeguards Research and Development Association (ESARDA) and the Nuclear Suppliers Group (NSG) on the regulatory implementation. The involvement in developing the in-house regulatory compliance programme has further enhanced the researcher's skills and understanding of compliance, verification, and interpretation of regulations. This wealth of experience and knowledge has guided the researcher in conducting the research and collecting relevant data.

Considering data collection from organisations, the type of organisations proposed for an interview is ‘nuclear organisations’, ‘major stakeholders’, and ‘other stakeholders’. The nuclear organisations will include a regulator, owner, and operator (specialised service provider). These organisations have a clear scope regarding nuclear development and implementation, making it easy to find suitable interviewees. The stakeholders are varied regarding involvement and range of work. The research was empowered by official approval from each organisation/entity toward facilitating their study by easily approaching decision-makers at the targeted entities. The organisations recruited to support this project are in **Table 6**.

**Table 6** shows the participant organisations in the survey. For each organisation, one or more senior staff members or managers completed the survey. These organisations can be split into three categories. The first 3 in the table (ENEC, FANR and NAWAH) are the three major nuclear organisations charged with implementing the design, building, commissioning, and operating the project introducing civil nuclear power in UAE. Together, they are the primary regulator, the power company, and the leading operator (or, in UK terms, the licensee). Together they are ultimately responsible to the government for the civil nuclear programme. All trace their leadership and direction to the federal government in some form, although FANR is immediately answerable to a different part of the government to ENEC.

Organisations 6, 7 & 9 in **Table 6** have governmental quality. Still, each holds broader responsibilities than just ‘nuclear’ and interacts with the first three organisations to facilitate their progression and ensure local regulation of the wider impact of 1, 2 & 3 activities.

Organisations 4, 5 & 8 also engage with Organisations 1, 2 & 3 to facilitate their progress and regulate their impact. However, the distinguishing nature of this third group of organisations is their importance in regional (or local) administration (e.g., local government/municipality).

Together, these nine organisations and ‘other stakeholders’ fulfil the purpose of directing and controlling the evolution of civil nuclear power at the Barakah site for UAE Energy policy. The ‘other stakeholders’ were asked to represent a broad set of ‘lesser’

stakeholders, such as principal design consultants, supply chain contractors, financial/economic groups, and other aspects of the state system (e.g., MOD and Environment agency).

Organisations	Who They Are/What They Do	Significance
1.FANR	Federal Authority for Nuclear Regulation was established in September 2009 to be the regulatory body for the nuclear sector in the UAE in accordance with Federal Law by Decree No 6 of 2009, Concerning the Peaceful Uses of Nuclear Energy, which was issued by the UAE President H.H. Sheikh Khalifa bin Zayed Al Nahyan.	High (‘nuclear organisations’)
2.ENEK	The Emirates Nuclear Energy Corporation (ENEK) was established by decree in December 2009 by his Highness Sheikh Khalifah bin Zayed Al Nahyan, President of the United Arab Emirates (UAE). ENK is responsible for the implementation of the UAE Peaceful Nuclear Energy Programme.	
3.NAWAH	Established in 2016 as a Joint Venture subsidiary of the Emirates Nuclear Energy Corporation (ENEK) and the Korea Electric Power Corporation (KEPCO), Nawah Energy Company (Nawah) oversees operating and maintaining Units 1 to 4 at the Barakah Nuclear Energy Plant, the first nuclear energy plant in the UAE and the Arab World, located in the Al Dhafra Region, Abu Dhabi.	
4.ADWIC/TAQA	TAQA is a top 10 integrated utilities champion in Europe, Middle East and Africa (EMEA) region with power and water and oil and gas operations in 11 countries around the world. Established in 1998 with the privatization of Abu Dhabi’s power and water sector, underscoring the importance of water security and provision of power to communities across the UAE.	High (Major Stakeholder)
5.Municipality	Regulate develop, and manage urban growth and transport, for the prosperity and happiness of the community, by ensuring an integrated and sustainable approach to pioneering and smart infrastructure, facilities, and services.	
6.Department of Energy	Abu Dhabi Department of Energy was established in accordance with Law No. 11 of 2018 to driving the emirate’s energy transition efforts with a clear focus on creating a sector that promotes economic growth and social development, and environmental sustainability.	

7.Ministry of Energy	The Ministry of Energy and Infrastructure implements a strategic plan aiming, in its entirety, to organize, develop and enhance the competitiveness of the UAE in the sectors of energy, mining, water resources and land and sea transportation, roads, utilities, housing, building and construction and in investment sustainability, as well as optimizing the partnerships, technology and advanced sciences, in addition to adopting global innovative solutions to improve the quality of the society's life.	
8.General Secretariat of the Executive Council	The General Secretariat is an administrative body entrusted to propose public policies and strategies to be decided on by the Emirate of Abu Dhabi Executive Council. It provides a slew of support services to the Council ranging from drafting and scheduling resolutions to preparing minutes and issuing and following up the execution of resolutions. The General Secretariat studies topics on the orders of the Executive Council follows up on the implementation of the directives.	
9.Abu Dhabi Executive Council	Abu Dhabi Executive Office is the authority in charge of supporting the Executive Council as well as its committees by virtue of the provisions of Law No. (18) of 2019. for example, the study and review of the applications and topics submitted to the Executive Council and its Committees, and submission of the appropriate recommendations in preparation for submittal thereof to take the decisions required to this effect.	
10.‘Other stakeholders’	The ‘other stakeholders’ are the organisation who are either effective in the process of atomic programme implementation, adequate experienced by nuclear programmes or, have personnel who used to work within nuclear industries.	Medium (‘other stakeholders’)

**Table 6:**Participant organisations. Source: The Author

These participant organisations were selected to provide a comprehensive representation of the key entities involved in directing and controlling the development of civil nuclear power in the UAE. The interviews were conducted with each organisation's senior staff members or managers to gather valuable insights and perspectives.

#### 3.6.4 Planning for the Interview Session

The interview sessions were designed to facilitate interactive discussions with participants on various aspects of the UAE's nuclear programme. The topics covered in the interviews included nuclear policy, government planning and facilitation, stakeholder engagement and management, overcoming challenges, public support and social acceptance, and success factors for implementing a civil nuclear capability. These discussions aimed to gather valuable insights and perspectives from participants to inform the development of a new conceptual framework for the UAE's nuclear programme.

Due to COVID-19 protocols, the interview sessions were conducted virtually, allowing participants to join remotely from their respective locations in the UAE. Participants were selected from the energy industry's private and public sectors, specifically focusing on individuals working in the nuclear sector and relevant regulatory agencies. This diverse representation ensured a comprehensive understanding of the nuclear programme from multiple perspectives and stakeholders.

By conducting the interviews in a virtual format, the research team could adhere to necessary health and safety guidelines while enabling effective communication and data collection. The insights and information gathered from the interviews would contribute to the research's objectives and provide valuable input for developing the new conceptual framework.

### **3.7 Methodological Reflections and Insights**

The research conducted in the UAE employed a methodology (section 3.1) that offered advantages and challenges. This method facilitated data collection through various approaches, enabling access to valuable information. However, it also required detailed data cleaning to eliminate unnecessary data and ensure relevance and reliability.

The researcher's industry experience provided the advantage of quickly identifying key individuals who could contribute essential information. However, bureaucratic requirements could have improved access to critical information from these organisations. Additionally, the COVID-19 pandemic presented challenges due to limited access to video conferences and the closure of prominent buildings, hindering early-stage engagement with organisations.

The chosen explanatory sequential design approach proved beneficial in planning and organising the research. This design's advantage lies in its sequential phases of data collection, making it feasible for a lone researcher to complete the study, as [166] demonstrated in defining strengths and weaknesses in nuclear development. Challenges include conducting the first phase to proceed to the next phase and the time-consuming process, which should be managed effectively through arrangements and agreements with the nuclear organisation. [168]

This research employed a different methodological approach than Sovacool and Valentine's Comparative case study approach [16, 20, 21]. While the case study method explores a contemporary phenomenon within its real-life context to examine causation and underlying principles for nuclear power development, comparative research aims to identify similarities and differences between social entities, such as nation-states, societies, or cultures. [16, 20, 21, 164, 165]

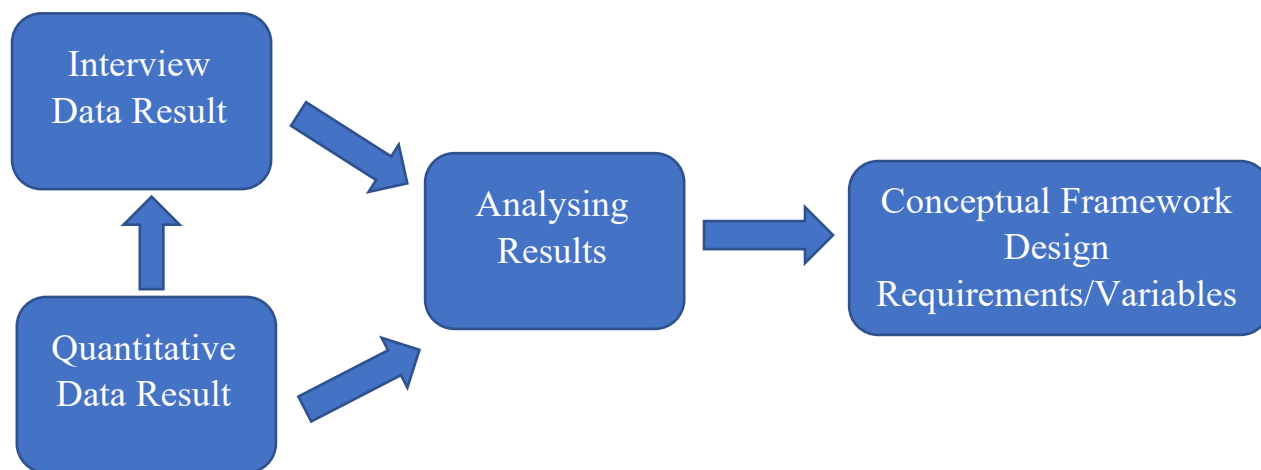
Sovacool and Valentine's methods have disadvantages, including the time-consuming nature of analysing different countries and their evaluation of nuclear programmes developed in the '50s and '60s. Their work needed more robust consideration of current international requirements post-Fukushima and the prevailing public perception of nuclear energy. Furthermore, they did not evaluate countries that phased out their nuclear power programmes. There was also a limited emphasis on the impact of climate change on the development of success factors in 2010 [16, 20] and the validation in 2014, which is attributable to the early stage of nuclear power development. The implemented methodology was successfully executed, enabling the generation and analysis of data for the research study. An overview of methodology workflow illustrated at appendices (Methodology Workflow).

## Chapter 4: Survey Results

### 4.1 Introduction

In this chapter, the survey results are demonstrated. Chapter five demonstrates interview results. The below 'follow chart' illustrates how these two results are integrated. According to the following chart, the questionnaire survey (mainly quantitative) was supported by the results from the interview (primarily qualitative) to arrive at the specific requirements for designing a new conceptual framework for the UAE Nuclear programme. The result of the survey has been considered in the discussion during the interviews. The results are then analysed and discussed (q.v.ch5&ch6).

Integration of Qualitative and Quantitative Data Source: The Author



Opinions were surveyed across the UAE nuclear industry and beyond, utilising a questionnaire. This was completed by representatives of organisations whose role suggests credibility in the knowledge and experience brought to bear when answering. Questions were asked from several sections. These began with personal details (to assist in categorising responses and seeking traits affected by personal circumstances). Other sections reflected known features that enabled the successful development of civil nuclear power. They sought to establish the influence of modern concerns as potential success factors for future development.

The chart above shows that integrating the survey and interview results allows for a comprehensive analysis. The survey data, primarily quantitative responses, provide a broad understanding of the participants' opinions and experiences. The interview data, on the other hand, offer qualitative insights and a deeper context to enrich the findings.

Combining these two data types, the research aims to derive a comprehensive set of requirements for designing a new conceptual framework for the UAE Nuclear programme. The analysis and discussion of the survey results and interview findings, presented in Chapter 5, contribute significantly to achieving the following objectives:

1. Defining the factors necessary for developing a new conceptual framework for the UAE in the context of national activities, policies, and priorities.
2. Exploring the evolving socio-political-economic circumstances in the Emirates and applying the new conceptual framework to predict the potential success of commissioning and operating a nuclear power plant within the next ten years.
3. Predicting the likely shifts in public perception of nuclear energy in the Emirates as the nuclear plant was commissioned for energy generation through planned fieldwork.
4. Based on the findings, comparing the expanded conceptual framework with the actual implementation of plans and operational activities, and refining the operational framework.

The following sections will present the survey results, analyse the data, and discuss the key findings. In Chapter 6, the integration of survey and interview results will be further explored, considering the implications of the findings about the existing literature and the overall objectives of the research.

By aligning the survey results chapter with the research objectives, readers will better understand how the collected data contributes to the development of the operational framework and the overall success of the UAE nuclear energy programme.



## 4.2 Survey Results

The total number of responses is 50. From 50 responses, there are 47 complete responses, and three are almost complete from two organisations. The multiple-choice question related to the “Low levels of civic activism were influential factors in supporting nuclear programme” was not answered by these three respondents because of the topic's sensitivity to the organisations. The two organisations thus affected are the General Secretariat of the Executive Council and the Department of Energy.

The individuals who answered the survey are employees who have work related to the nuclear programme, either directly or indirectly. There was no need to get answers from people not involved in nuclear policy implementation, such as administrative posts or general support. The responses are sorted into three main groups. FANR, ENEC and NAWAH are the ‘nuclear organisations’ group. This group provides the energy or related it. The ‘major stakeholders’ groups are AQWIC/TAQA, the Municipality, the Department of Energy, the Ministry of Energy, the General Secretariat of the Executive Council, and the Abu Dhabi Executive Council. This group is responsible for supplying or regulating civil infrastructure impacting (or impacted by) the Barakah nuclear power programme. The third group is ‘other stakeholders’ involved in the nuclear programme (refer to Table 6: Participant organisations). This group is essential in enabling the creation of the Barakah Nuclear Power Plant, such as design, supply chain, construction, main contracting, sub-contracting, operation, etc.

This distribution of respondents was justified to understand the responsibilities and implementation methods of the nuclear programme. It helps determine the factors that contributed to the successful completion and operation of the Barakah Nuclear Power Plant and identify sustainable success factors beyond what Sovacool and Valentine have established. It is worth pointing out that the three organisations in the ‘nuclear organisations’ group represent the most influential organisations charged with contracting and implementing a safe and secure civil nuclear power programme in the UAE. The ‘major stakeholders’ group are public bodies representing the public in fields affected by the UAE nuclear programme. The ‘other stakeholders’ are keenly interested in the programme's progress, including main contractors, sub-contractors, design consultants, civil organisations, and the media. However, all respondents are delegated from a senior or management level within their organisation, with initial knowledge of the organisation’s role and performance. This is both an advantage and potentially a disadvantage since the data created by this questionnaire develop a picture of the programme as perceived by a wide range of representative skilled and knowledgeable people but omit opinions by administrative staff and less credible sources.

## 4.2.1 Section 1: Personal Details

*In the survey, respondents were asked to indicate their organisation.*

**Table 7** below shows the organisations that participated in the survey and the number of people representing each organisation.

**Question 1:**

Your organisation?

<i>Participant's Organisation</i>	<b>responses</b>
FANR	7
ENEC	4
NAWAH	5
ADWIC/TAQA	1
Municipality	2
Department of Energy	1
Ministry of Energy	1
General Secretariat of the Executive Council	2
Abu Dhabi Executive Council	2
Other	25
<b>Total responses</b>	<b>50</b>

*Table 7: Participant's Organisation. Source: The Author.*

Based on the responses, it can be observed that FANR had the highest number of respondents, with seven participants. NAWAH followed with five respondents, while ENEC had four respondents. Therefore, the total number of keys 'nuclear organisations' responses is 16.

In addition, the survey included participants from the 'major stakeholders' group, which provided nine responses. The 'other stakeholders' group, consisting of companies involved in the local community, supply chain, consultancy, or otherwise affected by the nuclear programme, contributed 25 responses.

This distribution of respondents allows for a diverse representation of different organisations involved in the UAE's nuclear sector. It ensures that perspectives from key nuclear organisations and other stakeholders are considered in the analysis.

Overall, the distribution of respondents reflects a balanced representation of various organisations involved in the UAE's nuclear sector, providing valuable insights and perspectives from different stakeholders.

**Question 2**

Question 2 provides insights into categorising the central purpose of the work units in which the respondents work. The question allowed for the selection of multiple categories (

**Table 8**), resulting in a total of 77 selections.

Role of your department within the organisation:

Regulation requirement implementation	20
Licensing and registration	8
Legal	3
Governance	10
Health and Safety	2
Security	8
Environmental	4
Public Relation	5
Other	17

**Table 8:** Role of Department within the Organisation. Source: The Author.

Note: Each responder has the option to choose multiple options.

The responses shed light on the different operational areas within the organisations, as shown by the number of respondents who selected each category. This varied functionality offers an insight into the broad scope of roles undertaken within nuclear organisations and their main stakeholders.

The most frequently chosen role was 'Regulatory Requirement Implementation' with 20 responses, primarily focusing on compliance with nuclear-related regulations and standards. The 'Licensing and Registration' role was identified by 8 respondents, showing their involvement in processes related to obtaining licenses and registrations for nuclear activities.

Three individuals associated their departments with 'Legal' roles, pointing to legal responsibilities linked to the organisation's operations, including handling legal issues, contracts, and agreements relevant to the nuclear industry. Meanwhile, 'Governance' was selected by 10 respondents, signifying responsibilities associated with the general governance and management of the organisation, such as strategic planning, policy development, and decision-making processes.

A minority of respondents (2) chose 'Health and Safety', suggesting a focus on upholding health and safety standards and implementing and maintaining safety protocols and procedures within their departments. Similarly, 'Security' was picked by 8 respondents, indicative of their departments' involvement in security-related activities designed to safeguard nuclear assets and operations.

'Environmental' and 'Public Relations' roles were chosen by 4 and 5 respondents, respectively, showing a commitment to environmental compliance and management, as well as public communication and engagement efforts.

Lastly, 17 respondents selected 'Other', denoting a range of roles not explicitly listed in the options provided. These roles include responsibilities related to safeguards and non-proliferation of nuclear weapons, advisory to the executive council, higher education, investment, construction projects, regulatory compliance with national policies and alignment with national strategy and development plans, infrastructure and environment, operations and maintenance (O&M), asset management, nuclear non-proliferation and safeguards, nuclear export controls/SGD, emergency preparedness, technical roles, international relations, and HR.

From the figures provided (**Figure 8**, **Figure 9**, and **Figure 10**), it can be deduced that the main focus of the workplace units within both nuclear organisations and main stakeholders is primarily regulatory activity. However, the broader stakeholder range presents a more comprehensive focus, indicating diverse opinions across the nuclear subsector. Despite fewer people being from health and safety and security functions, their roles still fall within the purview of regulatory authorities. Moreover, many 'Other' roles relate to regulatory requirements, such as safeguards, export control, and compliance.

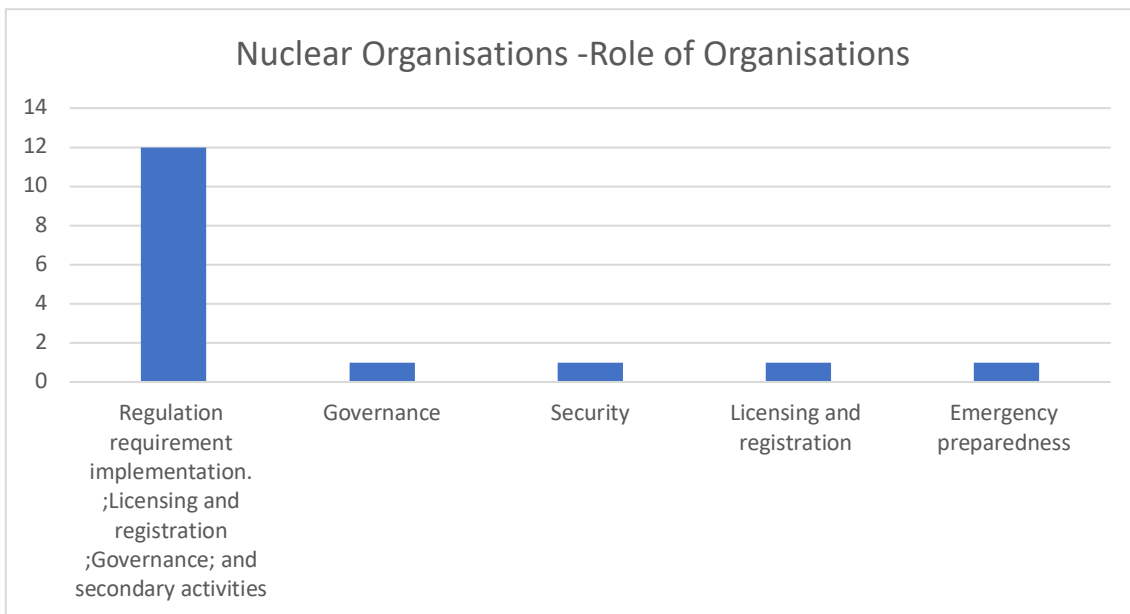
The results highlight two key facts: 1) the survey successfully gathered data from sources involved in nuclear regulation in the UAE, and 2) regulatory requirements in their work bind various stakeholders. The survey sample comprises organisations directly involved in nuclear regulation, embodying various roles and responsibilities within the nuclear sector.

The survey emphasised gathering information from public bodies and industrial concerns representing the civilian and public populations. Nonetheless, it is worth noting that the survey did not seek explicit input from the public or those opposed to the nuclear programme, assuming such credible sources exist. The survey has compiled invaluable viewpoints from organisations involved in nuclear regulation and various stakeholders within the broader

nuclear subsector. This comprehensive approach provides a well-rounded understanding of the different roles and responsibilities within the UAE's nuclear sector and their correlation with regulatory requirements.

The following figures visually represent the distribution of roles within nuclear organisations, main stakeholders, and other stakeholders, further enhancing the understanding of the survey results. The analysis presents a robust and holistic understanding of the distribution of roles within the UAE nuclear sector and their various responsibilities concerning regulatory requirements.

**‘Nuclear organisations’**



**Figure 8:** *‘nuclear organisations. Source: The Author.*

**‘Main Stakeholders’**



**Figure 9:** ‘Main Stakeholders’. Source: The Author.

**‘Other stakeholders’**



**Figure 10:** ‘other stakeholders. Source: The Author.

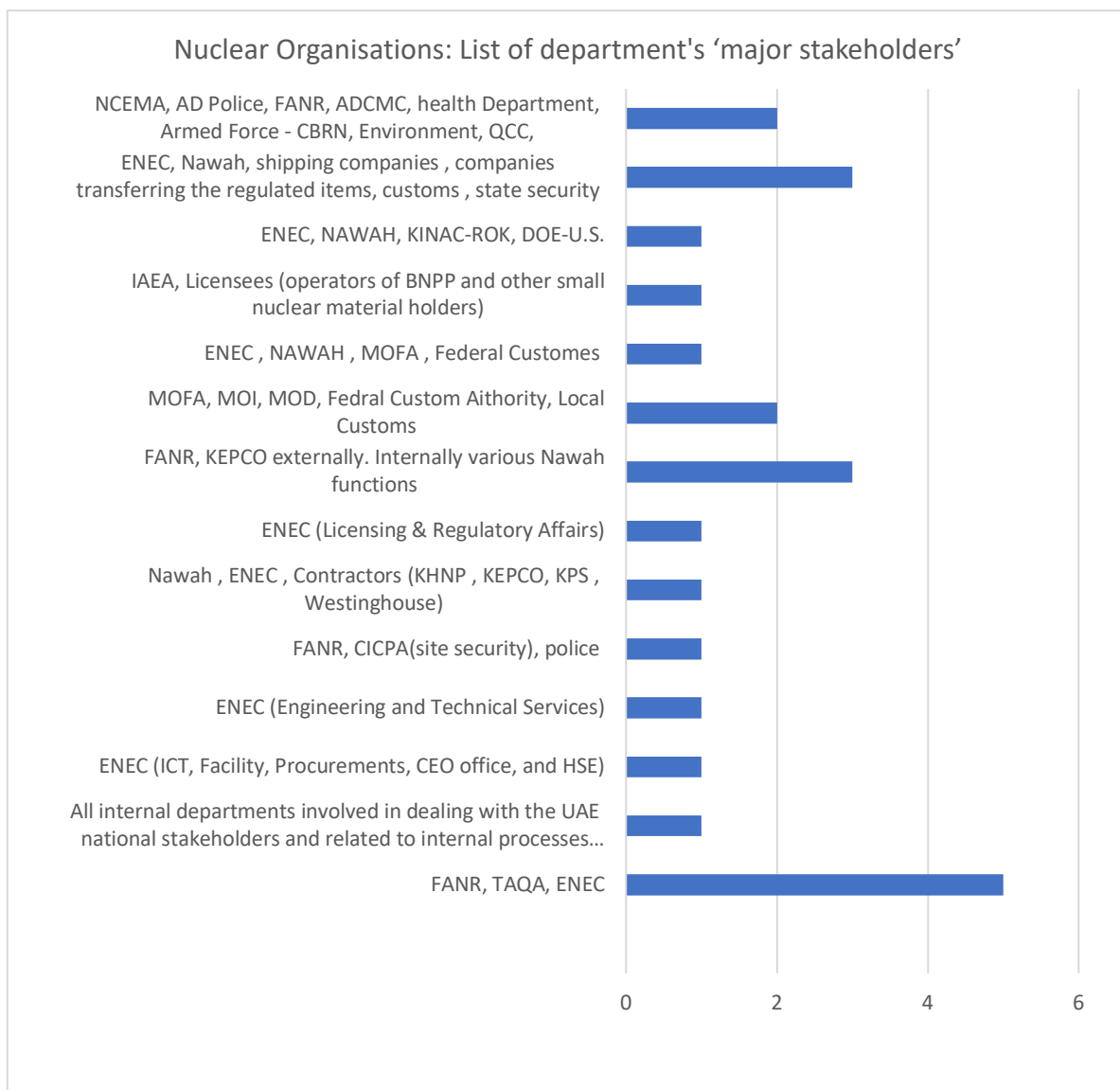
**Question 3**

Within your organisation, please list your department's 'major stakeholders'.

Question 3 aims to identify the major stakeholders within respondents' organisations. The analysis provides an in-depth understanding of the responses and sheds light on the different perspectives on major stakeholders within the UAE's nuclear sector. The researcher asked respondents to list the significant internal and external stakeholders. For security reasons, individuals in sensitive positions did not provide a complete list of their stakeholders.

Responses were divided into three categories. First, in **Figure 11**, responses by 'nuclear organisations':

**'Nuclear Organisations'**



**Figure 11:**Nuclear Organisations. Source: The Author.

To interpret **Figure 11**, it should be read as follows. One responder listed the part of ENEC dealing with Engineering and Technical services as their ‘major stakeholders’. Another listed the part of ENEC dealing with licensing and regulatory affairs specifically, but another listed ENEC in its entirety alongside NAWAH and various specific contractors; and five responders recorded ENEC alongside FANR and TAQA, while another responder tied ENEC with NAWAH, the ministry of foreign affairs and federal customs.

Note: Each responder has the option to choose multiple options. **Table 9** shows how many respondents mentioned some of the expected responses.

#	Org	responses	Note
1	ENEC	16	That include internal functions of ENEC
2	NAWAH	10	Some functions are integrated with ENEC
3	FANR	11	selection based on role of the responder
4	TAQA	5	Power distribution
5	Security	16	Security, NCEMA, MOD (CBRN), ADCMC, CICPA, MOI (police)
6	Contractors	9	Mainly from US and ROK. Including consultation
7	MOFA	3	Ministry of Foreign Affairs
8	Custom	8	Including federal and local
9	IAEA	1	International organisation
10	Companies	6	Shipping and transferring companies
11	other	6	Quality, Health, and Environment organisations
Total responses		91	

**Table 9:** Nuclear Organisations: responses. Source: The Author.

From (**Figure 11 & Table 9**) reveal that one or more of the ‘nuclear organisations’ (FANR, ENEC, NAWAH) are listed as a major stakeholder in 24 ( $14+5+5$ ) responses, making 37/91. Moreover, other respondents also gave overarching terms to mean public licensing or regulators. So ‘nuclear organisations’ list other ‘nuclear organisations’ as ‘major stakeholders’, suggesting an insular nature to the nuclear industry. Interestingly, ‘nuclear organisations’ take full control of the whole programme and get assistance from ‘other organisations that provide specialised services (such as customs and security). This aligns with three of the defined factors in Sovacool and Valentine: Centralisation of national energy planning, strong state involvement in guiding economic development and; subordination of challenges to political authority. The ‘nuclear organisations’ provide education and awareness to the public, but there is no interference with the implementation by public authorities (municipality). The wider public representation in the municipality (in the locality of the nuclear power plant) is not listed as a major stakeholder by the ‘nuclear organisations’. This contrasts with **Figure 12**, where organisations providing wider public representation are listed as ‘major stakeholders’ by other



‘major stakeholders’ (e.g., Environment Agency of Abu Dhabi, local Emirate’s entities, and public residents of the UAE).

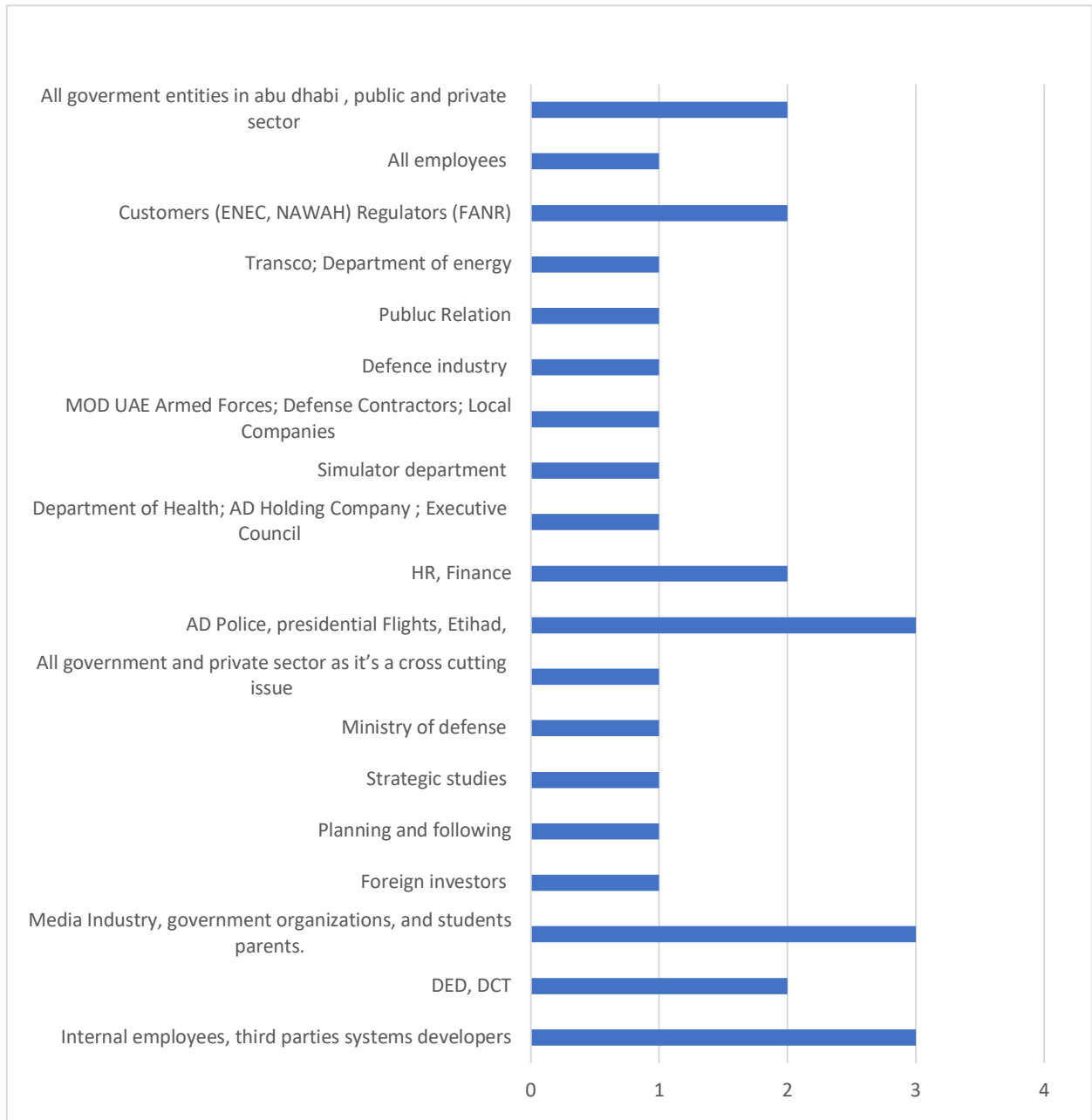
**‘Major stakeholders’**



**Figure 12:** Major stakeholders. Source: The Author.

Figure 11 shows that ‘nuclear organisations’ are listed only once as major stakeholders by ‘major stakeholders’. However, the freedom of responders to list using their terminology means that some others in Figure 10 may have been inclusive of parts of ENEC when mentioning those responsible for oversight of operations, outage management, engineering etc., or may mean FANR is included when saying “all government organisations within Abu Dhabi including regulators ...” etc. Other ‘major stakeholders’ tend to be selected as ‘major stakeholders’ by this category. Yet it is this category that, collectively, is responsible to ‘nuclear organisations’ for broader activity impacting the nuclear programme. This might be because there is less interference between the ‘major stakeholders’ and ‘nuclear organisations’ than expected. It could also reveal an insular approach where major ‘nuclear organisations’ and

‘major stakeholders’ do not integrate as much as one might have expected. The ‘major stakeholders’ provide specialised services to the programme as the government planned, yet do not list those charged with programme delivery explicitly except in one case. This is in line with three of the defined factors, which are (i) Centralisation of national energy planning, (ii) strong state involvement in guiding economic development and (iii) subordination of challenges to political authority. Figure 13 supports Figure 12, with ENEC, NAWAH and FANR only explicitly listed in 2 of the 29 given.



**Figure 13:** Other stakeholders. Source: The Author.

In Figure 13, it can be seen that people working in these other organisations have categorised 'other stakeholders' as major; and have a tendency to list other similar organisations as their 'major stakeholders'; and typically, non-nuclear civil powers or those who place contracts.

The findings highlight the different perspectives on major stakeholders within the UAE's nuclear sector. The 'nuclear organisations' predominantly view each other as their major stakeholders, while the 'major stakeholders' category focuses on external stakeholders as their major stakeholders. The 'other stakeholders' category emphasises similar organisations and contracting entities as their major stakeholders. These insights contribute to understanding the dynamics and relationships between various stakeholders in the UAE's nuclear programme.

## Question 4:

Job Responsibility in relation to Nuclear (directly and indirectly).

Question 4 aims to explore the job responsibilities of respondents about nuclear activities, both directly and indirectly. The table provided (**Table 10**) presents the categories of organisations (nuclear organisations, major stakeholders, and other stakeholders). It specifies the job responsibilities mentioned by the respondents. 13 indicated that they have indirect responsibilities, minor support to responsible function or left the nuclear industry. In contrast, the remaining 37 have direct responsibility for nuclear policy development and implementation in the UAE.

**Table 10** specifies each category's responsibilities. The respondent represents one of the three types of organisations and sets his responsibility in a box. The respondents who respond direct mean they have direct involvement within their organisation. Conversely, the respondents who respond indirectly suggest they provide minor support to decision-makers or responsible functions. Some respondents provide job titles which represent the field of work they are at where they can either manage or provide support. Others describe the nature of work they are at. Moreover, some employees left the nuclear programme and moved to organisations unrelated to nuclear. However, their input is still valuable to this research.

Overall, the findings suggest that job responsibilities within the nuclear sector in the UAE are diverse and encompass a wide range of roles, including policy development, compliance, export control, legal advice, and strategic planning. The interconnectedness of these roles indicates a collaborative and interdependent approach to nuclear activities in the country.

### Summary Outcome:

This table shows that the questionnaire has elicited responses from a wide range of organisations involved in or affected by the civil nuclear programme in the UAE. However, it also shows a degree of interdependency in job roles and activities, implying connectivity in the programme that could support group-think opinions being developed. To some extent, this suggests more connectivity (or interference, or integral dependency) between 'nuclear organisations', major and other stakeholders than **Figure 11**, **Figure 12** and **Figure 13** had implied.

NUCLEAR ORGANISATIONS	'OTHER STAKEHOLDERS'	'MAJOR STAKEHOLDERS'
Senior specialist on export control	Indirect	Indirectly
Chief Commercial Officer	Indirectly. Policy advisory	Management approval for organisation hiring (HR)
Regulatory compliance with national policies and alignment with national strategy and development plans and all related internal processes.	Indirectly	Road maintenance, infrastructure approval
Indirectly	NA	civil engineer
Chief Programme Officer	Indirectly	Direct
Indirect	Director of the nuclear business	Indirect: Ensure continuity of supply the water and power to customers
Maintain Export Control technology within the organisation	Indirectly	Arrange meeting to with international delegation whom they would like to visit or meet with the ENEC
Directly, Safeguards	R&D	Support Operations and other plant groups with regulatory updates and commitments and handle their questions and requests for possible changes. Some regulator inspections support.
Ensure compliance within Nawah for various FANR Regulations the Nuclear Law	Stakeholders	legal advice
<p>Import and export control is a vital component of the international nuclear non-proliferation regime which aims to prevent the diversion, misuse and illicit trafficking in nuclear material, equipment and technology which can be used for development and proliferation of nuclear weapons.</p> <p>We brought into force a Regulation on the Export and Import Control of Nuclear Material, Nuclear Related Items and Nuclear Related Dual-Use Items (FANR-REG-09) which details the licensing and reporting requirements for companies involved in the import, export, transit and trans-shipment of all types of Nuclear Material, Nuclear</p>	Strategic partners	indirectly

Related Items and Nuclear Related Dual-use Items that come under the UAE's jurisdiction. These are the items that are defined by the Nuclear Suppliers Group Guidelines and represent an international standard for export control. The Import and Export Control Section at FANR performs licensing of transfers, conducts inspections of licensees and, in cooperation with Customs, on suspicious shipments directly on the country's borders to assure the exclusively peaceful use of materials, equipment and technology.		
Directly	UAE Master planning in related to the future power supplies and energy	
Implementation of CSA (Comprehensive Safeguards Agreement and Additional Protocol) including but not limited to the provision of information to Agency and facilitating the IAEA visits and inspections. We also do licensing, inspection, outreach and others.	Nothing	
Export control	Indirect	
Licensing the transfer of the regulated items, verification of the correctness and completeness of the information provided by the licensees. inspections	indirectly	
Nuclear Export Control Senior Specialist	Indirectly	
Directly	By simulation may be rarely related to nuclear	
	Capability Development Industrial Development	
	Indirectly	
	No related matters	

**Table 10:** Job Responsibility. Source: The Author.

## Question 5.

### Nationality

The researcher asked a question related to the nationality of respondents. The justification for this question is to establish evidence of the nationality and hence background and customs of respondents who work in the Energy sector of the UAE; to provide insights into the diversity of the sector within the UAE (Table 11). The data revealed that 40 of 50 respondents are from the UAE, and ten are from different nationalities. (Provide some documents from organisations which show the demography)

In the first group of organisations (i.e., those with major direct involvement in leading the implementation of the civil nuclear programme (FANR, ENEC and NAWAH), 12 Emirate nationals completed the survey, alongside four ex-patriots whose expertise and skill had been recruited from abroad. Considering the similarities and differences between the responses given by these two subgroups of respondents acting for these organisations is interesting.

So  $\frac{3}{4}$  of the respondents from the main nuclear organisations were Emirate. The ratio of Emirate to ex-patriot respondents is not significantly dissimilar in the responses from the main stakeholders (i.e., outside the main organisations holding direct responsibility for the civil nuclear project at Barakah) and among the other 25 organisations that participated, to whit  $\frac{7}{10}$  and  $\frac{21}{24}$ . The ten non-Emirates were from Russian Federation, Poland, Sweden, Austria, the USA, New Zealand, India, Italy, Turkey, and the UK, as shown in Table 11.

It was initially anticipated that nationality might influence differences of opinion among the respondents. However, nationality had little to no significant effect for most survey questions. Any notable effects are discussed in the corresponding results.

The overall outcome highlights the diverse representation of nationalities within the UAE's nuclear sector, with Emirati nationals playing a crucial role about **Table 11**. This diversity brings a range of perspectives and expertise to the sector, contributing to its development and success.

	Nuclear Organisation	Major Stakeholder	Other Stakeholder
Emirati	12	7	21
Other	4	3	3
total	16	10	24

*Table 11: Nationalities. Source: The Author.*

## Question 6

Age:

	Below 30	31 - 40	41 - 50	51 - 60	Above 60
Emirati	1	20	14	4	1
Other	0	2	3	2	3

*Table 12: Age group. Source: The Author.*

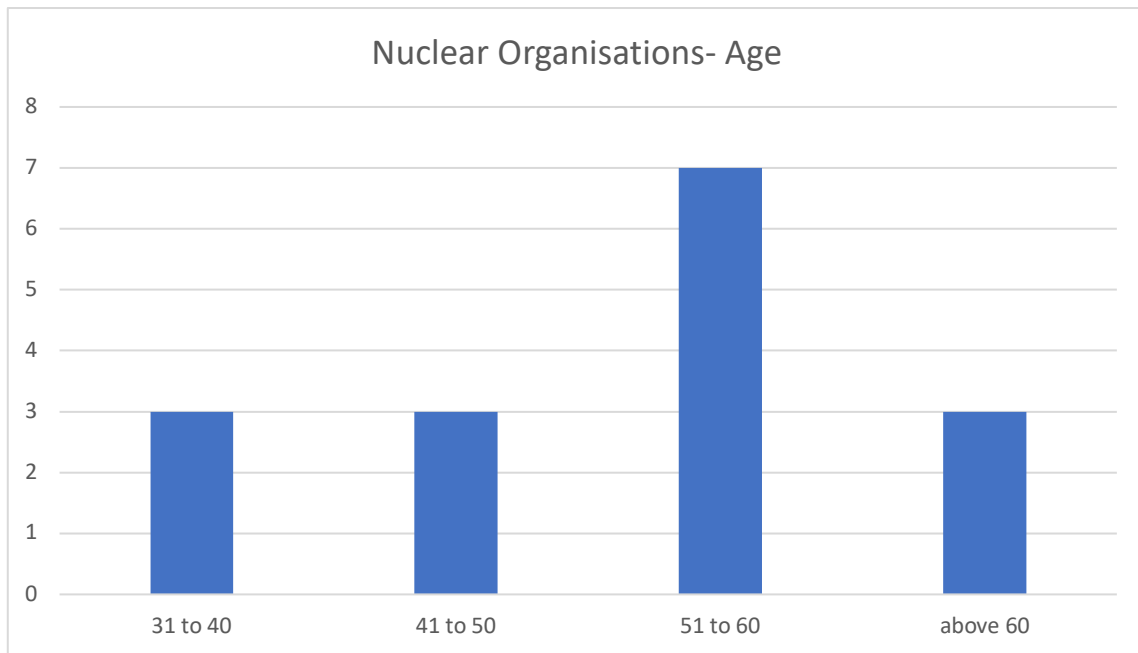
The analysis of age about the survey responses provides valuable insights into the demographics of the respondents and their potential influence on the results. Additionally, the age of respondents was explored in the questionnaire. Given the differences in professional and life experiences between different age groups, the researcher thought it necessary to include the age question in the questionnaire. This is characteristic of age groups, where people around a similar age typically share similar characteristics and ways of thinking.

The age of respondents might affect the results of other questions. However, the first thing to note in the result (**Table 12**) is that (even allowing for the 25 'other' organisations), only 2% of the respondents had attained less than 30 years of age when completing the survey. The largest body of respondents are between 31 and 50 years of age. This is perhaps unsurprising given the anecdotal evidence of the age profile of the Emirate population involved as professionals in the responding organisations and leaving 20% at 51 and above.

However, it should be noted from (**Figure 14 & Figure 15 & Figure 16**) that it is the 'nuclear organisations' in which older (and maybe more experienced?) employees dominate the respondents. In contrast, the 'other organisations' respondents tend to have a more balanced age profile; and the 'major stakeholders' had only one respondent over 50.

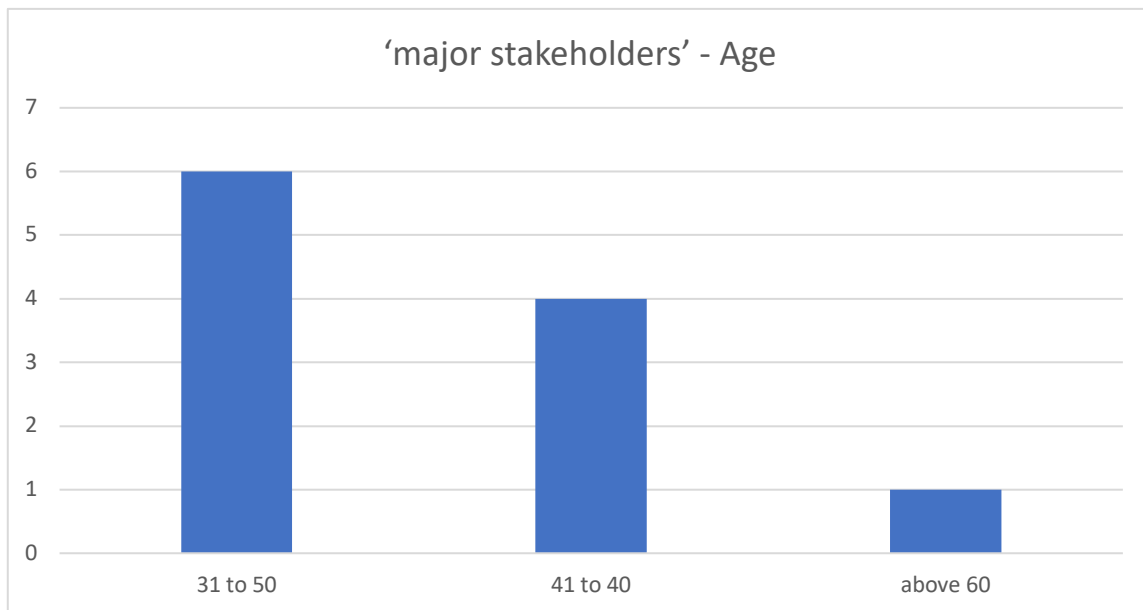


**‘Nuclear organisations’**

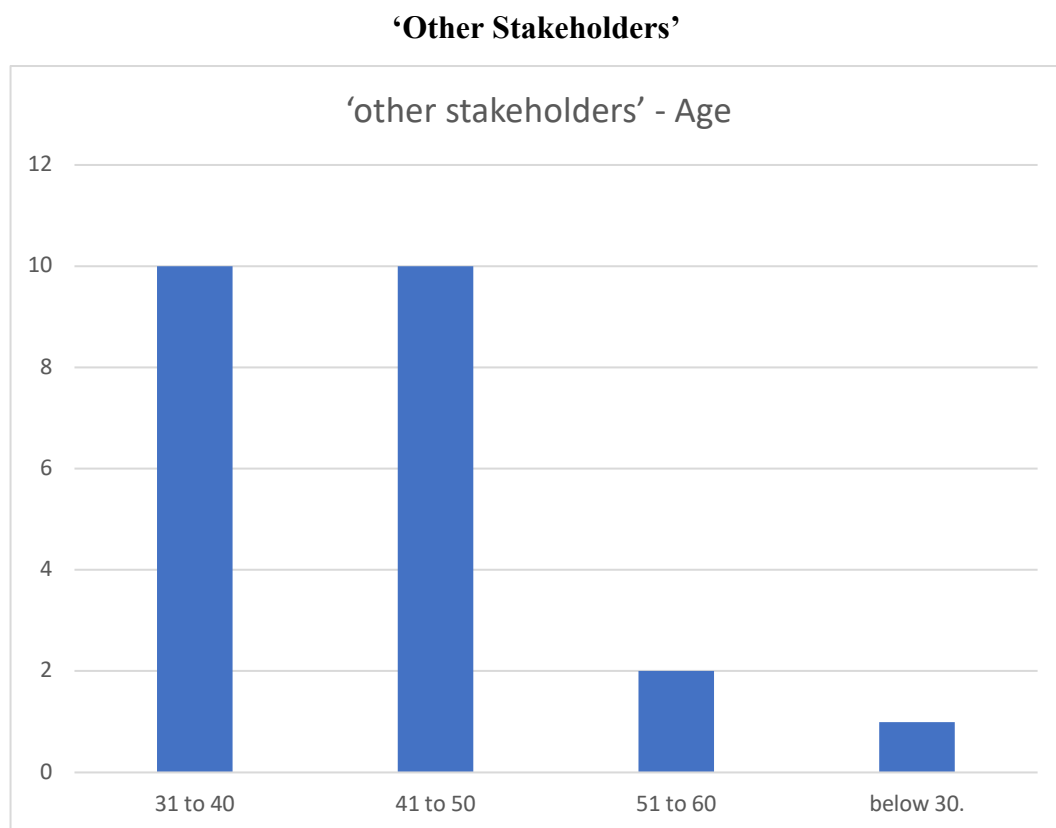


*Figure 14: Nuclear Organisations- Age. Source: The Author.*

**‘Major stakeholders’**



*Figure 15: ‘major stakeholders’ - Age. Source: The Author.*



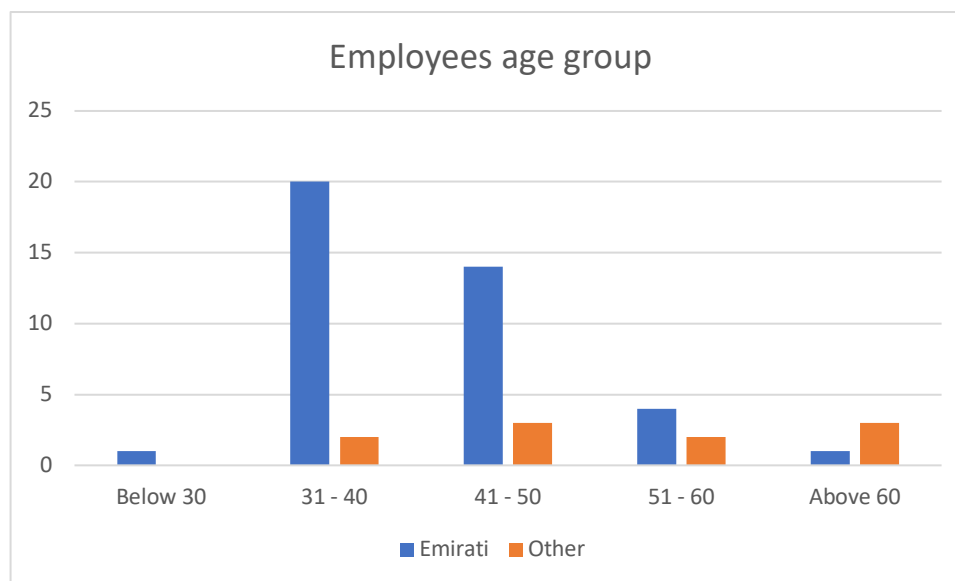
*Figure 16: ‘other stakeholders’ - Age. Source: The Author.*

In (Figure 14 & Figure 15 & Figure 16), it can be seen that 10/16 respondents from the ‘nuclear organisations’ were over 50 years of age, whereas only 3/34 of the respondents in the ‘other organisations’ were over 50 (including both ‘major stakeholders’ and ‘other stakeholders’).

This shows that most employees are between 31 and 50 years old. The nuclear programme is new to the country; the Barakah project started in 2010, indicating the low age range among UAE nationals. We need to remember that the UAE's pension age is either 60 or 25 years of service, and it can be extended as per employee request.

Putting the results of Table 11 alongside Table 12 (also see Figure 17), it can be seen that age influence will be partially affected by the ex-patriot nature of half of that population aged over 50 but it will not have a significant effect in the entire population (refer to Table 12).

## Employees



**Figure 17:** *Employees age group. Source: The Author*

Arguably, the result of questions 5 & 6 might be interpreted as follows:

- (i) Few staff and managers below 30 were respondents and, when taken with the answers to later questions it shows that only those with sufficient experience to provide knowledgeable answers were trusted/asked to do so.
- (ii) The Emirate age profile gradually tails off toward the older generations, with the bulk of those completing the survey being in a middle age bracket, unlike the age profile of ex-patriots completing the survey.
- (iii) There is a distinct difference between the age and experience of a typical ex-patriot survey completer (compared with the Emirates completing the survey) and the type of organisation they work for; one which could have affected the results for other, later questions if age and experience were going to affect the responses. However, age and experience has rarely had a noticeable effect, suggesting a similar opinion between older and younger participants.

Overall, the age profile of the respondents reflects the level of experience and expertise required to provide informed answers. While some variations may be based on age and nationality, the analysis suggests that age and experience do not affect the survey responses, indicating a similar opinion between older and younger participants.

**Question 7**

Total years of experience in the nuclear industry (directly/indirectly)?

	1 - 5	6 - 10	11 - 15	16 - 20	21 - 25	>25	other
Emirati	6	14	8	5	2	0	5
Other	1	2	1	1	0	5	0

**Table 13:** years of experience. Source: The Author

The analysis of the respondents' total years of experience in the nuclear industry provides valuable insights into the expertise and knowledge of the participants. To assess the depth and quality of the answers to the questionnaire, the researcher wanted to know the experience of the representative sample of respondents within the nuclear industry in the UAE. Fifteen respondents indicated they have had 6-10 years of industry experience within the nuclear industry from 50 respondents. Nine respondents said they had 11-15 years of experience, and six respondents were between 16-20 years old. However, five respondents indicated that they had had 25 years or more experience within the industry; and five respondents said they had had 1-5 years of working experience. Because most UAE nationals are relatively new to the nuclear industry (and we have already seen that most respondents representing their organisation are UAE nationals), the profile in (

**Table 13**) is not surprising. However, some very experienced people were employed (with much international experience), so the slight rise above 25 years is anecdotally correct from the author's experience working in the industry.

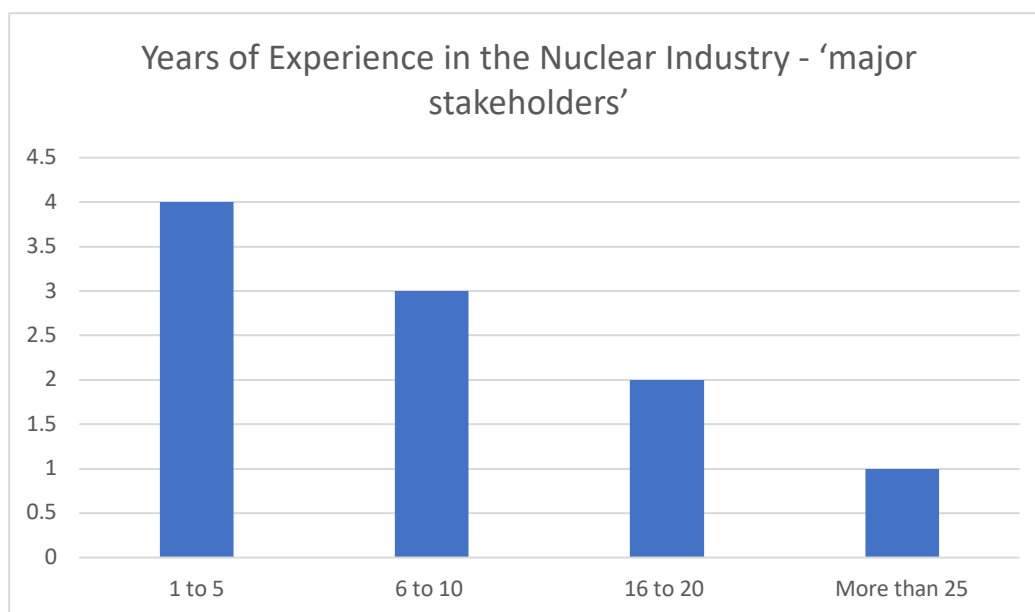
The split of experience between the three types of organisations is logical. The non-nuclear but major stakeholders (**Table 12**) involve experienced professionals whose careers lead here to management or senior professional roles that can represent their organisation. Still, little of that experience will emphasise nuclear work. The 'other category is an interesting deviation. It represents experienced people in their organisation, such as regulations but not nuclear. For those aged over 60 and some of those aged 51-60, they may have spent their entire career in the nuclear industry and, if joining from university, will have over 25 years of experience. Even for the Emirates, nuclear activity or radiological regulators were needed in the UAE before the nuclear power programme. It is worth mentioning that the five responders with more than 25 years of experience are from Russian Federation, Turkey, Sweden, Austria, and America.

The data presented in

**Table 13)** further delves into the years of experience based on the respondents' nationality. It reveals that among Emirati nationals, there was limited nuclear experience before the issuance of the nuclear policy in 2008.

In summary, the survey indicates the presence of experienced professionals within the UAE's nuclear industry, particularly within the 'nuclear organisations'. The range of experience spans from newcomers to highly experienced individuals, contributing to the successful establishment and operation of the civil nuclear programme.

### ‘Major Stakeholders’



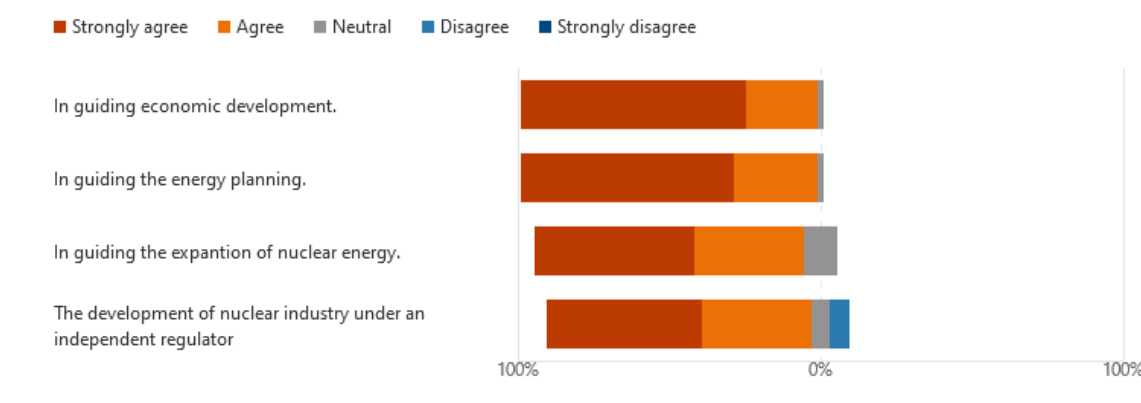
**Figure 18:** 'major stakeholders' employees' experience. Source: The Author

#### 4.2.2 Section 2: Strong State Involvement in Guiding Economic Development

This section aims to delve into the rationale behind the UAE's decision to pursue nuclear energy and explore the role of governmental organisations in shaping and implementing nuclear policy. The questions posed aim to uncover the methods employed by the government to contribute to the development of nuclear policy and shed light on the factors that led to the decision to invest in nuclear energy. This is particularly significant considering the UAE's unique position as a new-entrant state actively involved in the nuclear arena. Furthermore, the section seeks to examine the extent to which various organisations have contributed to the formulation and implementation of "The Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy" (referred to as Nuclear Policy)[18]. By understanding the involvement of these organisations, we can gain insights into the collaborative efforts and strategies employed by the UAE government to establish and foster the growth of the nuclear energy sector. Through exploring strong state involvement in guiding economic development, we aim to uncover the underlying motivations, decision-making processes, and collective efforts that have shaped the UAE's nuclear energy journey.

### Question 8

To what extent do you agree with the below statements on how the UAE government has significantly contributed to the development and implementation of the nuclear policy initiative?



**Figure 19:** Contributions and involvement. Source: The Author

The options have been developed based on the researcher's experience, a pilot study, Sovacool and Valentine articles [16, 20, 21], and discussion with the research supervisor.

Question 8 of the survey aimed to assess how respondents agreed with statements about the UAE government's contributions and involvement in developing and implementing the nuclear

policy initiative. The researcher used a Likert scale to determine the respondents' perceptions (refer to **Figure 19**). The analysis of the responses reveals the following key findings:

1. **Guiding Economic Development:** A significant majority of respondents (76%) strongly agreed that the UAE government had contributed significantly to guiding economic development, indicating a high level of support for the government's role.
2. **Guiding Energy Planning:** Similarly, most respondents (72%) strongly agreed that the UAE government is guiding or driving energy planning, indicating a strong belief in the government's involvement in shaping the country's energy landscape.
3. **Expanding Nuclear Energy:** Regarding driving the expansion of nuclear energy, slightly over half of the respondents (52%) strongly agreed, while 38% agreed. This indicates a substantial level of support for the government's efforts in promoting the growth of the nuclear energy sector.
4. **Development of the Nuclear Industry under an Independent Regulator:** Regarding the development of the nuclear industry under an independent regulator, 52% of respondents strongly agreed, 36% agreed, 6% were neutral, and 6% disagreed. This demonstrates a generally positive perception of establishing an independent regulatory authority to oversee the nuclear sector.

This is overwhelming support for significant government contribution planning and development of critical aspects of the UAE, where the nuclear programme is immersed, with support from within the expert population. Since the data is anonymous, the researcher cannot identify the respondent who disagreed with how the UAE government is involved in developing the nuclear industry under an independent regulator or whether there was any age, experience, or nationality influence. More respondents of any non-emirate background must be needed to ensure anonymity if delving too far.

It is worth mentioning that FANR is financing its operation from the licensing fees of the licensees. It also reports directly to the presidential office without interference from other governmental organisations. This method helped the nuclear regulator to be independent and transparent. Independence of the Regulator from those responsible for providing nuclear energy is critical in ensuring a safe industry whose regulator can maintain the trust of all involved, local communities and the general public. This is an internationally recognised pillar by IAEA on which to base civil nuclear power [186]. The small number of grey/blue colours

in the 4th part of this question strongly suggests general confidence within the industry about how their industry has been set up. According to the International Centre for Theoretical Physics and IAEA, the UAE's nuclear policy established an independent regulatory process for the peaceful nuclear energy programme. This nuclear policy also stated the UAE's intent to draft a comprehensive national nuclear law and establish a fully independent nuclear regulatory authority. [187]

Federal Law by Decree No 6 of 2009, concerning the peaceful uses of nuclear energy (the "Nuclear Law"), was issued by the President in September 2009. It aimed to guide and control the UAE nuclear sector towards peaceful purposes, ensure nuclear safety, security, and radiation protection, and prohibit the operation of enrichment and reprocessing facilities in the UAE. [187]

The establishment of the Federal Authority for Nuclear Regulation ("FANR") is stated in Article 2 of the nuclear law as the regulatory body of the UAE Nuclear Sector with independent legal personality, total legal capacity, and financial and administrative independence.

The independence of FANR stated:

1. Article 6, the sole issuer of licences and regulations to conduct regulated activities.
2. Article 10 prohibits the board members from engaging directly or indirectly in a regulated activity.

This indicates that the UAE government has been successful in garnering strong support from industry professionals, both in terms of guiding economic development and energy planning, as well as in driving the expansion of nuclear energy. The presence of an independent regulator adds to the confidence in the overall governance and safety of the nuclear industry.

Overall, the survey results demonstrate high confidence and support within the industry regarding the UAE government's contributions and involvement in developing and implementing the nuclear policy. Establishing an independent regulatory authority and adherence to international standards further enhance the credibility and trustworthiness of the UAE's nuclear programme. The findings from Question 8 affirm the positive perception of the UAE government's role in developing and implementing the nuclear policy, highlighting the government's contributions and effective involvement in shaping the nuclear sector.



**Question 9**

Which of the following is the most critical driver(s) of your organisation's contribution to implementing the Nuclear Policy?

Environmental	24
Energy management	30
Economic opportunities	19
International treaties.	20
Public opinion and health	19
Other.	4

**Table 14:** Contribution made to implementing the Nuclear Policy. Source: The Author

Note: Each responder has the option to choose multiple options.

The options have been developed based on the research experience, pilot study, Sovacool and Valentine articles [16, 20, 21], and discussion from the research supervisor. The researcher wanted to determine the most critical driver of their organisation's contribution toward successfully implementing a nuclear policy in the UAE.

Table 13 shows that 30 of the 50 respondents selected energy management as the most critical driver. This result aligns with the primary objective of the nuclear programme, which is to generate clean and secure power sources. Given the current geopolitical situation and the UAE's dependence on imported gas for power generation, nuclear energy presents an efficient solution with low gas emissions. The focus on energy management indicates the importance of achieving energy security and sustainability through nuclear power.

Environmental factors were also significant drivers, with 24 respondents selecting this option. This highlights the UAE's commitment to environmental sustainability and the desire to reduce carbon emissions through nuclear energy.

International treaties were chosen as critical drivers by 20 respondents, indicating the importance of aligning with global standards and regulations in the nuclear industry. The UAE's adherence to international agreements strengthens its credibility and demonstrates a commitment to nuclear safety and non-proliferation.

19 respondents selected economic opportunities associated with nuclear energy. This suggests that organisations recognise the potential economic benefits of developing and implementing

the Nuclear Policy. These opportunities may include job creation, investments, and the growth of related industries.

Additionally, 19 respondents identified public opinion and health as critical drivers. This reflects the importance of public acceptance and trust in the nuclear programme. Addressing public concerns regarding safety and health impacts is essential for successfully implementing the policy.

The "other" category of responses included drivers such as regulatory oversight, nuclear safety and risk management, transportation (logistics), and leading the national Nuclear Policy. These responses highlight additional factors that organisations consider significant in their contribution to the nuclear policy.

From (Table 14), energy management is the highest with 30. This is due to the main reason for the development of the programme, which is to produce clean energy and have secure sources of power. With the current and recent geopolitical situation (as was mentioned in the literature review), there is a high risk of dependence on imported gas to generate power. The UAE produces 1.7% of the world's wild gas production but consumes 2% to generate power[66]. Nuclear power is the most efficient solution for the UAE. That is due to low gas emissions. The environment also contributed to driving nuclear technology for power production. Other drivers are at a similar level. From the distribution of the responses, it is suggested that non are critically dominant over the rest.

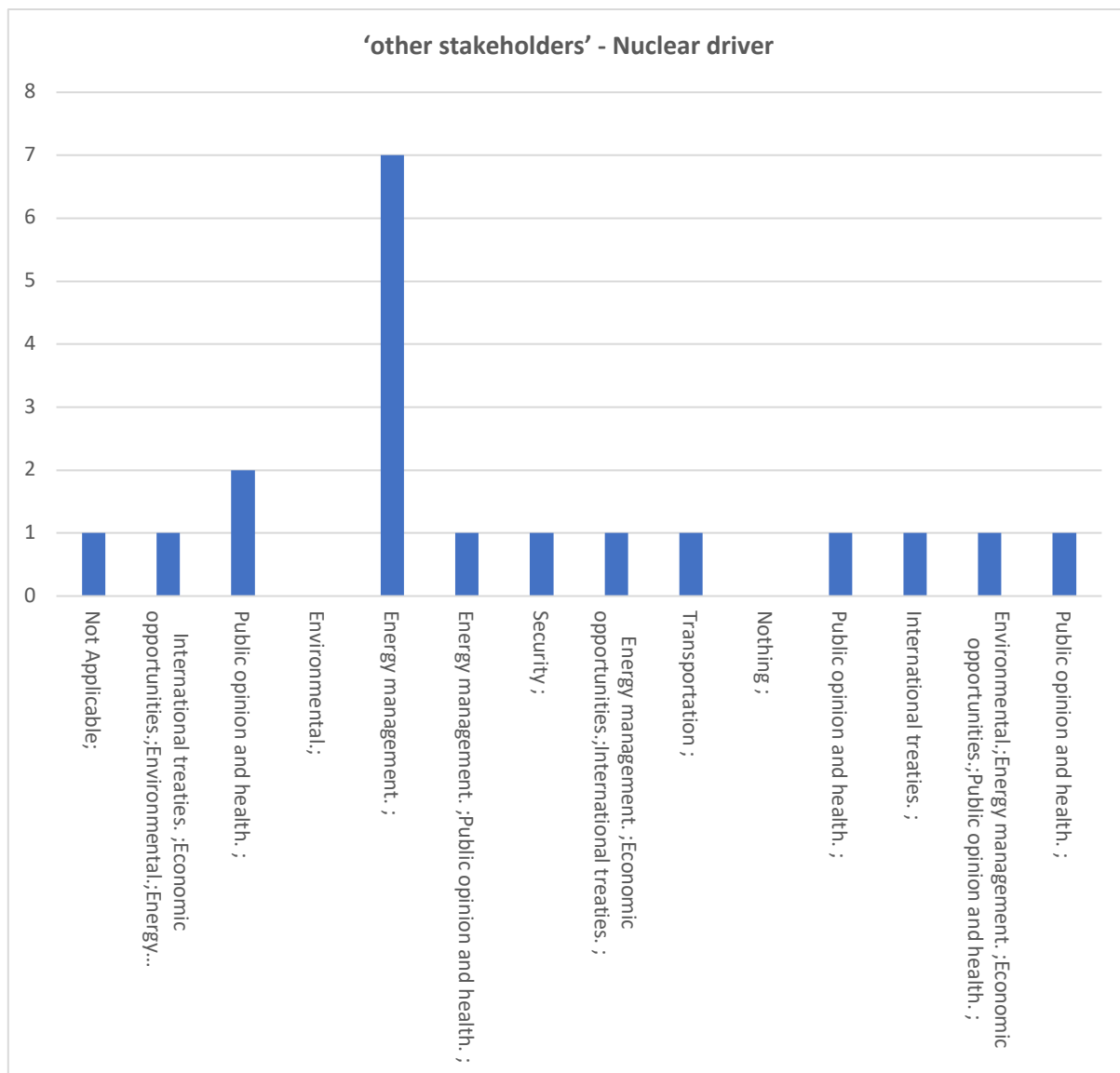
When analysing the distribution of responses, it can be observed that no single driver significantly dominates over the rest. The multifaceted nature of the drivers reflects the complex and interconnected aspects of implementing a nuclear policy. The result is explained by the questionnaire design following the literature review and pilot study, as well as the author being an experienced senior manager in ENEC.

Figures produced for 'nuclear organisations' respondents alone and for 'major stakeholders' respondents alone are similar to (Table 14). However, responses from the other 25 respondents (of the 'other' category) cited a wide range of drivers alongside energy management, as can be seen in (Figure 20).

In summary, the survey results demonstrate that energy management is the most critical driver of organisations' contributions to implementing the Nuclear Policy. Environmental considerations, international treaties, economic opportunities, public opinion, and health are

significant drivers. The findings emphasise the multifaceted nature of the nuclear policy and the need to address various aspects such as energy security, environmental sustainability, international cooperation, economic benefits, and public acceptance.

**‘other stakeholders’**



**Figure 20:** ‘other stakeholders’ - Nuclear Driver. Source: The Author

## Question 10

Which of the following is the most critical driver(s) of the contribution that your department (within the organisation) has made to implementing the Nuclear Policy.

Reduce gas emission and focus on environment (Climate Change).	19
Securing power resources and meet power demand increase.	24
Improving businesses opportunities and provide jobs.	20
Focusing on safety, security, safeguards, and other related international treaties.	30
Evaluating public input and considering their opinion.	10
Regulatory services.	18
Other.	4

**Table 15:** Contribution of department. Source: The Author

Note: Each responder has the option to choose multiple options.

Here, the researcher wanted to know the department's contributions to implementing the 'Nuclear Policy' and the department's contribution to Question 9 above. The options have been developed based on the research experience, pilot study, Sovacool and Valentine articles [16, 20, 21], and discussion from the research supervisor. The analysis of the responses from **Table 15** reveals the following key drivers and their corresponding number of selections:

1. Focusing on safety, security, safeguards, and other related international treaties: The most respondents selected this driver, with 30 indicating its significance in their organisation's contribution to implementing the Nuclear Policy. Safety, security, and adherence to international treaties are critical aspects of any nuclear programme to ensure operational integrity and prevent risks.
2. Securing power resources and meeting power demand increase: This driver was chosen by 24 respondents, highlighting the importance of ensuring a stable and sufficient power supply to meet the growing demand. Securing power resources is crucial for the successful implementation of the Nuclear Policy.
3. Improving business opportunities and providing jobs: 20 respondents mentioned this driver as a significant contribution of their organisation. It indicates the positive economic impact of the Nuclear Policy, creating business opportunities and employment prospects.

4. Reduce gas emissions and focus on the environment (Climate Change): 19 respondents recognised the importance of reducing and addressing climate change concerns as a critical driver for their department's contribution to the Nuclear Policy. This reflects the environmental focus and the commitment to sustainable practices.
5. Evaluating public input and considering their opinion: 10 respondents emphasised the importance of engaging with the public, assessing their input, and considering their views in implementing the Nuclear Policy. Public involvement and feedback are crucial in building trust and ensuring a transparent decision-making process.
6. Regulatory services: 18 respondents identified regulatory services as a significant driver of their department's contribution. This highlights the role of regulatory compliance and the need to maintain effective regulations for the safe and secure operation of nuclear activities.

From the analysis, it is evident that safety, security, safeguards, and other related international treaties are the most critical driver mentioned by the respondents, followed by securing power resources and increasing power demand. It is not surprising that in the following sub-figure, the respondents for the main 'nuclear organisations' have selected their own department's responsibilities as being driven by safety, security, and safeguards since the regulation of these aspects is the primary concern of the regulator (FANR) and the driving force they place on the licensee and operator (ENEC and NAWAH). The major and 'other stakeholders' emphasise other concerns more, with a small tendency toward environmental and security of supply issues. The 'major stakeholders' emphasised public opinion, economic opportunities, and the environment. This shows how the responsibilities are divided between 'nuclear organisations' and their 'major stakeholders'.

The overall information suggests that organisations recognise the importance of safety, security, and international obligations in their contributions to implementing the Nuclear Policy. Factors such as securing power resources, improving business opportunities, addressing environmental concerns, considering public input, and providing regulatory services also contribute to their contributions. The survey results demonstrate that various drivers influence departments' contributions to implementing the Nuclear Policy. Safety, security, and international obligations are the primary focus, reflecting the criticality of these aspects in the nuclear industry. The findings also highlight the interconnected nature of drivers, including power resource security, environmental considerations, public engagement, and effective regulatory services.

### Question 11

As your organisation contributed to setting or conducting the initial feasibility study of the Barakah Nuclear Power Programme before signing the nuclear contract in 2010, please indicate to what extent it was involved.

Strong direct involvement	8
Direct Involvement	13
Minor direct involvement	6
Indirect involvement	8
Minor indirect involvement	2
No involvement or little involvement	4
The organisation was not existed	7
Other	2

**Table 16:** Contributed to the initial feasibility study. Source: The Author

To determine an organisation's level of contribution or involvement in the initial feasibility study for the Barakah Nuclear power programme, the researcher asked respondents to indicate the extent of their participation in the study, as presented in Table 16. Eight stated that they were strongly involved. And 13 showed that their organisation was directly involved. Six said that their organisation was minor directly involved in the initial study. Eight stated that they had indirect involvement in the examinations, while two indicated little indirect involvement with the investigations. Seven showed that their organisation did not exist at that time. And 2 selected other options that they identified as leading the initial feasibility study of the Barakah Nuclear Power Programme

The leadership of the initial feasibility study must surely count as strong and direct involvement. Hence this category should have 10 (8 + 2 from the other option) responses. This means that 23 of the 50 respondents were direct involvement. This will affect their standpoint in later questions (see cross-cutting section).

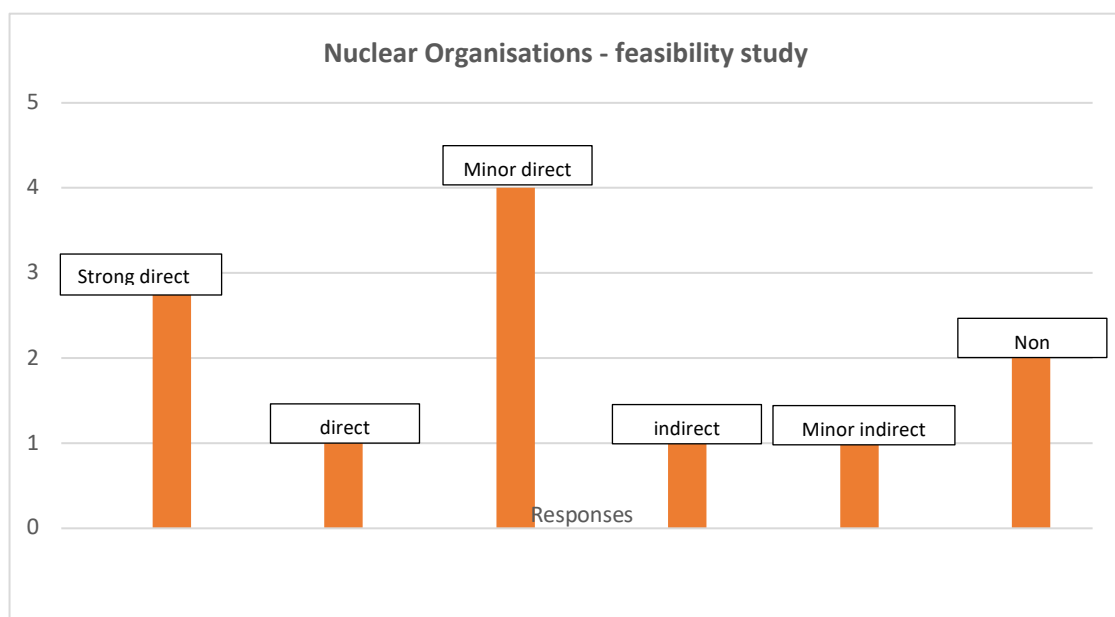
However, the direct and/or strong involvement is not restricted to the 'nuclear organisations' alone, as shown in the below figures (**Figure 21**, **Figure 22** or **Figure 23**). Even some of the 'other stakeholders', which span a range of lower tier organisations (contractors, consultants, sub-contractor, etc.), have some real and strong and/or direct involvement in the initial work before signing the contract.

Regarding the other stakeholders’ group, these organisations provide information or services to decision makers such as security, infrastructure services, etc. ‘Other’ are employees who formerly worked for nuclear programmes and changed jobs. NAWAH did not exist during the feasibility study.

The level of involvement in the feasibility study can shape organisations' perspectives and understanding of the nuclear programme. Those with direct or strong involvement may have a deeper understanding of the programme's intricacies, while those with little or no involvement may have a different perspective.

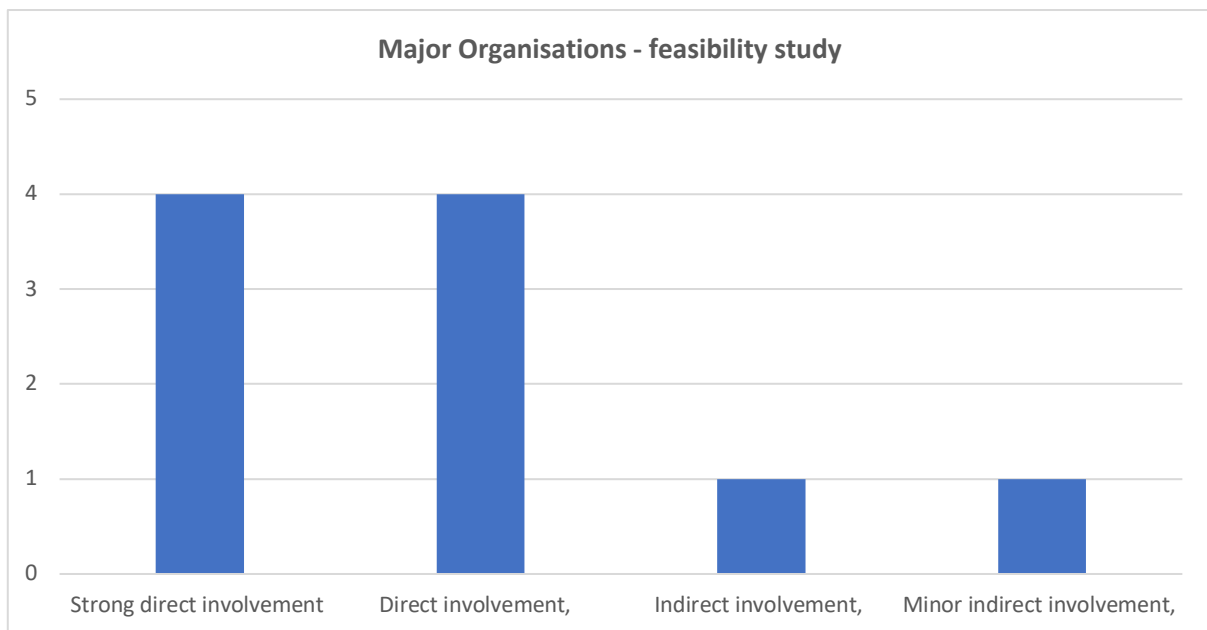
Overall, the survey results provide valuable insights into the extent of organisations' involvement in the initial feasibility study of the Barakah Nuclear Power Programme, highlighting the diverse range of contributions and potential variations in viewpoints among respondents based on their level of involvement.

**‘Nuclear organisations’**



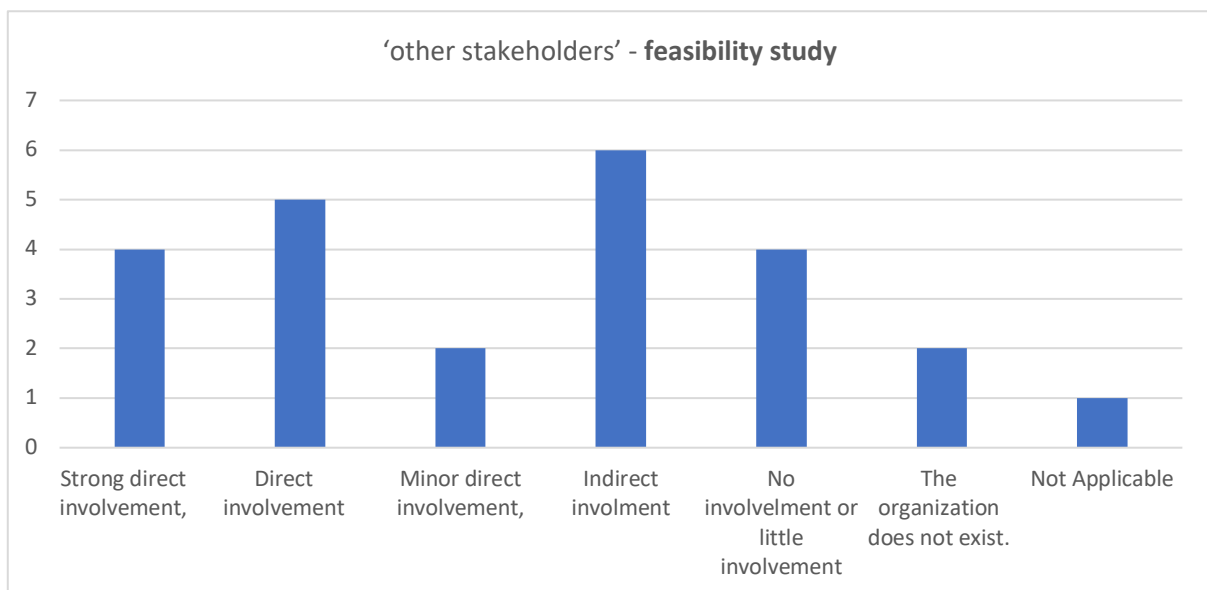
**Figure 21:** *Nuclear Organisations - feasibility study. Source: The Author*

**‘Major Stakeholders’**



**Figure 22:** *Major Organisations – a feasibility study. Source: The Author*

**‘Other stakeholders’**



**Figure 23:** *‘other stakeholders’ - feasibility study. Source: The Author*



## 4.2.3 Section 3: Centralisation of National Energy Planning

Nuclear Governance: the method of implementation of requirements to ensure compliance with national regulation and international requirements.

**Question 12**

How does your organisation help develop the national economy by supporting nuclear power as a primary source of electricity in the UAE? By Acting as:

Utility providers	12
Regulatory Authority	21
Public Authority representing the public	13
Support Service provider	21
Planning	9
Owner	6
Other	6

*Table 17: Development of the national economy. Source: The Author*

Note: Each responder has the option to choose multiple options.

The options have been developed based on the researcher's experience, pilot study and discussion with the research supervisor.

Here, the researcher wanted to find out how each organisation contributed to developing the national economy by supporting nuclear power as a primary source of electricity in the UAE, as presented in

**Table 17.**

The following analysis is made:

Out of the 88 responses received, several significant patterns emerge. 21 respondents indicated that their organisations contribute as regulatory authorities, highlighting the importance of ensuring compliance with regulations and overseeing nuclear activities in a regulated manner. Another 21 respondents stated that their organisations contribute as support service providers, emphasising the role of these organisations in offering essential services to the nuclear industry.

Additionally, 12 respondents mentioned that their organisations act as utility providers, indicating their involvement in supplying electricity generated from nuclear power to

consumers. 13 respondents stated that their organisations act as public authorities representing the public, suggesting that they play a role in communicating and representing public interests about nuclear power.

Furthermore, 9 respondents indicated that their organisations contribute to the planning aspect, underscoring their involvement in strategic decision-making and long-term planning related to nuclear power. Six respondents specified that their organisations contribute as owners, which could imply their ownership of nuclear assets or investments in the nuclear sector. Lastly, six respondents selected "other" options, which would require further clarification to understand their specific contributions.

The distribution of responses among different categories indicates the diverse and collaborative nature of contributions to developing the national economy through nuclear power. Regulatory authorities, support service providers, and utility providers play crucial roles in ensuring the safe and efficient operation of the nuclear industry. Public authorities representing the public contribute to safeguarding public interests, and organisations involved in planning contribute to the strategic development of the nuclear sector.

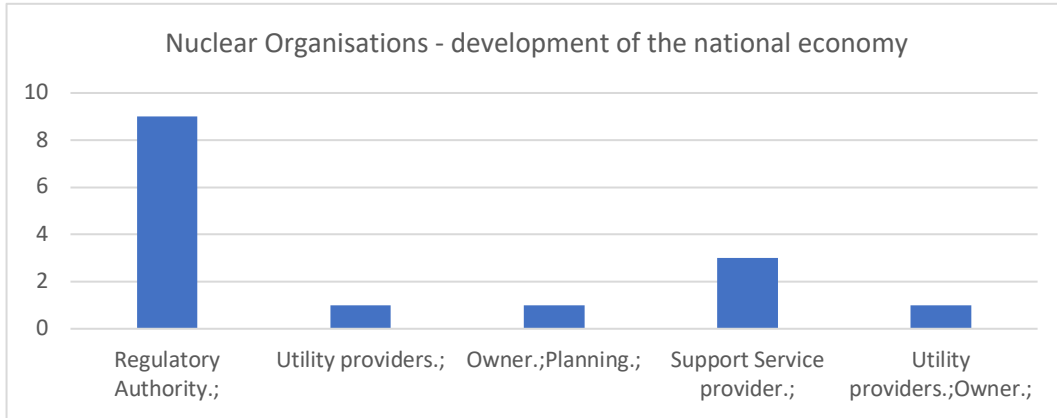
The findings suggest a well-established framework and collaboration among various organisations to support nuclear power as a primary source of electricity in the UAE. The regulatory oversight, provision of essential services, representation of public interests, and strategic planning collectively contribute to the development and success of the national economy in the context of nuclear power. On its own, it does not show a lack of public activism, but the result needs to be considered alongside interviews to reveal the extent to which the public are represented here.

From the figures below (Figure 24, Figure 25 and Figure 26), it is worth noting that the responses from 'nuclear organisations' and 'major stakeholders' are primarily concentrated in the regulatory authority category, reflecting their roles within the regulatory framework. On the other hand, the 'other stakeholders' category shows a higher proportion of support service providers, which may include organisations offering specialised services to the nuclear industry.

Overall, the survey results demonstrate different organisations' diverse and interdependent roles in supporting the development of the national economy through nuclear power. The collaborative efforts of regulatory authorities, support service providers, public authorities, and

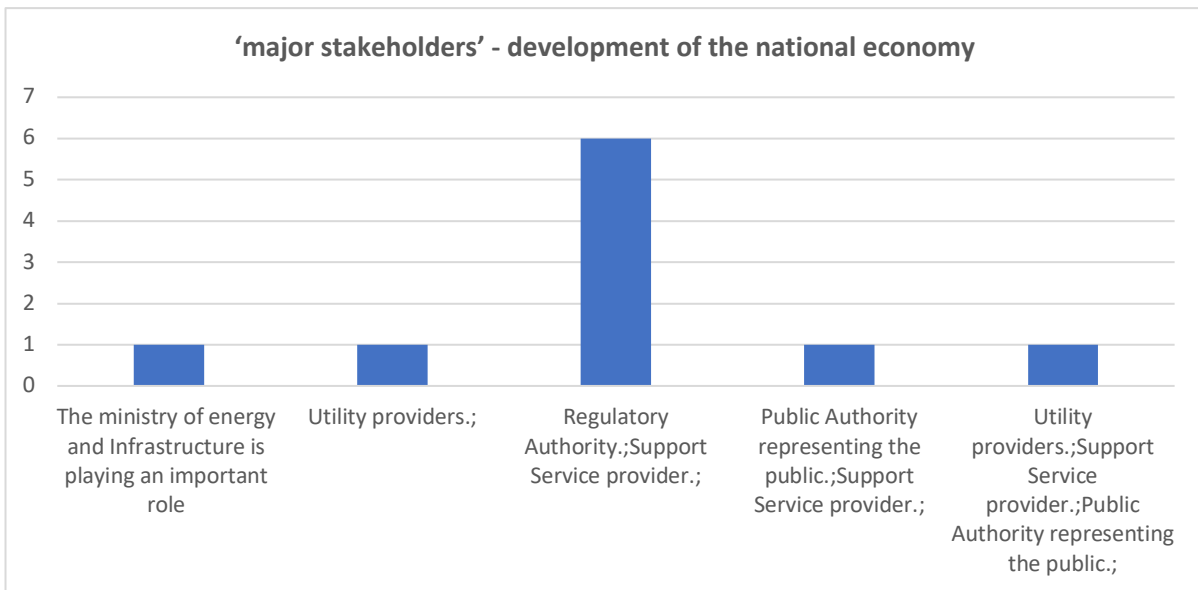
other stakeholders contribute to the successful implementation and operation of the nuclear power programme in the UAE.

**‘Nuclear organisations’**



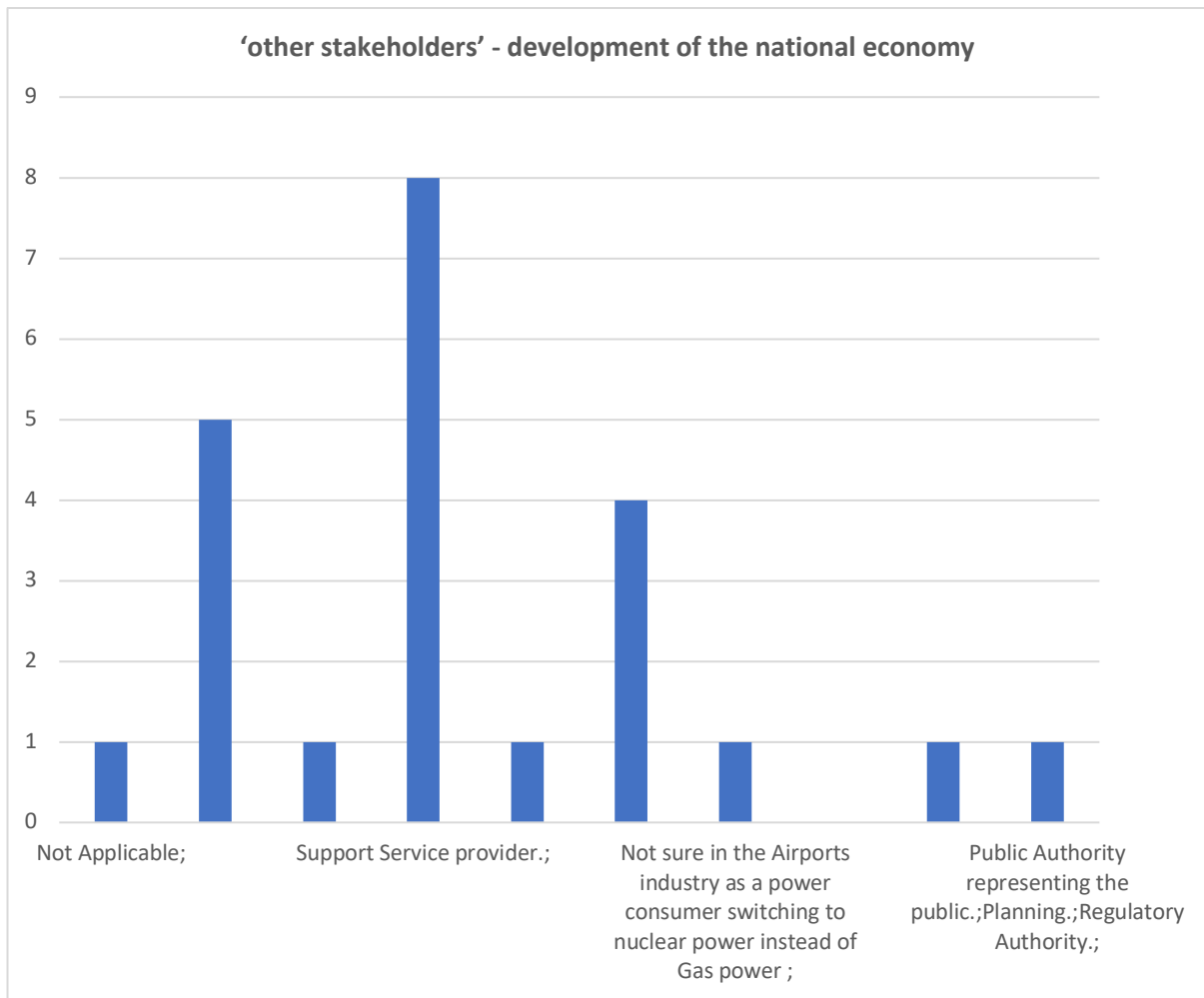
**Figure 24:** Nuclear Organisations. Source: The Author

**‘Main Stakeholders’**



**Figure 25:** Major Stakeholders. Source: The Author

**‘Other stakeholders’**



**Figure 26:** Other Stakeholders. Source: The Author

**Question 13**

In what areas did your organisation aid the government's decision to achieve the economic development plan associated with the Barakah nuclear power plant programme?

Assisting in guiding economic development (UAE vision 2021)	21
Centralization of national energy planning (UAE Energy Strategy 2050)	22
Campaigns to link technological progress with national revitalization (e.g., promoting technological advancement as method of moderation).	9
Influence of technocratic ideology on policy decisions (e.g., deploying & relaying on scientist & technical expert on policy decisions & implementations).	14
Working with government to overcome challenges and assisting other organisations.	23
Social need and public expression (UAE vision 2021).	10
Taking the advantages and utilising political agreements (UN/IAEA) to achieve government aim.	15
Environmental needs (UAE Green Growth Strategy).	14
Other	5

**Table 18:** Contribution to aiding the government's decision. Source: The Author  
 Note: Each responder has the option to choose multiple options. The listed options are based on the 'UAE Energy Strategy 2050' report [42]. The report provides the government's plans, challenges, and best international practices. Also, critical factors have been considered by Sovacool and Valentine articles [16, 20, 21].

The responses from 133 participants provide valuable insights into how organisations have aided the government's decision to achieve the economic development plan associated with the Barakah Nuclear Power Plant programme, as shown in

**Table 18.** The responses highlight the diverse contributions made by different organisations towards this goal.

The analysis derived from the responses to question 13 offers critical insights into the multifaceted roles organisations play to aid the UAE government's decision towards the economic development plan linked with the Barakah Nuclear Power Plant project.

Working hand-in-hand with the government to surmount challenges and assist other organisations was the most recognised contribution, having been mentioned by 23 respondents. This emphasises the importance of collective action and unity in achieving broader economic

goals. The role of organisations in centralising national energy planning as outlined in the UAE Energy Strategy 2050 was the second most acknowledged contribution with 22 mentions. This reflects an understanding the necessity of coordinated planning to realise the Barakah nuclear power plant programme and drive the UAE's holistic energy development.

Support in guiding economic development aligned with the UAE Vision 2021 was acknowledged by 21 respondents, highlighting the organisations' role in shaping economic policies and initiatives in backing the government's development blueprint. The influence of technocratic ideologies in policy decisions related to the nuclear power plant programme and the commitment towards sustainable development and environmental stewardship were each mentioned by 14 respondents.

The utilisation of political agreements, especially those involving international organisations like the UN and IAEA, to buttress the economic development plan was recognised by 15 respondents, highlighting the critical role of international collaborations. Ten respondents indicated the role of their organisations in addressing social needs and including public sentiments in decision-making processes, pointing to the significance of public engagement and inclusivity.

Promoting technological advancement as a national revitalisation strategy was acknowledged by nine respondents, demonstrating the lower emphasis on technological progress and public involvement in government organisation relations. Some respondents also mentioned unique contributions like research publications, identifying healthcare needs related to the project, and offering financial support.

In (Figure 27), 6 people have similar answers, but 2 other people also pick (Centralization of national energy planning) in non-similar answers. The type of organisations the respondents answered for showed slight variation in the importance of economic development as a driving force (see Figure 27, Figure 28 & Figure 29). Still, the centralisation of energy planning was not considered necessary for 'nuclear organisations' to the same extent as 'other stakeholders'. This is because the 'other stakeholders' provide general support.

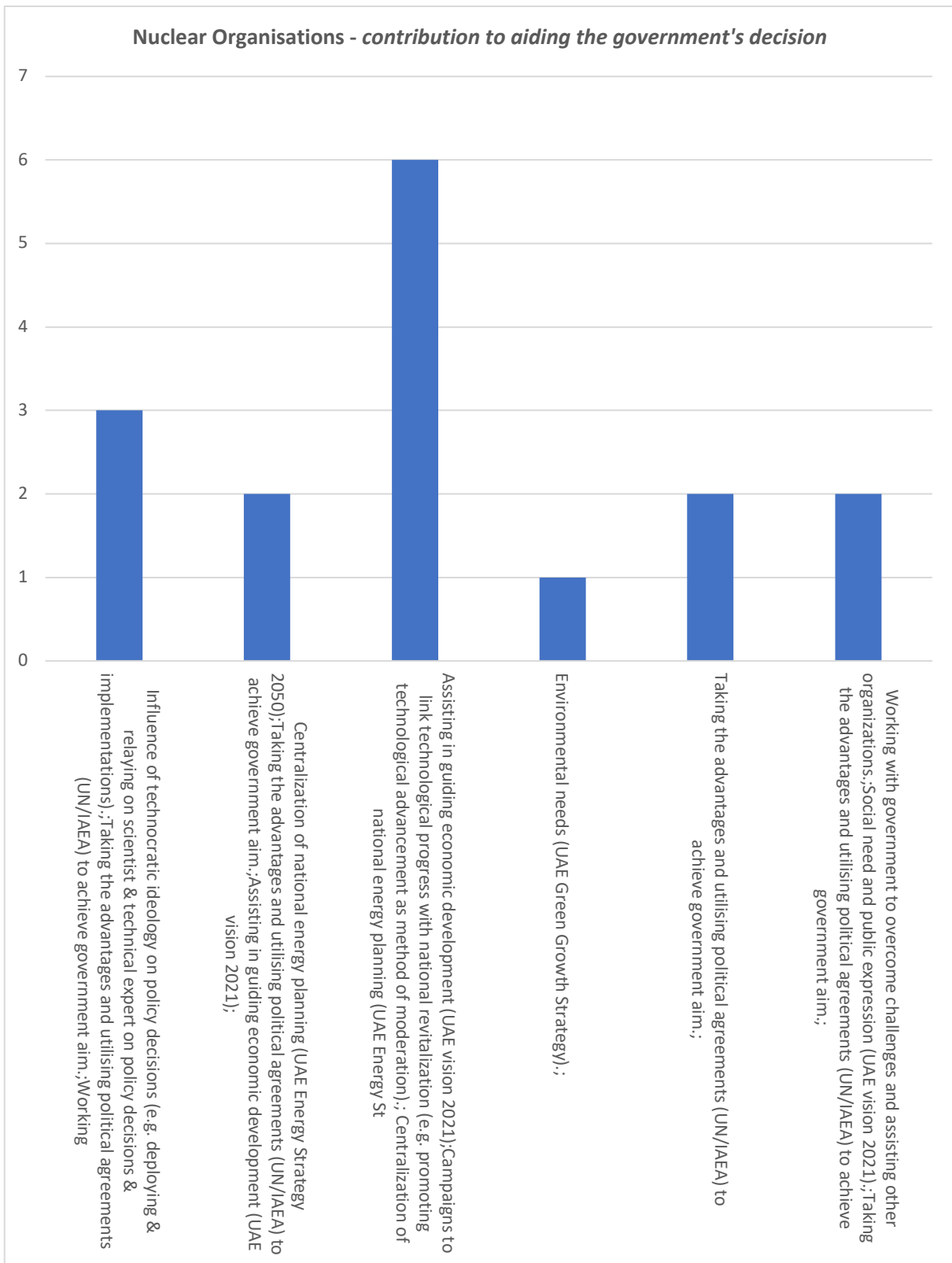
The UAE government uses a method to improve collaboration and coordination among different organisations. The method is based on the board of directors' selections. Each organisation will have board members from their 'major stakeholders' who are affected or play a major role in the decision taken. Due to this, we can see how the selection of provided options are focused on playing a significant role in assisting economic development (which has been

stated on the UAE vision 2021 and explained in Chapter 2), complying with national energy planning (defined at 2050 strategy) and contribute to overcome challenges and assist other organisations.

The findings indicate that organisations have played diverse roles in aiding the government's decision-making process for the Barakah nuclear power plant programme. Their contributions span economic development, energy planning, policy influence, environmental considerations, social needs, and public engagement. This comprehensive approach reflects the concerted efforts made by various stakeholders to ensure the programme's success and the UAE's overall economic development.

The data also reveals that different types of organisations prioritise specific areas of contribution. While centralisation of energy planning was considered more important for 'other stakeholders,' nuclear organisations focused more on economic development and working with the government to overcome challenges. This highlights the specialization and specific roles different types of organisations play in supporting the government's decision-making process. The findings demonstrate various organisations' collaborative and coordinated efforts in aiding the government's decision to achieve the economic development plan associated with the Barakah nuclear power plant programme. These collective contributions underscore the significance of multi-stakeholder involvement, technical expertise, sustainable practices, and public engagement in driving the programme's successful implementation and the UAE's broader economic goals.

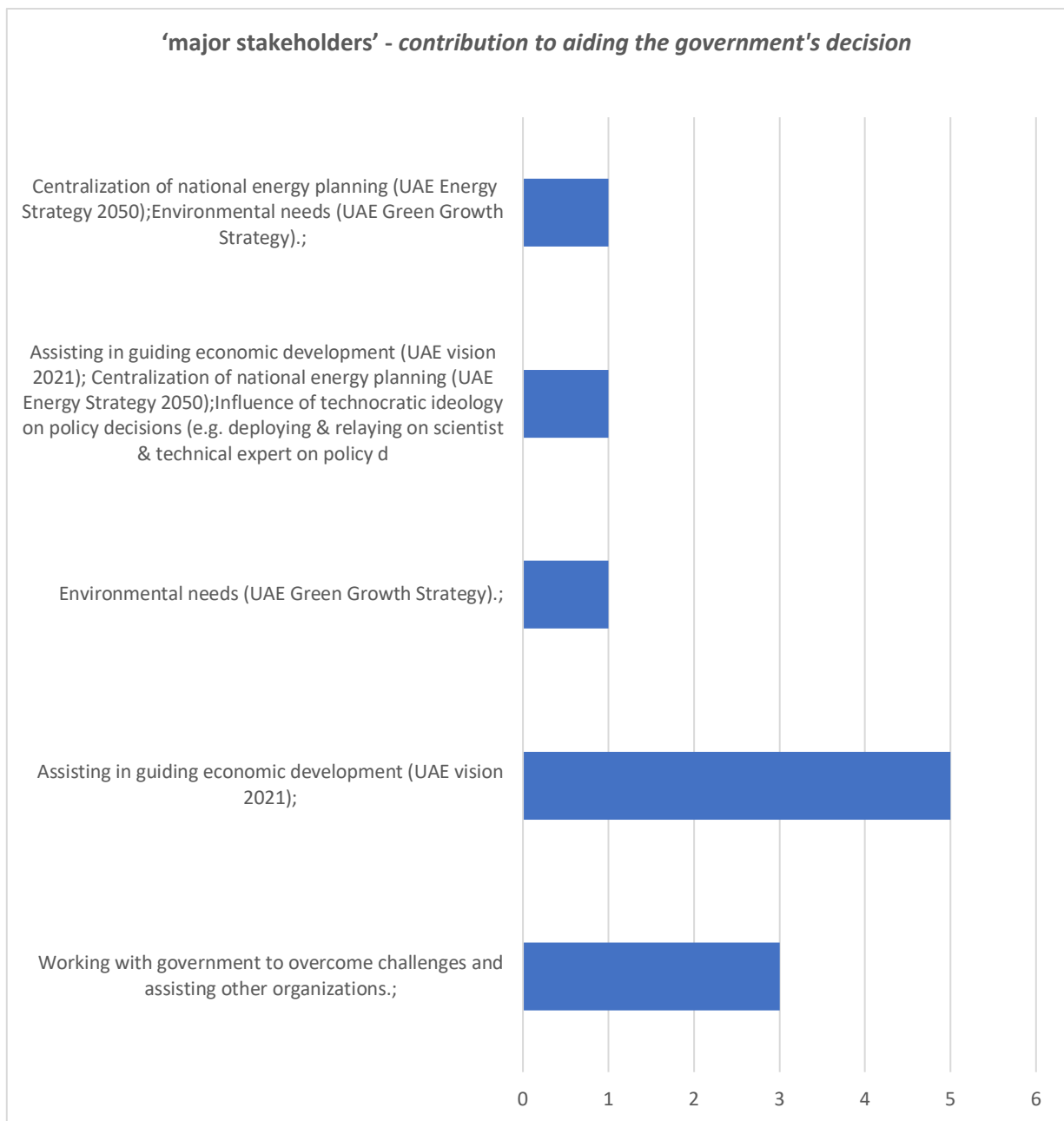
**‘Nuclear organisations’**



**Figure 27:** Nuclear Organisations. Source: The Author

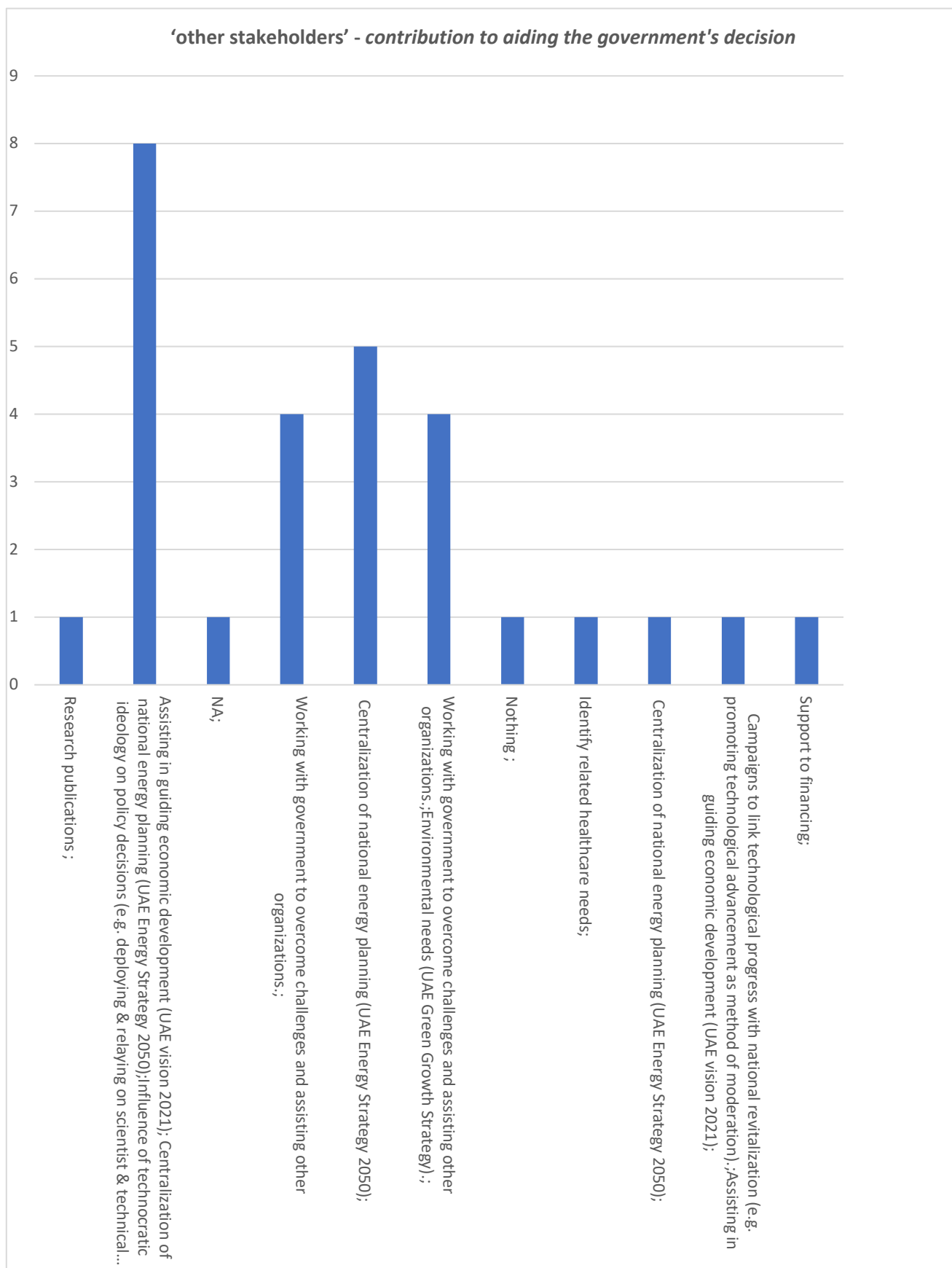


**‘Major stakeholders’**



**Figure 28:** Major Stakeholders. Source: The Author

**‘Other stakeholders’**



**Figure 29:** Other Stakeholders. Source: The Author

#### 4.2.4 Section 4: National Revitalisation of Technological Progress

This section explores the efforts made to promote the advancement of technology as a national goal in the context of the Barakah nuclear power plant programme. The survey data provides insights into the organisations' involvement in campaigns and initiatives to link technological progress to national revitalisation. Let's delve deeper into the data and analyse the responses.

#### Question 14

What challenges did your organisation encounter during the nuclear programme planning and implementation phases (including all activities before nuclear power generation)? You can select more than one option and add more, if any.

Lack of technical expertise/knowledge of staff.	24
Lack of administrative expertise/knowledge of staff	12
Lack of managerial expertise/knowledge of staff	14
Lack of professionalism amongst staff	11
Changes in government requirements or expectations	15
Changes in public or public body requirements or expectations	7
Lack of encouragement to public engagement in decision making.	2
Lack of legal framework and regulation.	11
Lack of other recent new-entrant country experience on which to draw	12
Lack of nuclear subject's education system which reflect on national human resources.	19
Other.	4

**Table 19:** Challenges. Source: The Author

The options were drafted during the pilot study based on discussion with nuclear regulatory experts, understanding of challenges mentioned in chapter two, "Nuclear Revitalisation Challenges" and discussion with the research supervisor.

In the preceding question, the researcher sought to find how organisations aided the government's decision towards achieving the economic development plan associated with the Barakah nuclear power plant; however, in this question, the researcher went on to ask about the challenges that respondent organisations encountered during the nuclear programme planning and implementation phases.

The responses to this question provide insights into the challenges encountered by organisations during the nuclear programme planning and implementation phases, as presented in

**Table 19.** A total of 131 responses were collected, and each option represents a specific challenge that organisations faced. The two challenges most often cited are linked to the nature of a new-entrant country to nuclear power. Education and technical expertise or training (refer to 2.7 'Challenges to the Creation of the Emirates Nuclear Programme' section) in a nuclear

environment will be lacking when a country first ventures into civil nuclear power, as there are few reasons for it to have been previously established. This question does not reveal, but other aspects of the study have clarified how these challenges impacted the creation and developments in Barakah.

The following is the analysis of the significant answers with a comprehensive summary:

Lack of technical expertise/knowledge of staff (24 responses) The most selected challenge was the need for more technical expertise and knowledge among staff members. This highlights the importance of the specialised skills and expertise required to plan and implement a nuclear programme successfully. It suggests that organisations needed help finding personnel with the necessary technical background and knowledge in the nuclear field.

Lack of administrative expertise/knowledge of staff (12 responses), some organisations also identified a need for more administrative expertise and knowledge as a challenge. This implies that managing the administrative aspects of a nuclear programme, such as regulatory compliance, project management, and coordination, presented difficulties for these organisations.

Lack of managerial expertise/knowledge of staff (14 responses), similar to administrative expertise, the lack of managerial expertise and knowledge was mentioned as a challenge. Effective leadership and management are crucial for overseeing complex projects like a nuclear programme, and the identified challenge indicates the need for developing managerial skills in this context.

Lack of professionalism amongst staff (11 responses), several organisations faced challenges related to professionalism amongst their staff members. This could encompass issues such as maintaining ethical standards, adhering to professional codes of conduct, and ensuring high competence and accountability within the workforce.

Changes in government requirements or expectations (15 responses), and the dynamic nature of government requirements and expectations posed challenges for organisations. The evolving nature of regulations, policies, and goals necessitates adaptability and flexibility during the planning and implementation phases of the nuclear programme.

Changes in public or public body requirements or expectations (7 responses), respondents also highlighted the challenge of meeting changing public or public body requirements and expectations. Public perception and opinions play a significant role in the acceptance and success of a nuclear programme, and organisations face challenges in aligning with these evolving expectations.

Lack of encouragement to public engagement in decision-making (2 responses), Only a small number of organisations identified the need for more encouragement for public engagement in decision-making as a challenge. This suggests that public involvement in the decision-making processes of the nuclear programme might have been a minor concern for these organisations. Lack of legal framework and regulation (11 responses), some organisations faced challenges related to the absence of inadequacy of a legal framework and regulations specific to the nuclear field. Robust legal frameworks and regulations are essential for ensuring safety, compliance, and effective governance within the nuclear programme.

The lack of other recent new-entrant country experience on which to draw (12 responses), and the lack of experience and lessons from other countries that recently embarked on a nuclear programme was mentioned as a challenge. New-entrant countries may face unique difficulties and need access to established best practices or previous case studies to guide their planning and implementation processes.

Lack of nuclear subject education system which reflects on national resources (19 responses); Organisations highlighted the challenge of a limited educational system that explicitly addresses nuclear subjects. This suggests a need for developing educational programmes and initiatives that foster the necessary knowledge and skills in the nuclear field within the national workforce.

Other (4 responses), A small number of respondents provided additional challenges not covered by the provided options. These challenges could vary and require further investigation to understand their specific nature and implications.

These findings emphasise the unique challenges faced by new-entrant countries in the nuclear industry. Investing in educational programmes and technical training bridges knowledge gaps and cultivates a skilled workforce. Adapting to changing expectations, establishing robust legal frameworks and regulations, and addressing educational needs are integral to successfully implementing the nuclear programme.

By addressing these challenges, organisations can enhance their capabilities, develop workforce expertise, and create an environment conducive to the safe and successful development of the UAE's nuclear industry. This challenge-centric analysis provides critical insights into specific areas that require focused efforts and actions to facilitate the smooth progression of the nuclear programme. Bridging knowledge gaps, fostering expertise, and establishing appropriate regulations and frameworks are pivotal steps in successfully planning and implementing the programme.

**Question 15**

How did your organisation overcome the above challenges, as indicated in question 14?

You can select more than one option and add more if any.

Economic prosperity and opening business opportunities.	15
Energy Security and subsidies with social benefits.	13
Reduce on fossil fuel reliance by proving alternative sources such as electrical cars services.	8
Enhancement on education and awareness.	21
Environmental advantages and provide/developing friendly green residential areas.	9
Promoting nuclear safety and advantages of use.	17
Following IAEA advice and recommendations.	20
Benchmarking best practices.	20
Establishment of a new specialization organisation.	13
Upgrading of existing related government organisations.	8
None of the above.	6
Other	3

**Table 20:** Overcome the challenges. Source: The Author

The options are developed based on above challenges (question 14), pilot study, LR and discussion with supervisor.

As a follow-up to the challenges identified in Question 14, the researcher wanted to understand how organisations overcame these challenges. The respondents gave a total of 153 responses as shown in **Table 20**. The responses from the organisations indicate various strategies and approaches they used to overcome the challenges faced during the nuclear programme planning and implementation phases. Here are the highlights:

Enhancement on education and awareness (21 mentions), respondent organisations indicated a significant emphasis on improving education and awareness as a key strategy in overcoming challenges. This effort sought to foster a better understanding of the nuclear programme, its benefits, and safety measures among stakeholders, bridging knowledge gaps.

Following IAEA advice and recommendations (20 mentions), International Atomic Energy Agency (IAEA) was critical to ensuring regulatory compliance with international standards and guidelines, promoting safe and effective nuclear programme implementation.

Benchmarking best practices (20 mentions) and learning from established nuclear programmes worldwide proved beneficial for organisations to identify effective strategies, processes, and technologies. This approach enhanced operational efficiency, helping them address the challenges associated with the nuclear programme.

Promoting nuclear safety and advantages of use (17 mentions), many organisations focused on promoting nuclear safety measures and highlighting the benefits of using nuclear energy. This strategy aimed to build public trust and foster a positive perception of the nuclear programme.

Another key strategy was economic prosperity and opening business opportunities (15 mentions), leveraging the nuclear programme for economic growth and opening new business opportunities. This focus on economic development contributed to attracting investments, fostering innovation, and creating jobs.

The high selection of "Enhancement on education and awareness," "Following IAEA advice and recommendations," and "Benchmarking best practices" highlights the organisations' recognition of the importance of knowledge sharing, learning from international experiences, and adopting industry-leading practices in the nuclear sector. These approaches effectively address knowledge gaps, regulatory compliance, and operational excellence challenges.

The emphasis on enhancing education and awareness can be attributed to introducing a new technology in the country. Given that many respondents have regulatory responsibilities, they understand the significance of international recommendations, such as those from the International Atomic Energy Agency (IAEA), and the importance of following best practices to ensure effectiveness. These choices demonstrate a focus on learning and educating local organisations to provide a well-informed and capable workforce.

Furthermore, the strategies mentioned, such as promoting nuclear safety, economic prosperity, energy security, and environmental sustainability, illustrate a comprehensive approach to overcoming challenges and ensuring the successful implementation of the nuclear programme. Organisations recognise the need to address various aspects, including safety, economic benefits, energy security, and environmental impact, to achieve long-term success.

It is worth noting that while other strategies related to public awareness of the programme's advantages were mentioned less frequently, they still play a role in tackling challenges. This highlights the importance of engaging the public and promoting the benefits of the nuclear programme to gain support and acceptance.

The organisations employed various strategies to overcome the challenges identified in Question 14. These strategies encompassed education and awareness, international guidance, benchmarking, safety promotion, economic prosperity, energy security, specialised organisations, environmental sustainability, reducing fossil fuel reliance, and upgrading existing infrastructure. The collective efforts of organisations demonstrate their commitment to addressing challenges comprehensively and ensuring the successful planning and implementation of the nuclear programme.



**Question 16**

How did your organisation create campaigns to link technological progress to national revitalisation?  
You can select more than one method and add more, if any.

Lobbying government or industry at Director level (board of directors from versus related organisations).	10
Collaborating with government or industry at senior official/management level	23
International forums, events, and exhibitions.	26
Domestic forums, events, and exhibitions.	25
Education, career fairs, scholarships, and sponsorship.	28
Printed material, media, and press/tv conferences.	13
Other	6

**Table 21:** Campaigns. Source: The Author

These options were developed based on the author experiences within his organisation ‘ENEC’. Also were discussed during the pilot study and some extracted from Energy Strategy 2050 [42].

This question examines the various methods organisations employed to construct campaigns that connect technological progress to national revitalisation. With 131 responses provided, **Table 21** shows the range of approaches, revealing a broad palette of strategies utilised. Education, career fairs, scholarships, and sponsorship (28 mentions):

Educational initiatives were the most mentioned approach, reflecting a dedication to fostering a climate of awareness and understanding around technological progress. Organisations reached out to diverse demographics, from students and professionals to the public, using these campaigns to generate enthusiasm and underline the abundant opportunities presented by advancements in technology.

International forums, events, and exhibitions (26 mentions), The frequency of references to international forums underscores a keen global outlook among the respondents. These events offered platforms for highlighting technological achievements, exchanging knowledge, networking with industry colleagues, attracting potential partners or investors, and, crucially, enhancing international reputations.

Domestic forums, events, and exhibitions (25 mentions), Domestic forums, events, and exhibitions provided a valuable touchpoint with local stakeholders, from government representatives to industry specialists. These events allowed organisations to cultivate collaboration, secure essential support, and align with national agendas promoting technological advancement.

Collaboration with government or industry at senior level (23 mentions), Respondents noted that forging strategic partnerships with senior officials in government and industry sectors was instrumental. Aligning with national priorities and leveraging these influential figures' expertise, resources, and networks helped promote technological progress and boost national revitalisation efforts.

Printed material, media, and press/TV conferences (13 mentions); Media engagement and press conferences offered an effective avenue for sharing information, celebrating success stories, and piquing public interest. These tactics aim to shape public perception, increase visibility, and highlight technological advancement's positive impact on national revitalisation.

Lobbying government or industry at the director level (10 mentions), Strategic lobbying efforts targeting influential stakeholders signified a proactive approach to shaping policy and gaining essential backing for technological advancement initiatives.

The high selection of education, career fairs, scholarships, and conferences, as well as international and domestic forums, events, and exhibitions, indicates a strong focus on promoting the advancement of technology as a national goal. This aligns with historical cases, such as promoting nuclear technology in France during the 1960s, as highlighted in Sovacool and Valentine's case study.[16, 20, 21]

These campaigns reflect the organisations' commitment to promoting technological progress and its contribution to national revitalisation. By employing various methods such as education initiatives, participation in forums and events, collaboration with stakeholders, media engagement, and strategic lobbying, organisations demonstrate their dedication to driving technological advancements and playing a role in achieving national revitalisation goals.

The organisations utilise diverse approaches to create campaigns that link technological progress to national revitalisation. These campaigns involve education and career-focused initiatives, participation in domestic and international events, collaboration with government and industry stakeholders, media and press engagement, and strategic lobbying efforts. Collectively, these efforts highlight the organisations' commitment to promoting technological advancements and their contribution to the country's overall development.

**Question 17**

Based on which data did your organisation monitor, analyse, and evaluate nuclear acceptance by the public? You can select more than one method and list others if any.

Face to face interview.	13
Question and answer sessions at events.	21
Posts and comments on social media.	17
Collected survey forms at forums and conferences.	14
Direct online questionnaires.	14
Participate and monitor the nuclear social activities.	15
My organisation is not evolving on nuclear acceptance by the public.	12
Other.	4

*Table 22: Nuclear acceptance. Source: The Author*

These options were developed based on the researcher's experiences within his organisation 'ENEC'. Also discussed during the pilot study and with the supervisor.

In Question 17, the researcher aimed to explore the methods used by organisations to monitor, analyse, and evaluate public acceptance of nuclear energy. 110 responses were received, indicating various data-gathering methods organisations employ. The following is a detailed analysis of the significant answers and the overall information:

Face-to-face interviews (13 mentions), Organisations adopting this traditional method can yield rich qualitative data, offering in-depth insights into public sentiment regarding nuclear energy. Direct interaction permits a nuanced understanding of people's attitudes, perceptions, and concerns, which is crucial for shaping effective communication strategies.

Question and answer sessions at events (21 mentions), Live Q&A sessions offer real-time engagement, enabling organisations to immediately address questions, demystify misconceptions, and gauge first-hand public sentiments. This interactive method encourages direct dialogue with the public, fostering a clear understanding of their queries and concerns.

Posts and comments on social media (17 mentions), The digital era has made social media a pivotal avenue for public discourse and opinion expression. Organisations can glean public sentiment trends and opinions about nuclear energy by tracking social media activity. This large-volume data analysis provides a real-time snapshot of the public's attitude.

Collected survey forms at forums and conferences (14 mentions); surveys, a structured approach to data collection, allow organisations to measure public opinions quantitatively.

Distributed during relevant events, these survey forms target specific audiences, providing data that can be statistically analysed for a well-rounded understanding of public sentiment.

Direct online questionnaires (14 mentions), Online questionnaires offer a practical way to reach a broader audience and collect large-scale data. This method gathers qualitative and quantitative data, providing a comprehensive view of public acceptance trends.

Participate and monitor nuclear social activities (15 mentions), Participation in nuclear-related social activities affords organisations the chance to assess public acceptance directly. Observing public reactions and interactions during these activities offers immersive insights into public sentiment and attitudes.

My organisation needs to evolve on nuclear acceptance by the public (12 mentions); some organisations do not actively monitor public acceptance of nuclear energy, either because they view public acceptance as irrelevant to their operations or they have a limited role in influencing public sentiment.

Other methods (4 mentions), A handful of organisations employ other unspecified methods, suggesting a bespoke approach to understanding public sentiment tailored to their unique needs and contexts.

The overall information suggests that organisations recognise the importance of understanding public sentiment and acceptance towards nuclear energy. They employ diverse methods to gather data, indicating a comprehensive approach to monitoring and analysing public acceptance. Organisations can better understand public sentiments and attitudes by utilising multiple channels such as face-to-face interactions, monitoring, surveys, online questionnaires, and participation in nuclear social activities. This enables them to make informed decisions, address concerns, and engage with the public effectively.

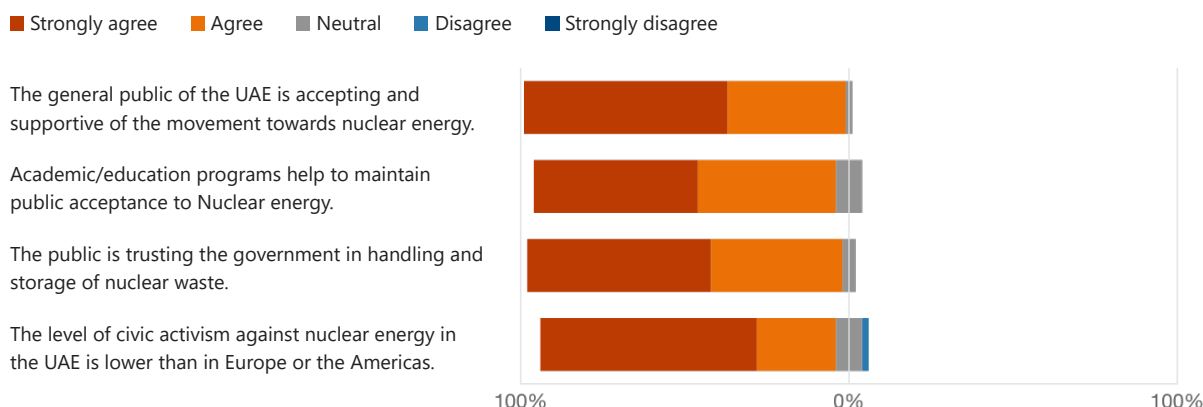
The organisations employ various methods to monitor, analyse, and evaluate public acceptance of nuclear energy. These methods include face-to-face interviews, question, and answer sessions at events, monitoring social media posts and comments, collecting survey forms at forums and conferences, using direct online questionnaires, participating in nuclear social activities, and other customised approaches. The collective efforts of organisations reflect their commitment to understanding and responding to public sentiment, contributing to the development and promotion of nuclear energy.

#### 4.2.5 Section 5: Influence of Technocratic Ideology on Policy Decisions

Technocratic ideology refers to the importance of technical expertise and knowledge in policy decision-making. In the context of nuclear energy programmes, the influence of technocratic ideology can be seen in the emphasis on promoting awareness of the benefits of nuclear energy among the public. This approach aims to maintain public acceptance and support for nuclear energy programmes.

#### Question 18

To what extent do you agree with the following statements?



**Figure 30: Technocratic Ideology.** Source: The Author

The options were extracted from ‘nuclear organisations ‘ENEC’ and ‘NAWAH’ surveys. The responses to these questions are similar to what has been reported at ‘ENEC’ website and the press. [149]

Question 18 aimed to assess respondents' agreement with statements related to public acceptance and trust in nuclear energy. The responses consistently showed strong agreement across all statements, indicating a high consensus regarding positive perceptions of public acceptance and trust in nuclear energy in the UAE.

The first statement, "The general public of the UAE is accepting and supportive of the movement towards nuclear energy," received strong agreement from most organisations. This suggests that professionals across various sectors widely believe that the public in the UAE accept and supports the country's nuclear energy initiatives.

The second statement, "Academic/education programmes help maintain public acceptance of nuclear energy," also received strong agreement from most organisations. This underscores the recognized importance of educational initiatives in promoting and sustaining public acceptance of nuclear energy.

The third statement, "The public trusts the government in handling and storing nuclear waste," received overwhelming agreement, indicating a high level of trust in the government's ability to safely manage and store nuclear waste. This trust is crucial for maintaining public acceptance and confidence in the UAE's nuclear energy programme.

The fourth statement, "The level of civic activism against nuclear energy in the UAE is lower than in Europe or the Americas," received strong agreement from most organisations. This suggests that respondents perceive a relatively lower level of opposition or activism against nuclear energy in the UAE compared to regions like Europe or the Americas. This finding aligns with reports of low civic activism in the country and reflects a favourable environment for the nuclear energy programme.

Together, the results in (**Figure 30**) demonstrate a strong bias toward agreement, indicating that respondents perceive low civic activism in the UAE and widespread acceptance of the nuclear policy, with trust in the government. This perception holds regardless of the type of organisations for which the respondents work. These factors have been identified as success factors in past civil nuclear programme developments worldwide.

The National Poll [149] has revealed enlightening statistics regarding residents' perceptions of the UAE Peaceful Nuclear Energy Programme. The poll included responses from over a thousand participants from diverse backgrounds, encompassing both UAE Nationals and expatriate residents. Notably, awareness of the programme increased from 58% in 2017 to 65% in the most recent findings. Furthermore, the survey indicated a growing confidence that the benefits of nuclear energy outweigh its risks, with positive sentiment increasing from 77% in 2017 to 78%. An overwhelming 85% of UAE residents, up from 83% in 2017, conveyed their support for the Peaceful Nuclear Energy Programme. Impressively, support from Al Dhafra residents surged from 84% in 2017 to 94%, reflecting the local community's growing trust in the programme.

Additionally, the belief that nuclear energy is a safe, clean, reliable, and efficient way to produce electricity rose dramatically from 82% in 2017 to 93% among Al Dhafra residents. In terms of faith in ENEC's commitment to upholding the highest standards of quality and safety for the Barakah Nuclear Energy Plant, an impressive 96% of residents endorsed this viewpoint, maintaining the same level of confidence as in 2017.[149]

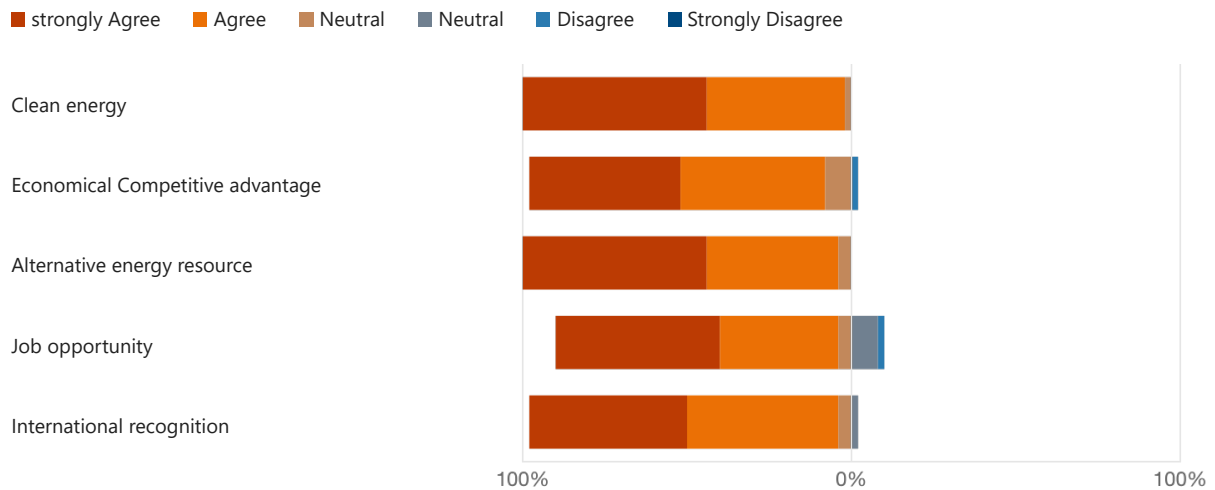
Key findings include high levels of awareness, support, and confidence among UAE residents regarding the peaceful nuclear energy programme. These findings align with the responses from the survey and reinforce the strong positive perception of public acceptance, trust in the government's handling of nuclear waste, and lower civic activism against nuclear energy in the UAE.

Overall, the responses to Question 18 indicate high public acceptance, trust, and support for nuclear energy in the UAE. These findings are consistent with external surveys and reports, demonstrating positive perceptions among residents and professionals. The strong alignment between the government's technocratic decision-making approach and public sentiment further reinforces the success and acceptance of the nuclear energy programme.

The harmonious synthesis of survey responses, external data, and a technocratic decision-making approach underscores public acceptance, trust, and support for nuclear energy in the UAE. This positive perception is vital in ensuring a symbiotic relationship between policy decisions and public acceptance of nuclear energy in the country.

### Question 19

To what extent do you think the following characteristics influenced developing the Barakah Nuclear Power Programme?



**Figure 31:** Characteristics. Source: The Author

Question 19 aimed to assess the extent to which respondents believed that certain characteristics were influential in developing the Barakah Nuclear Power Programme. The responses indicate a strong consensus among the participants, with a majority agreeing or strongly agreeing with the suggested characteristics. Again, the responses were concentrated left of centre, meaning that those asked tended to agree with the suggestion that these 5 characters of the programme were influential. In fact, the (5 highly) lesser support is for job opportunities being influential, but none strongly disagree with any of the suggestions.

Analysing the data from Figure 31 provides insightful findings: 56% of respondents strongly agreed that the importance of a clean energy source was instrumental in developing the Barakah nuclear plant, emphasising a recognition of clean energy's significance in the programme's development. 46% of respondents strongly agreed that economic and competitive advantages played a significant role. This perception underlines the belief that the programme holds the potential to confer economic benefits and enhance the nation's competitiveness. 56% of respondents strongly agreed that securing an alternative energy source was crucial. This viewpoint reflects an understanding of the imperative to diversify the energy portfolio and reduce dependence on traditional energy sources. 50% of respondents strongly agreed that creating job opportunities was consequential. This belief illustrates the perceived capacity of the programme to foster employment and promote economic growth. Finally, 48% of respondents strongly agreed that international recognition was a programme objective,



suggesting an ambition to position the UAE as a leader in the nuclear energy sector and achieve worldwide recognition.

The collective responses indicate a shared belief among respondents that these characteristics fundamentally influenced the development of the Barakah Nuclear Power Programme. The strong consensus transcends the specific types of organisations that respondents represent, suggesting a common understanding of the importance of clean energy, economic competitiveness, alternative energy sources, job creation, and international recognition in the programme's development.

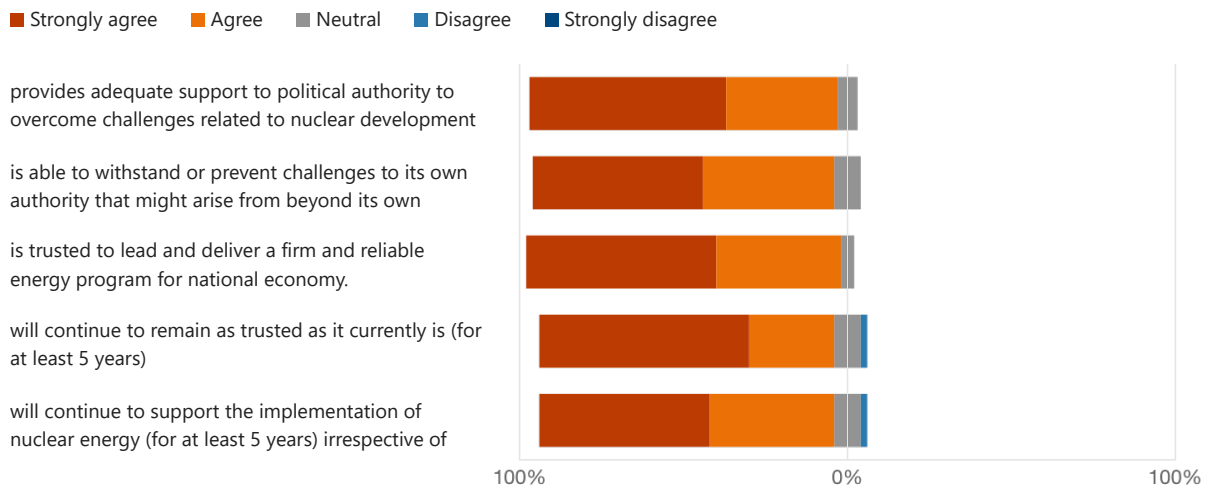
These findings align with the UAE's nuclear energy programme's goals and objectives, emphasising the significance of clean and sustainable energy, economic development, and establishing the country as a global player in the nuclear energy sector. The strong state involvement mentioned by Sovacool and Valentine [16, 20, 21] further emphasises the successful strategies observed in other worldwide civil nuclear programme developments.

In summary, the responses to Question 19 highlight the perceived significance of clean energy, economic competitiveness, alternative energy sources, job creation, and international recognition in developing the Barakah Nuclear Power Programme. The consensus among respondents supports the alignment between these characteristics and the objectives of the UAE's nuclear energy strategy.

4.2.6 Section 6: Subordination of Challenges to Political Authority

**Question 20**

To what extent do you agree with the following statements about the UAE government:



**Figure 32:** The UAE government. Source: The Author

The options have been developed based on the research experience, pilot study, Sovacool and Valentine articles [16, 20, 21], and discussion from the Professor.

Question 20 aimed to assess the extent to which respondents agree with statements about the UAE government's role in overcoming challenges related to nuclear development. The responses indicate high confidence and trust in the government's ability to support and lead the nuclear programme. Subordination of challenges to political authority is one of the six success factors identified from historical development programmes by Sovacool and Valentine [16, 20, 21]. In this question, the researcher wanted to determine the extent to which respondents agree with the statements above about the UAE government. A total of 50 responses were collected from the chosen organisations.

Analysing the data from **Figure 32** yields significant findings: 60% of respondents strongly agreed that the UAE government provides sufficient support to political authorities for overcoming challenges related to nuclear development. This view suggests a perceived level of government assistance in identifying and addressing challenges within the nuclear sector. 52% of respondents strongly agreed that the UAE government could resist or neutralise challenges to its authority from beyond its borders. This belief signifies confidence in the government's ability to safeguard its authority and manage external threats that could impact the nuclear programme. 58% of respondents strongly agreed that the UAE government is trusted to lead and deliver a robust and reliable energy programme for the national economy.

This view reflects a high trust in the government's leadership and its capacity to ensure the successful implementation and operation of the energy programme, including the nuclear sector. 64% of respondents strongly agreed that trust in the UAE government will persist for at least five years. This belief represents strong confidence in the government's consistency and dependability in handling the nuclear programme, resulting in sustained trust and confidence in its actions and decisions. 52% of respondents strongly agreed that irrespective of internal objections, the UAE government will continue to support the implementation of nuclear energy for at least the next five years. This perception suggests a commitment from the government to the long-term development and progression of nuclear power, even in the face of potential domestic opposition or challenges.

The overall information from the responses indicates a strong consensus among the organisations surveyed regarding the UAE government's role in overcoming challenges and ensuring the success of the nuclear programme. The high agreement levels suggest confidence in the government's support, authority, and ability to deliver a reliable and sustainable energy programme.

These findings align with the research objective of assessing the subordination of challenges to political authority in the UAE's nuclear programme. The strong bias towards agreement reflects a positive perception of the government's support for organisations involved in the nuclear programme and their ability to overcome challenges.

In summary, the responses to this question highlight the high level of confidence and trust in the UAE government's ability to provide support, withstand challenges, lead the energy programme, maintain trust over time, and support the implementation of nuclear energy. The consensus among respondents demonstrates a positive perception of the government's role in the nuclear sector and its commitment to ensuring the success and reliability of the programme.

### ***Question 21***

Please elaborate on the government's role in supporting its organisation in overcoming challenges in developing the nuclear programme.

Also, outline what can create internal objections to nuclear energy and what mitigation exists to support the continued use of nuclear power.

This question aimed to gather insights on the importance of the government's role in supporting its organisations in overcoming challenges related to nuclear development. The responses provided valuable perspectives on the topic, shedding light on the significant role played by the UAE government in supporting its organisations and addressing challenges in developing the nuclear programme.

The analysis of the responses reveals several key points:

1. Strong support and confidence:

The internal population is supportive and confident in the government's measures for a safe and reliable nuclear programme. This indicates a high trust and belief in the government's ability to address safety concerns and ensure the programme's success.

2. Policy interventions:

The government is crucial in removing obstacles and creating incentives through policy interventions. These interventions include regulatory and non-regulatory tools such as fees, taxes, awareness campaigns, and behavioural insights. The aim is to achieve the government's objectives in developing the nuclear programme.

3. Positive perception of government decision-making:

There is a belief that objections to government policies, including the nuclear programme, are unlikely to arise. This suggests a positive perception of the government's decision-making process and the public's acceptance of its policies.

4. Comprehensive support:

The government's support extends from budget allocation to education and covers decision-makers at all levels. This highlights the comprehensive nature of government support and its commitment to developing the nuclear programme.

5. Addressing nuclear waste:

The potential internal objection mentioned is related to nuclear waste. This highlights the importance of addressing waste management and ensuring proper disposal methods to alleviate concerns and objections.

6. Leadership in infrastructure development:

The government should lead in developing the nuclear industry infrastructure, supporting services, and necessary policies such as nuclear waste policy. This emphasises the government's role in providing a favourable environment for the growth and sustainability of the nuclear sector.

7. Public trust in the government:

The people trust the government, essential for garnering support and confidence in the nuclear programme.

8. Challenges from other energy sectors:

Challenges may arise from the fossil fuel and solar energy industries. It is essential to have a clear national strategy emphasising an efficient energy mix to address potential opposition from these sectors. Diversifying the energy mix and promoting nuclear energy as clean energy are crucial steps.

9. Collaboration and support from stakeholders:

The government's role in supporting organisations involved in the nuclear programme is vital for overcoming challenges. This highlights the collaborative nature of the government-industry relationship and the need for support from various stakeholders.

10. Clear and transparent communication:

Clear and transparent communication is crucial in mitigating objections and maintaining public trust. Providing continuous updates, information on benefits and risks, and transparency in business operations and plans are important in building public acceptance.

11. Role of the regulatory body (FANR):

The establishment of FANR as the regulatory body has been instrumental in ensuring safety, security, and international cooperation in the nuclear sector. FANR's transparency, sustainability efforts, and recognition from the International Atomic Energy Agency (IAEA) contribute to the overall success of the nuclear programme.

After reviewing the responses, it is clear that the Emiratis trust the government and support its plans and decisions. The government is working hard to remove obstacles to public goods via regulatory and non-regulatory tools. It also utilises its ministries and organisations to overcome challenges to implement its plans. This is in addition to using a high budget, educating young Emiratis, and directing decision-makers to support the programme. The government is encouraging the private sector to invest in nuclear by leading and supporting nuclear infrastructures.

Regarding the country's challenges from importing natural gas and the high cost of solar energy, the government is trying to utilise nuclear power to diversify its energy mix. That is done by promoting nuclear energy as clean energy. FANR as a regulator utilised best practices and outreach programmes and complied with international treaties to promote transparency, sustainability, capacity building and international recognition. All of that was in line with points made by Sovacool and Valentine.

The overall information from the responses highlights the significance of the government's role in supporting the development of the nuclear programme. The government's proactive approach, allocation of resources, regulatory measures, and collaboration with stakeholders contribute to overcoming challenges and ensuring public acceptance. The emphasis on transparency, safety, sustainability, and international recognition aligns with the research objective and the success factors identified by Sovacool and Valentine. The responses to Question 21 emphasise the importance of the government's role in supporting its organisations, addressing challenges, and promoting public acceptance of the development of the nuclear programme. The government's efforts in regulation, resource allocation, education, policy development, and communication contribute to the success and sustainability of the programme. The comments reinforce the positive perception of the government's commitment to safety, transparency, and the long-term viability of nuclear energy in the UAE.

#### 4.2.7 Section 7: Low Levels of Civic Activism

Low levels of civic activism were influential factors in supporting the nuclear programme. This means there needed to be more widespread public activism or engagement in opposing or questioning the development of the nuclear programme. The absence of comprehensive public consultation as part of the National Law meant that governmental departments represented the public in decision-making processes related to the nuclear programme.

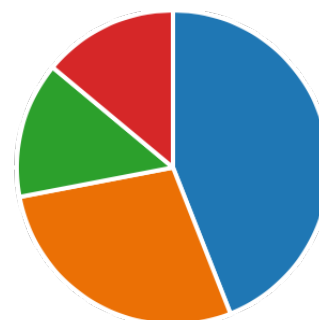
The questions in this section aim to investigate legal activities in which people may engage to demonstrate their objection to, disrupt, or discourage the development of the nuclear programme. These questions do not focus on illegal or subversive activities, as those are presumed to be restricted to a minority (if any) and are not expected to have public support.

This section explores the extent of civic activism and public engagement about the nuclear programme. It seeks to understand the level of opposition or support expressed through legal means and activities.

#### **Question 22**

Is there a recognisable role in civic activism in the Emirates?

● Yes	22
● No	14
● Maybe	7
● Other	7



**Figure 33:** a recognisable role for civic activism in Emirates. Source: The Author

This question investigated whether civic activism has a recognisable role in the United Arab Emirates (UAE). The data from **Figure 33** reveals that out of the 50 responses received, 22 indicated the presence of a recognisable role for civic activism in the UAE. At the same time, 14 disagreed and stated that there is no such role. Seven respondents expressed uncertainty with a "maybe" response, and seven provided other comments.

Among the other responses, some participants mentioned that the entire population of the UAE supports the nuclear programme. In contrast, others suggested that civic activism might develop after the operation of the Barakah plant begins. It is worth noting that the UAE has a population composition where citizens comprise approximately 10% of the total population [2], while the majority consists of people from different nationalities working in the country

[3]. This gives the impression that some individuals from other nationalities may not support the nuclear power programme.

The overall information derived from the responses indicates that civic activism in the UAE, particularly regarding the nuclear programme, is perceived to be relatively low or less pronounced compared to other countries or contexts. Most respondents either disagreed or expressed uncertainty regarding the existence of a recognisable role for civic activism in the UAE. This suggests limited public engagement or organised activism surrounding the nuclear programme in the country.

These findings raise several important points for further analysis and consideration. It is crucial to explore the reasons behind the perceived low level of civic activism in the UAE, especially about the nuclear programme. Factors such as cultural norms, the role of the government in decision-making processes, and the composition of the population with a significant expatriate workforce may contribute to this perception. Additionally, understanding the potential impact of low civic activism on public engagement, decision-making processes, and policy development related to the nuclear programme.

In summary, the responses to Question 22 indicate low civic activism in the UAE, particularly concerning the nuclear programme. Most respondents either disagreed or expressed uncertainty regarding the existence of a recognisable role in civic activism. Further analysis and exploration of the reasons behind this perception would provide valuable insights into public engagement and decision-making processes surrounding the nuclear programme in the UAE.



**Question 23**

In your opinion, how did the government (through your organisation) maintain social acceptance of nuclear energy development? Please list other methods as other options.

By introducing intensives education programmes.	30
Reliance on interaction with different government departments and other recognised public representatives.	25
Participate or organise Events/forums.	33
Promote sustainability on energy as part of institutional programmes service enhancement and communication department.	28
Promote nuclear energy benefits and awareness on the social media and TV.	32
Having higher rate of subsidised services.	8
Provide job opportunities.	28
International recognition and relations.	26
Trade alliances with major countries.	15
Other.	4

**Table 23:** Social acceptance of nuclear energy development. Source: The Author

Note: Each responder has the option to choose multiple options.

The options have been developed based on the research experience, pilot study, Sovacool and Valentine articles [16, 20, 21], and discussion from the research supervisor.

The research aimed to investigate how the government, through respondent organisations, maintains social acceptance of nuclear energy development. The data indicate that the government has implemented multiple strategies to achieve this goal, as shown in

Table 23. A detailed analysis of the significant answers is as follows:

The study emphasises the pivotal role of educational initiatives in shaping public perceptions about nuclear energy, as indicated by 30 responses. By introducing intensive education programmes, the government seeks to inform the public about nuclear energy's benefits, safety measures, and realities. This strategy effectively dispels unfounded fears and misconceptions, ensuring public opinion is based on facts rather than baseless fears.

Communication and collaboration with government departments and public representatives have also emerged as key factors, as underscored by 25 respondents. Regular interactions

between these entities help facilitate stakeholder engagement, essential for maintaining social acceptance and support for nuclear energy development.

Another significant finding, supported by 33 respondents, is the utility of events or forums as platforms for dialogue and information dissemination. These platforms engage the public and address their concerns related to nuclear energy. This strategy fosters transparency and trust, making the public feel heard and valued in the conversation about nuclear energy development.

The role of promoting sustainability as part of institutional programmes is also highlighted, receiving support from 28 respondents. This strategy frames nuclear energy as a sustainable solution to the world's energy needs, presenting the government's commitment to a responsible and forward-thinking approach.

Furthermore, the study strongly focused on public outreach through social media and TV campaigns. Thirty-two respondents acknowledged this strategy as instrumental in raising awareness about nuclear energy's benefits and shaping positive public perceptions. This finding underlines the media's significant role in influencing public opinion and gaining social acceptance.

Moreover, providing job opportunities in the nuclear sector is an effective strategy. According to 28 respondents, this economic incentive contributes significantly to local economic development and social acceptance, highlighting the interplay between economic factors and public opinion.

The importance of international recognition and alliances, highlighted by 26 respondents, is another factor that boosts the credibility of the UAE's nuclear programme. Collaboration with international organisations reinforces acceptance and ensures the UAE aligns with global best practices in nuclear energy development.

15 respondents have emphasised trade alliances with significant countries involved in the nuclear field as a factor that can enhance social acceptance. These alliances symbolise economic cooperation and contribute to the overall acceptance and success of the UAE's nuclear programme.

The study also records a miscellaneous category of strategies employed to maintain social acceptance, as mentioned by four respondents. The specifics of these methods should have been provided, suggesting the need for further inquiry for a complete understanding. These could encompass diverse strategies not mentioned in the survey options.

Lastly, the relatively low response rate to the availability of subsidised services (8 responses) could be attributed to the comparatively low electricity costs in the UAE and the country's pre-established contracts, such as the turnkey contract with KEPCO, a Korean nuclear contractor. This finding suggests that economic factors, while significant, may play a different role depending on the specific context of the country in question.

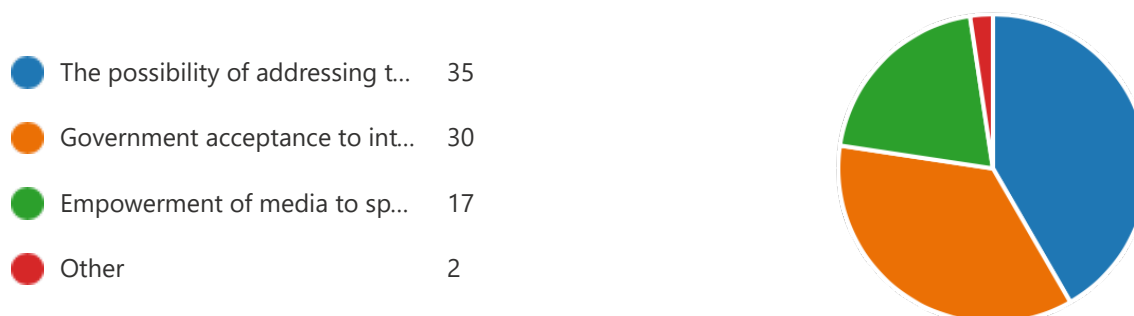
It is important to note that the responses suggest a multi-faceted approach to maintaining social acceptance, encompassing education, communication, economic incentives, international engagement, and collaboration with various stakeholders. This comprehensive approach demonstrates the efforts made by the government and respondent organisations to address different aspects of social acceptance and build public support for nuclear energy development in the UAE.

The general response is balanced across most strategies except subsidisation and trade alliances. This can be attributed to the low electricity cost rate in the UAE and the signing of a turnkey contract with KEPCO (a Korean nuclear contractor). Another option mentioned by respondents is research publications.

The data indicate that the government and respondent organisations have implemented diverse methods to maintain social acceptance of nuclear energy development in the UAE. These methods include education programmes, stakeholder engagement, participation in events and forums, promotion of sustainability and benefits, job creation, international recognition, and trade alliances. These efforts reflect a proactive approach to ensuring social acceptance and fostering a positive perception of nuclear energy among the public in the UAE. Despite the predominance of certain strategies over others, the combined effect of these varied approaches highlights the comprehensive nature of the UAE's efforts to build public support for nuclear energy development.

**Question 24**

From your perspective, select the option that describes transparency in nuclear energy development. More than one option can be chosen.



**Figure 34:** transparency in nuclear energy development. Source: The Author

Note: Each responder has the option to choose multiple options.

The options have been developed based on the research experience, pilot study, and discussion with the research supervisor.

This question aimed to explore the respondents' perspectives on transparency in nuclear energy development in the UAE. The data from **Figure 34** provides insights into how transparency is perceived within this context. A total of 84 responses were recorded for this question. The following is a detailed analysis of the significant answers and their implications:

The possibility of addressing the public concerns through the federal national council of the UAE: Out of the 84 responses, 35 respondents (41.7%) identified the possibility of addressing public concerns through the federal national council as a critical aspect of transparency. This indicates that involving the public in decision-making processes and providing a platform for their problems to be heard is essential to transparency in nuclear energy development.

Government acceptance to interact through social communication platforms: 30 respondents (35.7%) highlighted the importance of the government's approval of interaction through social communication platforms. This suggests that utilising channels such as social media for communication and engagement contributes to transparency. It enables direct government and public interaction, fostering transparency and accountability.

Empowerment of media to speak freely on government decisions: 17 respondents (20.2%) emphasised the empowerment of the media to talk freely about government decisions as a factor contributing to transparency. This indicates that free and independent media is vital in disseminating information, promoting transparency, and holding the government accountable for nuclear energy development.

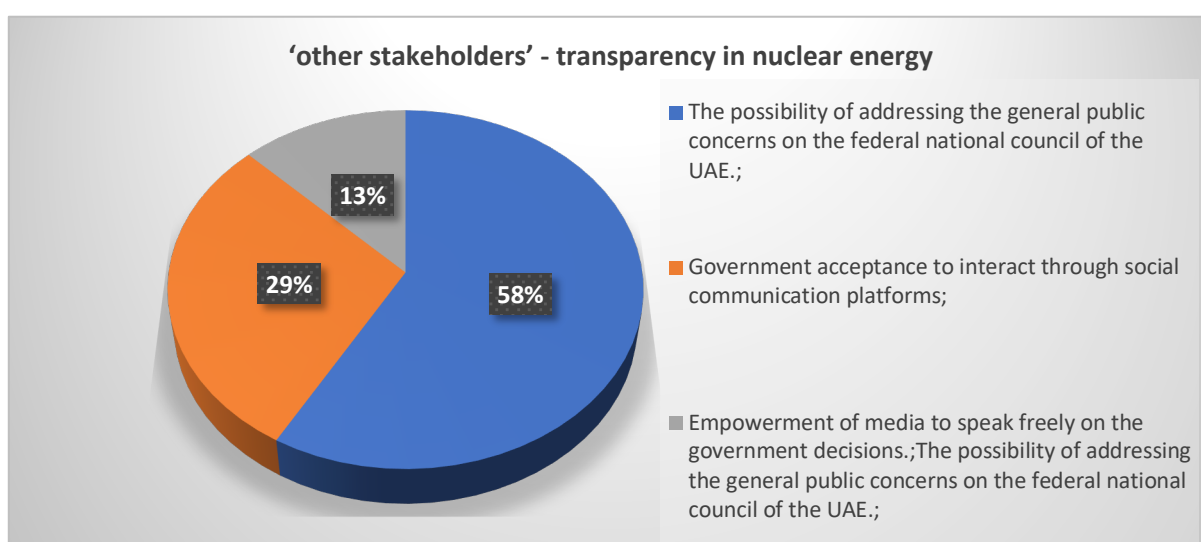
Two respondents selected "other" as their perspective on transparency, indicating they have a different understanding or view of transparency in nuclear energy development.

Most responses revolve around the interaction between the government and the public through social media and the federal national council. This indicates that respondents perceive transparency enhanced through formal communication and engagement between the government and the public. Additionally, the option of establishing an independent regulatory and supervisory body to monitor the project was mentioned to ensure transparency.

Interestingly, respondents working for organisations in the 'nuclear organisations' and 'major stakeholders' groups, which are mostly government organisations or companies regulated by them, were more likely to choose the options related to media and the federal national council. On the other hand, only 13% of respondents from 'other organisations' attributed transparency to these factors. This suggests a potential difference in perception between stakeholders directly involved in the nuclear industry and those from other sectors. (Refer to Figure 35).

In summary, the data reveals that transparency in nuclear energy development, as perceived by the respondents, is closely associated with addressing public concerns through the federal national council, government acceptance of social media interaction, and the empowerment of the media to freely report on government decisions. The findings underscore the significance of open communication, public engagement, and accountability in fostering transparency in developing nuclear energy in the UAE.

### ‘Other stakeholders’



**Figure 35:** ‘other stakeholders’ - transparency in nuclear energy. Source: The Author

#### 4.2.8 Section 8: Promoting Environment Protection and Public Health

From UAE Vision 2021, the UAE Green Growth Strategy is a long-term national initiative under the slogan "A Green Economy for Sustainable Development." This strategy aims to enhance the country's competitiveness and the sustainability of its development while preserving the environment for future generations.

The UAE's green growth strategy reflects its commitment to promoting environmental protection and public health for current and future generations. The UAE strives to achieve a green economy that ensures the well-being of its citizens, preserves the environment, and sets an example for sustainable development on a global scale.

#### **Question 25**

How did your organisation contribute to implementing UAE Vision 2021 to achieve a Sustainable and Diversified Economy as UAE sought to diversify the UAE economy, including developing low-carbon technologies and eco-efficient production and consumption methods?

Develop/amend internal policies and standards to enforce government policies to encourage Green Economy investments.	27
Taking in consideration, during internal decision making, the government initiatives in promoting green technologies.	23
Benchmark best practices from other organisations including international.	26
Close coordination with responsible government departments.	19
Hire subject matter experts to support the strategy implementation.	22
Develop new functions within the organisation to support the government initiatives.	21
Develop and take the required training for staff.	21
Utilised media and conferences to promote the government initiatives.	18
None of the above.	6
Other.	2

**Table 24:** Contribution to implementing UAE Vision 2021. Source: The Author

Note: Each responder has the option to choose multiple options.

The options have been developed based on the research experience, pilot study, Sovacool and Valentine articles [16, 20, 21], and discussion from the research supervisor.

This question was designed to explore how organisations contribute to implementing UAE Vision 2021 to establish a Sustainable and Diversified Economy, emphasising developing low-carbon technologies and eco-efficient production and consumption methods. The data from Table 24 provides insights into the specific contributions made by organisations toward this goal. A total of 185 responses were recorded.

The analysis of the significant answers and their implications is as follows:

**Develop/amend internal policies and standards to enforce government policies to encourage Green Economy investments:** This option received the highest number of responses, with 27 organisations selecting it. It indicates that organisations recognised the importance of aligning their internal policies and standards with government policies to promote investments in the Green Economy. This proactive approach reflects their commitment to supporting sustainable development and economic diversification.

**Taking into consideration, during internal decision-making, the government initiatives in promoting green technologies:** 23 organisations emphasised the importance of considering government initiatives promoting green technologies in their internal decision-making processes. This suggests that organisations actively incorporate the government's agenda for green technologies into their strategies and operations.

**Benchmark best practices from other organisations, including international:** 26 organisations recognised the value of benchmarking best practices from other organisations, both domestically and internationally. This indicates their willingness to learn from successful models and adapt them to local contexts, contributing to the UAE's sustainable and diversified economic development goal.

**Close coordination with responsible government departments:** 19 organisations highlighted the importance of close coordination with responsible government departments. This emphasises the collaborative approach taken by organisations to align their efforts with government priorities and ensure the effective implementation of UAE Vision 2021.

**Hire subject matter experts to support the strategy implementation:** 22 organisations acknowledged the significance of hiring subject matter experts to support the implementation of strategies related to the UAE Vision 2021. This demonstrates their commitment to acquiring specialised knowledge and skills to drive sustainable and diversified economic growth.

Develop new functions within the organisation to support government initiatives: 21 organisations reported developing new ones to support government initiatives. This indicates their organisational adaptability and willingness to evolve to meet the requirements of UAE Vision 2021.

Develop and take the required training for staff: 21 organisations recognised the importance of developing and providing training for their team. This indicates their focus on building capacity and ensuring employees have the necessary skills and knowledge to contribute effectively to the vision's implementation.

Utilised media and conferences to promote government initiatives: 18 organisations utilised media and conferences as platforms to promote government initiatives related to UAE Vision 2021. This highlights the significance of public outreach and awareness campaigns in driving sustainable and diversified economic development.

Notably, 6 organisations selected "None of the above," indicating their contributions did not align with the options provided. Additionally, 2 organisations chose "Other," suggesting they had unique contributions not covered by the options.

The analysis of the responses reveals diverse strategies and actions organisations take to contribute to UAE Vision 2021. There is a strong emphasis on developing internal policies, benchmarking best practices, considering government initiatives, and coordinating closely with responsible government departments. These efforts reflect a collaborative and integrated approach towards achieving the objectives of UAE Vision 2021.

The results demonstrate a wide diversity of mechanisms used, with no particular dominant option. All organisations have made significant efforts to contribute to the vision, and only a few reported no specific mechanism or other mechanisms. This suggests that the industry has adopted a group-think approach and enjoys integrated activities, as supported by the Literature Review chapter in the section on (the Emirate energy sector and Greenhouse gas emissions (GHG)).

There is a notable emphasis on defining government direction through policies and benchmarking best practices from other domestic and international organisations. The importance of clear policies aligns with the research outcomes of Sovacool and Valentine.

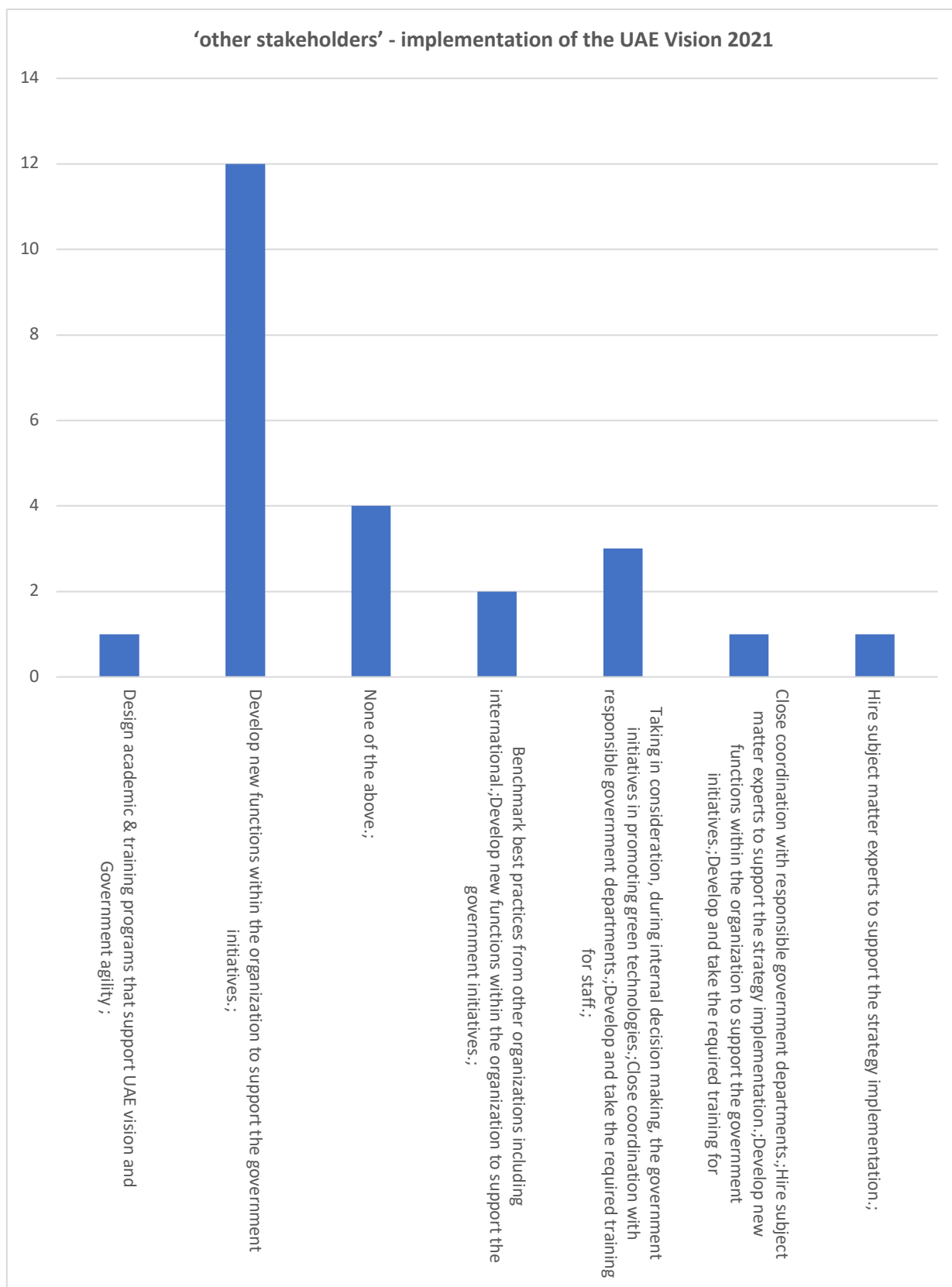
The options not chosen by most organisations include designing academic and training programmes that support the UAE's Vision and government agility. Additionally, there is a



mention of FANR's vision and objectives, indicating that at least one senior in FANR sees the organisation as focused on nuclear safety, security, and safeguards rather than broader national concerns. This serves as an excellent example of an independent regulator. However, even the "other stakeholders" have considered broader government-led initiatives in driving the development of responsible parts/functions of their organisations to address them (Figure 36).

Overall, the responses demonstrate the commitment of organisations across different sectors to support UAE Vision 2021 for a sustainable and diversified economy through various strategies and actions. The reported contributions align with the fundamental principles of UAE Vision 2021, including the promotion of green technologies, collaboration with government entities, capacity building, and knowledge sharing. These collective efforts contribute to the overall implementation and success of UAE Vision 2021 in fostering a sustainable and diversified economy in the UAE. The data highlights the commitment of organisations across different sectors to support UAE Vision 2021 for a sustainable and diversified economy. The reported contributions align with the fundamental principles of UAE Vision 2021, such as promoting green technologies, collaboration with government entities, capacity building, and knowledge sharing. These collective efforts contribute to the overall implementation and success of UAE Vision 2021 in fostering a sustainable and diversified economy in the UAE.

**‘other stakeholders’**



**Figure 36:** Implementation of the UAE Vision. Source: The Author

**Question 26**

How did your organisation contribute to implementing UAE Vision 2021 by supporting the energy transition from fossil fuel to renewable sources and nuclear energy?

Benchmark best practices from other organisations including international.	29
Close coordination with responsible government departments to achieve the goal.	24
Hire subject matter experts to support achieving the goal.	18
Develop new functions within the organisation to achieve the goal.	18
Develop and take the required training for staff.	24
Utilised media and conferences to promote the new initiative.	16
Develop/amend internal policies and standards to enforce government policies to encourage the use of country resources in a sustainable matter.	17
Contribute to providing or assisting on disclosing carbon-intensive assets, the carbon footprint of investment and portfolios.	15
Taking in consideration, during internal decision making, the government initiatives in regard to Climate Change.	15
None of the above.	6
Other.	3

**Table 25:** Support energy transition. Source: The Author

Note: Each responder has the option to choose multiple options.

The options have been developed based on the research experience, pilot study, Sovacool and Valentine articles [16, 20, 21], and discussion from the research supervisor.

Question 26 differed from question 25 in the focus of the question. Question 26 focused more on energy transition (as a part of the broader sustainable development). From (

Table 25) shows very little difference in the responses.

Question 26 aimed to assess how organisations contributed to implementing UAE Vision 2021 by supporting the energy transition from fossil fuels to renewable sources and nuclear energy.

The data from

Table 25 provides insights into the specific contributions made by organisations toward this goal. A total of 185 responses were recorded.

The analysis of the significant answers and their implications reveals that benchmarking best practices from other organisations, including international entities, received the highest responses, with 29 organisations selecting this option. This highlights the importance of learning from successful models and experiences worldwide in renewable energy and nuclear technologies. It indicates a recognition of the value of adopting proven practices to accelerate the energy transition in the UAE.

24 organisations emphasised close coordination with responsible government departments to achieve the goal. This reflects the significance of collaboration between organisations and government entities in driving the energy transition. Aligning organisational efforts with government priorities and policies ensures effective implementation and maximises the impact of renewable energy and nuclear technologies initiatives.

Recognising the need for subject matter experts, 18 organisations mentioned hiring professionals with specialised knowledge and skills in renewable energy and nuclear technologies. Acquiring the right expertise is crucial to driving the energy transition and ensuring its successful implementation.

Another finding is that 18 organisations reported developing new functions within their organisations to support the energy transition. This demonstrates a proactive approach to organisational development and adaptation, aiming to meet the challenges and opportunities associated with renewable energy and nuclear technologies.

Investing in staff training and development was acknowledged by 24 organisations, emphasising the importance of building internal capacity. Ensuring that employees have the necessary knowledge and skills to contribute effectively to the energy transition is vital for its success.

Additionally, 16 organisations utilised media platforms and conferences to raise awareness and promote the energy transition. This highlights the significance of public outreach and communication in mobilising support and fostering a positive perception of renewable energy and nuclear technologies.

Aligning internal policies and standards with government policies was recognised by 17 organisations as an essential contribution. This ensures that organisational practices align intending to utilise country resources sustainably, contributing to the energy transition.

Transparency and disclosure about carbon-intensive assets were acknowledged by 15 organisations, reflecting a commitment to addressing climate change and promoting sustainable investment practices in the context of the energy transition.

Similarly, 15 organisations highlighted the importance of considering government initiatives related to climate change in their internal decision-making processes. This proactive approach aligns organisational strategies with broader climate change goals and targets.

Notably, 6 organisations selected "None of the above," indicating they did not precisely align their efforts with the options in the question. Additionally, 3 organisations chose "Other," suggesting they had unique contributions not covered by the options.

Overall, the responses reflect a comprehensive approach taken by organisations to support the energy transition and align with UAE Vision 2021. The emphasis on benchmarking best practices, coordination with government departments, and investing in staff training demonstrates a commitment to continuous improvement and knowledge sharing in renewable energy and nuclear technologies. These efforts are vital in achieving the vision's sustainable and diversified economic goal. The data highlights the commitment of organisations across different sectors to support UAE Vision 2021 in achieving the energy transition from fossil fuels to renewable sources and nuclear energy. The reported contributions align with critical principles such as knowledge exchange, collaboration with government entities, capacity building, and policy alignment. These collective efforts contribute to the overall implementation and success of UAE Vision 2021 in promoting a sustainable and diversified energy landscape in the UAE.

### ***Question 27***

Please add any concluding remarks that you think are relevant.

The survey's final question, Question 27, aimed at collecting concluding thoughts from respondents about the UAE's nuclear programme. The range of perspectives and sentiments provided valuable insights into the overall perception of the programme and its implications.

One respondent highlighted the UAE's advancement in domestic nuclear power development yet pointed out the need to keep up with international progress in this field. The sentiment reflects an awareness of the UAE's place within the larger global landscape and the importance of continuous learning and improvement.

Another respondent touched on the unique nature of the nuclear industry, noting its difference from other energy industries such as fossil fuels or renewable energy. They stressed the importance of safety and technical aspects over commercial considerations, emphasising the need for rigorous safety protocols and robust oversight mechanisms.

One participant lauded the UAE Peaceful Nuclear Energy Programme as a potential benchmark for other countries developing nuclear energy. This indicates a belief in the programme's success and ability to inspire and guide other nations.

One respondent applauded the idea of nuclear energy in the UAE, showing enthusiastic support, and acknowledging its environmentally friendly and economic benefits. This viewpoint reflects an understanding of nuclear power's potential role in addressing energy challenges and climate change.

Non-proliferation and the peaceful use of nuclear material and energy in the UAE were underscored by another respondent. They emphasised the role of the Federal Authority for Nuclear Regulation (FANR) in enforcing strict safeguards and controls to prevent nuclear weapon proliferation, thus highlighting the commitment to the responsible use of nuclear technology.

Finally, one participant conveyed an optimistic viewpoint, expressing that the UAE's nuclear programme has been a success story and expressing hope for its continued progress and achievements. This remark reveals a sense of confidence in the programme's ability to meet its objectives.

The concluding remarks offered various perspectives demonstrating optimism, support, and recognition for the UAE's nuclear programme. They underlined the uniqueness of the nuclear industry, the need for stringent safety and compliance, and the potential of the UAE's programme to be a benchmark for others. This aligns with most survey respondents' sentiments, showing a positive outlook and commitment to sustainable development in the UAE's energy sector.

The responses to Question 27 reflect a sense of optimism, support, and recognition of the achievements of the UAE's nuclear programme. They emphasise the importance of safety, non-proliferation, and the potential of the UAE's programme to be a model for others. These responses and the overall survey results demonstrate the public's positive perception and commitment to sustainable development within the UAE's energy sector.

### 4.3 Cross-Cutting Analysis of Survey Result

The survey questionnaires were divided into eight sections, and a cross-cutting analysis was conducted across all sections. Cross-cutting methods are versatile techniques of policy analysis that can be applied at various stages of the analysis process. They include but are not limited to interviewing for policy data, quick surveys, fundamental data analysis and communicating the analysis [188]. But here, this analysis cuts across all eight sections of the questionnaire and is followed by the analysis of the questionnaire results in the context of the finding of the literature review.

The traditional cross-cutting analysis reveals commonalities and differences in results in different sections. For example, “sixty per cent of those who believe X also agree with Y, but only half of these would agree with Z. This is possible because .....”. However, the degree of left-handedness in the Likert scale responses and the balanced spread of choices to other questions makes this analysis less valuable. Nevertheless, in line with the survey structure, here are some interesting points noticed from each section, as follows:

**Section 1:** Most respondents work (used to work) in the nuclear industry, with more respondents categorised as "other stakeholders". These "other stakeholders" come from various organisations that serve the nuclear industry or are major stakeholders in the sector. Most respondents have job duties related to regulation, governance, licensing, and security. Even the other response options in the survey tend to be related to these job responsibilities, such as safeguards and non-proliferation treaty, regulatory compliance, and export control. As a result, the respondents indicated that their "major stakeholders" are the organisations responsible for implementing requirements related to their respective responsibilities (as mentioned in Question 4).

In terms of nationality, 40 respondents are from the United Arab Emirates (UAE), while ten respondents are from different countries. However, it is noteworthy that despite their different nationalities, their responses are similar to most other survey questions. This suggests a common understanding and alignment among respondents, irrespective of nationality, about the topics covered in the survey.

**Section 2:** This section focuses on the "Strong State Involvement in Guiding Economic Development" and examines the justification for the UAE's choice to pursue nuclear energy and the methods for developing and implementing the Nuclear Policy.

The survey results reveal a consensus among respondents regarding the efficiency of the UAE government in providing guidance and development capabilities. Most respondents, who predominantly have a regulatory background, believe that the UAE government effectively



utilises its regulatory capacity to support the critical drivers of the nuclear programme, including energy management, environmental considerations, and compliance with international treaties.

Question 8 confirms the agreement among respondents regarding the UAE government's contribution to the development and implementation of the Nuclear Policy, particularly in collaboration with an independent regulator. The government's role in guiding economic development and energy planning is recognised.

The results of question 9 highlight the most critical driver for organisations to contribute to the nuclear policy, with a specific focus on energy management and environmental protection. Respondents acknowledge that nuclear energy can mitigate the environmental impact of fossil fuel emissions. However, they also emphasise the importance of ensuring compliance with international treaties, promoting economic opportunities, and maintaining public opinion for the long-term sustainability of the nuclear programme.

The findings of questions 8 and 9 demonstrate a level of agreement, particularly regarding the significance of economic development and energy planning in the context of the UAE's nuclear programme.

Question 10 further supports the previous findings by emphasising the importance of nuclear energy in supporting economic opportunities and securing energy resources while highlighting the need to adhere to international obligations. This question strengthens the alignment of responses from questions 8 and 9.

Question 11 highlights the substantial support that the nuclear programme receives from the government, as it involves various organisations in supporting the programme's initiation and the establishment of related entities.

Overall, these findings underscore the alignment among respondents regarding the UAE government's role in guiding economic development, energy planning, and the importance of nuclear energy in achieving economic, environmental, and energy-related goals while upholding international obligations. The survey results reflect a recognition of the government's efforts and the potential of nuclear energy to contribute to sustainable development in the UAE.

**Section 3:** This section is titled "Centralisation of National Energy Planning, Development, and Implementation" and focuses on implementing methods to ensure compliance with national regulations and international commitments supporting energy planning.

The survey results demonstrate how the government determines the scope of each type of organisation to deliver a successful nuclear programme, as evidenced in section 8. This

centralised approach to drafting and implementing development plans and strategies has emerged as one of the main advantages. It has facilitated collaboration and coordination among organisations, allowing them to plan their resources effectively to achieve the government's aims and objectives.

There are notable commonalities between sections 2 and 3, particularly in the responses highlighting the importance of economic development, energy security, and compliance with international treaties. The establishment of an independent regulator and the presence of sufficient planning are emphasised in both sections. These elements contribute to maintaining public acceptance and ensuring compliance with international obligations. Furthermore, the results of both sections highlight an essential government action, which involves engaging major stakeholders in the nuclear planning stage and establishing new organisations to support the implementation of the nuclear programme.

The alignment between sections 2 and 3 signifies the integrated approach taken by the government in guiding the energy planning and development process. The government can enhance public acceptance and fulfil its international commitments by involving major stakeholders, coordinating resources, and ensuring compliance. This cross-cutting analysis highlights the interconnectedness of different sections and underscores the importance of a centralised approach to achieve a successful and sustainable nuclear programme.

**Section 4:** This section is titled "Campaigns to Link Technological Progress to National Revitalization" and focuses on promoting technological advancement as a national goal. It addresses the challenges faced in achieving sustainable solutions.

The survey results reveal that the government effectively addressed the defined challenges with the support of its organisations. Education and awareness played a significant role in developing the technical skills of nuclear operators and employees and maintaining public acceptance. Education emerged as a critical tool in enhancing nuclear expertise and fostering public trust. As a result, the government adapted its requirements and expectations during the programme's implementation based on the organisations' learning from benchmark best practices. This adaptive approach led the government and its nuclear organisations to continuously learn from the International Atomic Energy Agency (IAEA) and other credible sources. The emphasis on public education and professional skills development fostered a reliance on the most credible guidance and relevant knowledge sources.

The survey results also highlight the importance of promoting economic opportunities, opening business prospects, and ensuring energy security in overcoming challenges and maintaining public acceptance. These factors are recognised in the national context and questionnaire

responses. The findings demonstrate that education and awareness are crucial in linking technological progress to national revitalisation. This aligns with the agreements in sections 2, 3, and 4, which underscore the significance of efficient planning and regulatory ability in providing sustainable economic opportunities, securing energy, and garnering public support through education and awareness.

The survey questions in this section collectively demonstrate various techniques to create campaigns and raise awareness about the connection between the nuclear programme and national revitalisation. These approaches were tailored to reach different target audiences. The importance of such campaigns also extends to the public, as evidenced in section 5 of the survey.

Overall, the survey results highlight the role of education, awareness, and strategic communication in promoting technological progress and national revitalisation. These findings reinforce the importance of integrated planning, regulatory expertise, and public engagement in achieving sustainable development goals and maintaining public support for the nuclear programme.

**Section 5:** This section focuses on the influence of technocratic ideology on policy decisions and the importance of promoting awareness among the public about the benefits of nuclear energy programmes to maintain public acceptance. The survey results indicate a general agreement among participants that the Emirates accepts and support the movement towards nuclear energy [149] (refer to Question 18 and **Figure 30**). This suggests that awareness initiatives have played a crucial role in maintaining public acceptance and building trust in the government's capabilities.

Compared to the Western context, the survey findings reveal a lower level of civic activism against nuclear energy in the UAE, which is further explored in section 7. The results of Question 19 demonstrate a general agreement on the characteristics that influenced the development of the Barakah Nuclear Power Programme, such as clean energy, economic, competitive advantage, alternative energy resources, job opportunities, and international recognition. However, job opportunities are only sometimes regarded as influential as the other factors. This question's results can be summarised into the following key aspects: environment protection, economic opportunities, energy security, job creation for the public, and international recognition through compliance with international treaties like COP 27.

This section highlights the importance of the job, economic opportunities, and education initiatives in maintaining public acceptance and support for nuclear energy. These findings align with the significance of education and awareness emphasised in the preceding sections

of the survey, which contribute to promoting nuclear power, building public trust, and fostering acceptance.

Overall, the survey results emphasise the role of technocratic ideology in shaping policy decisions and the need for public awareness campaigns to maintain public acceptance of nuclear energy. The findings indicate that the UAE population supports the movement towards nuclear power and trusts the government's efforts. Compared to the West, the lower level of civic activism against nuclear energy in the UAE reflects a favourable environment for nuclear energy development. The survey highlights the importance of environmental protection, economic opportunities, energy security, job creation, and international recognition as factors influencing public acceptance and support for the nuclear programme.

**Section 6:** This section focuses on the subordination of challenges to political authority in the context of the UAE's nuclear programme. The survey results indicate that the UAE government has supported developing the nuclear programme. This support is driven by the country's greenhouse gas emission reduction obligations stemming from the 2005 Kyoto Protocol COP11 commitments. The government has devised plans and strategies coordinated with various organisations to fulfil these obligations. The announcement of these plans and strategies has taken place at multiple events.

The government has effectively distributed the implementation responsibilities to its organisations based on their respective scopes of work and has provided them with adequate support. The nuclear programme is the best solution for the country to fulfil its promises of reducing greenhouse gas emissions.

The government's substantial support has enabled political authorities to overcome challenges related to nuclear development in the UAE. The public trusts the government's ability to lead and deliver a safe and reliable energy programme for the national economy. Question 21 indicates government support in overcoming challenges associated with implementing nuclear plans.

These findings highlight the government's commitment to the nuclear programme and its efforts to address challenges through effective coordination, distribution of responsibilities, and adequate support. The government's trusted role in leading the programme reinforces the public's confidence in the country's ability to achieve its greenhouse gas emission reduction targets and deliver a safe and reliable energy programme.

**Section 7,** titled 'Low Levels of Civic Activism', was influential in supporting the nuclear programme.

This section highlights the influential factors behind the support for the nuclear programme, considering the low levels of civic activism in the UAE. Since the National Law does not mandate comprehensive public consultation, the responsibility of representing the public falls on the governmental departments. The survey investigates legal activities through which individuals may express objection, disruption, or discouragement toward the nuclear programme. Notably, these activities are not associated with illegal or subversive actions and are presumed limited to a minority, if any, without public support. This section examines civic activism as a potential challenge for new nuclear programmes.

The survey results show how the government gains and maintains public acceptance of the nuclear programme. These findings align with the previous sections, emphasising the connection between tools for success and public acceptance. The results highlight several key factors in maintaining public acceptance, including education and awareness initiatives, promotion of sustainability in energy to protect the environment, job opportunities offering economic benefits, and international recognition.

Transparency is also identified as a crucial element in the survey results. The government addresses public concerns through social media and forums, demonstrating a commitment to transparency. This open engagement allows for interaction and ensures that the public have a platform to voice their opinions and have their concerns addressed. Additionally, empowering the media to discuss government decisions freely contributes to transparency and public trust. Question 23 explores how the UAE government maintains social acceptance of nuclear energy development. The responses demonstrate that engagement through events and forums, intensive education programmes, awareness campaigns on social media and TV, promotion of energy sustainability, and job opportunities all play a role in maintaining social acceptance. Furthermore, gaining international recognition and relations is also a factor in fostering public support.

Question 24 examines the definition of transparency in nuclear energy development. The responses indicate that transparency includes addressing public concerns through the Federal National Council of the UAE, accepting interaction through social media platforms, and empowering the media to speak freely on government decisions.

Overall, the survey results indicate that the UAE government is actively monitoring and taking significant steps to ensure public satisfaction regarding civil nuclear development. This commitment to public acceptance is a crucial success factor for a thriving nuclear programme. The government strives to gain and maintain public support for the nuclear programme in the

UAE by employing various strategies, such as education, awareness, transparency, and engagement.

The last section is **section 8**, titled ‘Promoting Environment Protection and Public Current and Future Generations’.

This section focuses on examining environmental concerns, including climate change, and their impact on the development of the UAE's nuclear programme. These concerns have been identified as essential success factors or concerns in civil nuclear development by experts like Sovacool and Valentine. However, it is necessary to strike a balance as the reduction in environmental damage from burning fossil fuels outweighs the environmental harm from the nuclear fuel cycle. The survey results suggest that current opinion in the UAE is favourable towards nuclear energy.

The UAE Vision 2021 and the UAE Green Growth Strategy are long-term national initiatives to achieve a "Green Economy for Sustainable Development." These initiatives enhance the country's competitiveness and promote the sustainability of its development. The government is committed to preserving the environment for future generations and aspires to become a global hub and a successful model of sustainable development. This commitment is driven by focused strategy areas that strongly emphasise international recognition.

This section highlights the government's dedication to environmental protection through the development of the UAE Green Growth Strategy and its support for the energy transition from fossil fuels to renewable sources and nuclear energy. The survey results indicate an agreement on the importance of developing and amending internal policies and standards to enforce government policies. The government's initiatives are considered for every internal organisation's decision, leading to efficient governance and effective compliance within these organisations. This allows each organisation to focus on its responsibilities and rely on others for specialised input. For example, the Federal Authority for Nuclear Regulation (FANR) concentrates primarily on nuclear safety, security, and safeguards, divorced from broader national concerns.

Education is emphasised as a crucial factor in achieving the government's goals. The survey responses highlight the importance of training, benchmarking best practices, and hiring subject matter experts. Education is not limited to individuals but extends to organisations through benchmarking best practices. This collaborative approach fosters a group-think mindset within the entire industry and enables integrated activities.

The government utilises various communication channels, such as the media and conferences, to promote its initiatives and engage with the public to maintain public support. These channels effectively convey and ensure public understanding of the government's efforts.

Overall, the survey results demonstrate the government's commitment to environmental protection and public support through the UAE Green Growth Strategy, the promotion of renewable and nuclear energy, the development of efficient governance, and a strong emphasis on education. The government's proactive approach in utilising media and conferences as communication channels further strengthen public engagement and support for the nuclear programme in the UAE.

#### ***The outcome from Survey Cross-Cutting***

The cross-cutting analysis of the survey results demonstrates a strong consensus among respondents from the nuclear industry regarding the effectiveness of the UAE government in guiding the development of the nuclear programme. The government's role in economic development, energy planning, and meeting international obligations is widely recognised and appreciated.

Education and awareness emerged as critical factors in supporting the nuclear programme. Respondents emphasised the importance of education and training for individuals and organisations, promoting technical skills and best practices. The government's efforts in raising awareness through campaigns, social media engagement, and other platforms have played a significant role in maintaining public acceptance.

Job opportunities and international recognition were influential factors in garnering public support. The creation of economic prospects and the country's commitment to international standards and obligations contribute to the positive perception of the nuclear programme.

Transparency and environmental protection were also considered essential to the government's approach. The government's transparent communication with the public, addressing concerns, and empowering the media have fostered trust and public confidence. The commitment to environmental protection through initiatives like the UAE Green Growth Strategy and the promotion of renewable and nuclear energy demonstrates the government's dedication to sustainable development.

Overall, the survey results indicate a strong alignment among respondents in recognising the UAE government's effectiveness in guiding economic development, promoting education and awareness, ensuring public acceptance, and protecting the environment. The findings underscore the government's successful efforts in these areas and highlight the importance of collaboration, education, and transparency in developing the UAE's nuclear programme.

#### 4.3.1 Enhancing the Conceptual Framework

As Sovacool and Valentine identified in chapters one and two, the success factors influencing the UAE's nuclear programme have played a significant role. Building upon this analysis, the following enhanced factors have been determined based on a cross-cutting analysis with survey findings and additional modern factors:

First, strong state involvement and guidance in economic development have contributed to the programme's success. The UAE government's active role in energy management, environmental needs, and compliance with international treaties ensures the nuclear programme's success.

Second, the centralisation of national energy planning allows the government to coordinate the efforts of various organisations involved in the nuclear programme. This collaborative approach ensures the achievement of government aims and objectives.

Third, the influence of technocratic ideology on policy decisions and promoting awareness of the benefits of nuclear energy helps maintain public acceptance and support for the programme.

Fourth, the subordination of challenges to political authority demonstrates the UAE government's commitment to overcoming obstacles related to nuclear development. Public trust in the government's ability to deliver a safe and reliable energy programme further contributes to its success.

Fifth, campaigns that link technological progress to national revitalisation, supported by media and education, emphasise the importance of technological advancement in driving national revitalisation.

New factors that have emerged as essential to success include emphasising transparency and public satisfaction. The UAE government's efforts to address public concerns through social media and forums, ensure transparency in nuclear energy development, and actively monitor general satisfaction contribute to the programme's success.

Furthermore, promoting environmental protection and sustainable development, demonstrated through initiatives like the UAE Green Growth Strategy and integrating renewable energy sources, aligns the programme with sustainability goals and enhances its success.

Considering these factors, the enhanced conceptual framework provides a comprehensive perspective on the success factors influencing the UAE's nuclear programme. It considers the specific context of the UAE, survey findings, and additional modern factors that contribute to the programme's achievements. This framework guides policymakers, stakeholders, and researchers in understanding and advancing the success of the UAE's nuclear programme.



### 4.3.2 Key Factors Supporting the Success of the UAE Nuclear Programme

Through cross-cutting analysis, several key factors have emerged that contribute to the success of the UAE nuclear programme. These factors include:

1. Government's establishment of an independent regulator and commitment to compliance:

The UAE government's establishment of an independent regulatory body for the nuclear programme demonstrates a commitment to ensuring safety, security, and compliance with national and international laws. This factor is crucial in building public trust and confidence in the programme.

2. International recognition as a role model:

Recognising the UAE government as a role model in the global nuclear community positively influences the public perception of the nuclear programme. This recognition enhances the programme's credibility and promotes a sense of pride and national achievement.

3. Investment in organisational development and strategic planning:

Adequate investment in organisational development, including formulating comprehensive plans and strategies, is essential for the success of the nuclear programme. Strategic planning helps ensure effective implementation, efficient resource allocation, and alignment with national goals and objectives.

4. Public outreach for education, awareness, and stakeholder engagement:

Engaging the public through educational campaigns, awareness programmes, and stakeholder engagement initiatives is crucial for gaining and maintaining public support. These efforts should include public and private organisations and focus on promoting the benefits and safety of nuclear energy.

5. Commitment to environmental preservation:

The UAE's commitment to preserving the environment for future generations is a critical factor in the success of the nuclear programme. This commitment includes proactive measures to mitigate environmental impact, promote sustainable practices, and prioritise the development of renewable energy sources alongside nuclear energy.

6. Learning from international best practices and credible guidance:

Learning from international best practices and utilizing reasonable guidance from the global nuclear industry helps the UAE benefit from the experiences and knowledge of other countries. This factor allows for adoption of proven strategies, technologies, and operational practices to ensure the programme's success.

7. Establishment of a group-think approach with wide participation in integrated activities:

The UAE's vision of a collaborative and inclusive approach involving the public, industry, and governmental organisations fosters collective decision-making, shared responsibility, and a sense of ownership. The government should facilitate open dialogue, establish mechanisms for public input, and involve diverse stakeholders in the decision-making process. This approach encourages innovation, ensures transparency, and strengthens the programme's resilience against potential challenges. (Refer to questions 4 & 25 of the survey and section 8 above (4.3)).

8. Promotion of opportunities for jobs and businesses:

Promoting job opportunities and fostering the growth of businesses within the nuclear industry contributes to the programme's success. This factor stimulates economic development, creates employment opportunities, and attracts skilled professionals to support the nuclear sector. [189]

9. Effective planning, organisation, and distribution of responsibilities:

The ability to plan, organise, and distribute duties between organisations involved in the nuclear programme is crucial for ensuring seamless coordination and efficient operations. The UAE government's role in monitoring progress and providing oversight helps maintain accountability and adherence to established plans.

10. Efficient governance and stringent compliance:

Efficient governance and effective compliance mechanisms imposed by the government on organisations involved in the nuclear programme are critical factors in its success. This includes robust regulations, rigorous safety protocols, and regular monitoring to ensure standards and best practices adherence.

11. Well-structured and coordinated organisational framework:

Each organisation within the nuclear programme focuses on its specific remit within a well-structured and collaborative framework. Clear delineation of responsibilities, effective communication, and collaboration between organisations contribute to streamlined operations and successful outcomes.

These enhanced key factors collectively contribute to the success of the UAE nuclear programme. These factors provide a comprehensive and successful operational framework by aligning the programme with national goals, gaining public support, ensuring environmental preservation, and fostering effective policy implementation. Continual evaluation and improvement of these factors will be vital for the long-term success and sustainability of the programme.

#### **4.4 Discussion of Survey Result with Literature Review**

The survey results, including the analyst results from the cross-cutting analysis, align with the findings from the literature review. Each aspect tested in the questionnaire is supported by evidence and information from the literature.

The researcher conducted semi-structured interviews to strengthen further and validate the findings. These interviews were carried out when the questionnaire data alone were insufficient to provide comprehensive insights into the research topic [176]. The thematic analysis of the interview data was conducted in line with [190] (see Chapter 5). Additionally, the author's extensive experience working at a senior level in critical organisations in the UAE provided valuable insights that complemented the analysis.

This section will discuss the survey results, including the analyst results from the cross-cutting analysis, the existing literature and the author's professional experience. This discussion will shed light on the key factors contributing to the success of the UAE nuclear programme and provide a comprehensive understanding of the research topic.

Section 1 of the survey primarily aimed to gather personal data and organisational information. It provided a foundation for understanding the demographics and backgrounds of the survey participants, which can contribute to the interpretation of the survey results in subsequent sections.

##### **Section 2: Strong State Involvement in Guiding Economic Development**

This section justified the decision taken by the UAE to go for civil nuclear energy. It tests the nuclear programme implementation method the government and its organisation use to contribute to economic development. The development and implementation of “The Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy” (Known as Nuclear Policy)[18] by organisations was also discussed in the literature review.

The questionnaire findings revealed several vital arrangements that support the Nuclear Policy, including:

1. Early development and activation of an independent nuclear regulator by the government.
2. Government-led guidance of the economy and energy development through well-established plans.
3. Establishment of specialised organisations that contribute to the delivery of nuclear energy and secure energy resources with the involvement of stakeholders.
4. Integration of environmental protection measures within the nuclear power programme, leading to a reduction in fossil fuel emissions.
5. The importance of achieving a sustainable nuclear programme through:
  - a. Compliance with international treaties.
  - b. Promoting economic opportunities.
  - c. Maintaining public support.

These findings from the questionnaire are in line with the literature review in Chapter 2. The UAE government took a proactive approach by developing an independent nuclear regulator, with assistance and guidance from the International Atomic Energy Agency (IAEA). As highlighted in section 2.4.1 of the literature review, the IAEA's recommendations and the best practices benchmarking have contributed to the UAE's compliance with international treaties. Additionally, the government's implementation of strategic plans such as UAE Vision 2021, UAE Green Growth Strategy, and UAE Energy Strategy 2050 supports the country's economic development, energy security, financial opportunities, and environmental protection efforts. The progress in implementing these plans is evident from the information provided in the EMIRATES energy sector and GHG section.

These findings reinforce the notion that strong state involvement, guided by well-defined policies and plans, is a crucial factor in the success of the UAE's nuclear programme. The government's proactive approach, including establishing an independent regulatory body and adherence to international standards, demonstrates its commitment to ensuring safe and sustainable nuclear energy development. Moreover, integrating environmental protection aligns with global efforts to reduce carbon emissions and transition towards cleaner energy sources.

To enhance the validity of the findings, a triangulation approach was employed, which included conducting semi-structured interviews alongside the questionnaire and literature review. These interviews were performed when the questionnaire data alone could not provide comprehensive insights into the research topic. The thematic analysis of the interview data, shown in line with the established methodology (see Chapter 5), further reinforces the alignment between the survey results, literature findings, and the author's professional experience.

The triangulation of data sources, including the survey, literature review, and interviews, strengthens the overall findings, and provides a comprehensive understanding of the UAE's nuclear programme. This convergence between different sources of information highlights the significance of strong state involvement and well-defined policies in guiding economic development through nuclear energy. It also underscores the government's commitment to international compliance, environmental sustainability, and public support, all of which are critical factors for the success of the UAE's nuclear programme.

### Section 3: **Centralisation of National Energy Planning, Development, and Implementation**

This questionnaire section focused on implementing methods to comply with national regulations and international commitments to support energy planning and resource security. Additionally, it justified how the centralisation of national energy planning, including the contribution of nuclear energy, enhances the national economy. The respondents primarily included regulatory authorities, support service providers, utility providers, and public authority representatives.

According to the questionnaire responses, organisations played a vital role in assisting the government's decision-making process and achieving the economic development plan associated with the Barakah nuclear power plant programme. Their contributions can be summarised as follows:

1. Collaboration and close coordination with government organisations and stakeholders.
2. Assisting in overcoming challenges and providing support to other stakeholders and organisations.
3. Guiding economic development in line with the UAE Vision 2021.
4. They contribute to centralising national energy planning, as outlined in the UAE Energy Strategy 2050, based on their respective responsibilities.

The survey results demonstrated that organisations supported the government's decisions through collaboration and coordination with various stakeholders to achieve economic development plans. They also aided the responsible organisations in making informed economic decisions and supported the centralisation of nuclear energy.

The findings from the literature review (sections 2.5 and 2.7) corroborate the importance of addressing challenges related to centralisation in energy planning. The government adopted two significant approaches: (i) adequate coordination and collaboration and (ii) establishing national plans. To overcome challenges associated with centralisation, the Federal Authority for Nuclear Regulation (FANR) was assigned the role of coordinating nuclear regulatory compliance with relevant organisations. This approach helped address challenges related to workforce development, familiarisation with diverse organisations, dosimetry services, and establishing an effective emergency preparedness system, drawing upon international experiences.

In line with the information presented in the "EMIRATES energy sector and GHG" section of Chapter 2, the government assigned the Urban Planning department to collaborate and coordinate with the responsible organisation in setting plans and monitoring their implementation. These plans include UAE Vision 2021 for economic development, UAE Green Growth Strategy for environmental protection, and UAE Energy Strategy 2050 for energy planning. These plans ensure that all energy development initiatives provide economic opportunities while protecting the environment.

The collaboration and coordination between government entities and organisations and the implementation of national plans are crucial in supporting the centralisation of energy planning and the success of the UAE's nuclear programme. These measures contribute to economic development, ensure environmental protection, and create sustainable energy opportunities.

#### **Section 4: Campaigns to Link Technological Progress to National Revitalisation**

This section focuses on the promotion of technological advancement as a national goal. The respondents were asked to identify challenges and explain how they were overcome. Additionally, the section explores the creation of campaigns to connect technological progress with national revitalisation and how organisations monitor and analyse public acceptance of nuclear energy.

Based on the questionnaire responses, the following challenges were identified:

- Lack of technical expertise and knowledge among staff.
- Need for subjects related to nuclear education in the national human resources framework.
- Changes in requirements or expectations imposed by the government.

To overcome these challenges, several strategies were employed, including:

- Enhancing education and awareness programmes to address the need for more expertise.
- Following recommendations and best practices benchmarked by the International Atomic Energy Agency (IAEA).
- Promoting nuclear safety and highlighting the advantages of nuclear energy to mitigate challenges.
- Emphasising economic prosperity, business opportunities, job creation, energy security, and social benefits through subsidies.
- Establishing new specialised organisations to support the nuclear industry.

In terms of creating a link between technological progress and national revitalisation, the following measures were taken:

- Collaboration between the government and industry at senior management levels.
- Organising educational events, career fairs, scholarships, and conferences to promote technological advancement.
- Conducting domestic and international forums, events, and exhibitions to raise awareness and gather feedback through surveys.
- Monitoring public acceptance through Q&A sessions and online platforms.
- Analysing posts and comments generated from social media platforms.
- Maintaining social acceptance through continuous efforts.

The literature review revealed that many factors constrain nuclear revitalisation and the renaissance of the nuclear power programme (refer to section 2.1). Countries strive to maintain a nuclear industry despite nuclear incidents while ensuring public support. For example, after the Fukushima incident, the Emirati nuclear industry, including the regulatory authority, conducted extensive reviews of plant designs based on IAEA advice. Modifications were made to the design, which gained acceptance from the nuclear industry with government support, and the changes were publicly announced. [69]

In the context of the UAE and by section 2.7 in Chapter 2, unique challenges were faced due to the A.Q. Khan proliferation activities and network. This led to scrutinising the UAE's relationship with the non-proliferation regime. The A.Q. Khan case impacted the nuclear industry in the UAE, resulting in challenges related to know-how and restrictions on accessing technologies and materials (refer to section 2.3 and [2]). To address these challenges, the UAE signed bilateral agreements with Nuclear Supplier Group member states, including the UAE-USA 123 agreement, which provided technical assistance and security agreements[2]. This agreement facilitated the utilisation of operational experiences, access to classified technologies, and the establishment of specialised organisations to support business opportunities in the Emirati nuclear industry [46]. The government also collaborated with local universities and international educational institutes to implement education and awareness programmes, including scholarships. Awareness programmes were conducted through domestic and international forums, events, exhibitions, and forums to maintain public acceptance of nuclear energy. [44]

These efforts demonstrate the UAE's commitment to overcoming challenges, promoting technological progress, and ensuring public acceptance of nuclear energy as a catalyst for national revitalisation.

#### Section 5: **Influence of Technocratic Ideology on Policy Decisions.**

This section highlights the importance of incorporating technical experts' feedback into policy decisions. Implementing the government's development plans, including economic development, environmental protection, and energy strategy, necessitates a new approach for each organisation. This approach involves considering government initiatives during their decision-making processes. Organisations prioritise benchmarking best practices and adhering to international guidelines while promoting awareness of the benefits of nuclear energy programmes among the public to maintain public acceptance. This approach helps align the public's understanding with the government's development direction.

Based on the survey results, the following points were agreed upon by the participants:

1. The public accept and supports the transition towards nuclear energy.
2. Academic and educational programmes contribute to maintaining public acceptance of nuclear energy.
3. The public trusts the government's ability to handle and store nuclear waste.



4. Civic activism against nuclear energy in the UAE is lower than in Western countries.

Regarding the development of the Barakah Nuclear Power Plant, participants recognised the importance of the following characteristics:

1. Clean energy generation.
2. Economic competitive advantage.
3. Diversification of energy resources.
4. Job opportunities.
5. International recognition.

In the "A conceptual framework for Emirates" section of Chapter 2, it was mentioned that the Emirates government joined relevant international nuclear organisations and signed memoranda of understanding (MOUs) with Nuclear Suppliers Group (NSG) member countries. These agreements provided technical assistance and allowed the government to benchmark best practices. As a result, the Emirates government was able to utilise a technocratic ideology in policy decisions and support the national political authority.

The research also indicated that the public had shown acceptance of nuclear energy and trust in the decision-making of nuclear organisations on their behalf, as evidenced by data obtained from the Emirates Nuclear Energy Corporation (ENEC) websites (refer to sections 2.10.4 and 2.13.4). This has implications for nuclear governance and the implementation methodology to ensure compliance with national regulations and international requirements. The surveys conducted in this research focused on public acceptance, education, trust in the government and public organisations, and economic development.

Furthermore, in the "Nuclear Power Milestones" section of Chapter 2, it was mentioned that the UAE committed to following the guidelines and best practices set by the International Atomic Energy Agency (IAEA) in its nuclear policy. The IAEA established 19 milestones for developing nuclear power infrastructure, which every state should consider achieving for a successful nuclear programme. One of these milestones is the management of radioactive waste, which the UAE's nuclear regulator fulfilled by issuing regulations on the disposal of spent fuel and radioactive waste in 2019. [191]

Incorporating technical expertise, adherence to international guidelines, and promoting public acceptance have influenced policy decisions in the UAE's nuclear programme. This approach reflects a technocratic ideology that aligns with national goals and ensures regulatory and international standards compliance.

### Section 6: **Subordination of Challenges to Political Authority**

Developing a nuclear programme comes with various challenges that require collaboration and coordination among the government, stakeholders, educational institutes, and public and international organisations. Overcoming these challenges necessitates the government's support for organisations involved in nuclear development.

Based on the survey findings, participants agreed on the following aspects regarding the UAE government:

1. The government provides adequate support to overcome challenges related to nuclear development.
2. It can be withstanding or prevent challenges to its authority from external sources, demonstrating sovereignty.
3. The government is trusted to lead and deliver a stable and reliable energy programme for the national economy.
4. The level of trust in the government is expected to remain for at least the next five years.
5. The government is expected to continue supporting the implementation of nuclear energy for at least the next five years, regardless of any internal objections.

In the (2.5 Nuclear Revitalisation Challenges) section of Chapter 2, it is mentioned that several challenges are faced by existing, developing, and planned nuclear plants. These challenges include site selection, cost overruns, construction delays, grid integration during commissioning, and nuclear waste management. Additionally, external challenges such as climate change, evolving requirements, and uncertainties surrounding emerging technologies can potentially increase the risk to nuclear safety.

Findlay highlights the challenges facing the global energy governance regime by citing the United Arab Emirates as a promising candidate for nuclear energy [44]. The government of the UAE encourages its organisations to continue training and educating nuclear staff while promoting the development and maintenance of nuclear subjects at universities. Furthermore, outreach efforts are conducted to raise public awareness about nuclear safety, the civil use of nuclear energy, environmental protection, and the economic opportunities associated with nuclear programmes.

The subordination of challenges to political authority is evident in the UAE's approach to nuclear development. The government's support, training initiatives, and outreach programmes demonstrate its commitment to addressing challenges and ensuring the successful implementation of the nuclear programme. The government plays a vital role in mitigating challenges and fostering public trust in the nuclear sector by exercising political authority.

### Section 7: **Low Levels of Civic Activism as Factors Supporting the Nuclear Programme**

The government employs various methods through its organisations to maintain social acceptance of nuclear energy development. These methods include:

1. Participation in and organising of social and educational events and forums to engage with the public.
2. Implementation of intensive education programmes to enhance awareness and understanding of nuclear energy.
3. Announcements of the benefits and awareness of nuclear energy through social media and television platforms.
4. Promotion of sustainability in energy and communication of institutional programmes to enhance services.
5. Provision of job opportunities to support economic growth.
6. International recognition and the establishment of relations as notable achievements.

Transparency is identified as a crucial aspect of maintaining social acceptance, and it is achieved through:

1. Addressing public concerns through the federal national council of the UAE.
2. Government interaction and acceptance of engagement through social media platforms.
3. Empowerment of media to freely discuss government decisions.
4. Establishment of an independent regulatory and supervisory body to monitor nuclear activities.
5. Involvement of the public in forums and events related to nuclear energy.

As discussed in the "Social Aspect" section 2.12, early public engagement in nuclear decisions has been recognised to improve public trust, garner support, and reduce conflicts with local communities. The UAE government announced its nuclear development plan early on and engaged the public through events and the introduction of nuclear education subjects at universities.

The unique governmental structure of the Emirates, which differs from Western systems, has yet to have formal requirements for public consultations or trade obligations with neighbouring countries. However, the state (UAE) provided details of its nuclear development responsibilities and decision-making structure to the International Atomic Energy Agency (IAEA) through the Federal Authority for Nuclear Regulation (FANR). This arrangement ensures compliance with international requirements. To understand how the UAE structured

its nuclear programme, significant stakeholders were targeted through interviews as part of the research process.

The UAE government's development of nuclear power reactors contributes to electricity production and reduces carbon emissions. It demonstrates the efficient utilisation of nuclear fuel, focusing on safety, security, and safeguards. With government oversight and changes in the implementation of the nuclear power programme, modifications have been made to support national private sectors and entrepreneurs during construction and power generation [192]. This has resulted in job creation and economic development, garnering public support. The UAE's approach is exemplary for the region and the world, highlighting the benefits of nuclear power programmes in power production, economic growth, and public acceptance. FANR, as the nuclear regulator, leads communication efforts with national and international stakeholders to ensure the efficient implementation of government plans.

#### **Section 8: Promoting Environment Protection and Public Health for Current and Future Generations**

The UAE Vision 2021 and the UAE Green Growth Strategy are long-term national initiatives aimed at achieving a green economy for sustainable development under the slogan "A Green Economy for Sustainable Development." These initiatives focus on enhancing the country's competitiveness and the sustainability of its growth while preserving the environment for future generations. From the survey, participants indicated that their organisations contribute to implementing UAE Vision 2021 and the transition to a sustainable and diversified economy. Participants highlighted the following ways in which their organisations contribute to implementing UAE Vision 2021:

1. Considering government initiatives in promoting green technologies during internal decision-making processes.
2. Developing or amending internal policies and standards to enforce government policies and encourage investments in the green economy.
3. Benchmarking best practices from other organisations, including international entities.
4. Hiring subject matter experts to support the implementation of green strategies.
5. Establishing new functions within the organisation to support government initiatives.
6. Providing training for staff members.
7. Maintaining close coordination with responsible government departments.
8. Utilizing media and conferences to promote government initiatives.

Regarding the ‘Emirates energy sector and GHG’ in section 2.8, the UAE has set goals for sustainable development in its Vision 2021. Implementing green growth and national innovation strategies, along with other relevant plans, policies, and programmes, has established a national clean energy target. This target led to initiatives such as:

1. Tariff reform.
2. Developing building and efficiency standards.
3. Demand management.
4. District cooling.
5. Appliance efficiency standards.
6. Mass transit development
7. Use of compressed natural gas.
8. Investing in renewable energy and R&D.

The UAE government's 2050 Strategy aims to diversify the economy from oil-based to service-based, focusing on achieving balanced and sustainable development and a high standard of living. The 2050-Strategy is implemented within three main focused themes:

- a. Initiatives for the quick transition of power consumption efficiency, diversifying its sources, and ensuring the security of its supply.
- b. Finding new solutions that complement power and transport systems.
- c. Ensure the sustainability of energy via research, development, and innovation.

In the context of decarbonisation, discussed in section 2.7.4, governments are facing the challenge of developing new policies to achieve their deep decarbonisation goals. Existing approaches need to be revised to drive the necessary reductions in carbon emissions. Decarbonising industrialised societies presents a complex and long-term policy problem involving distributive politics, time-inconsistency issues, and uncertainties over time. Governance pathways must address long-term and short-term concerns by analysing the political, administrative, and legal structures necessary for successful climate policies [130]. Policy scope is crucial in coordinating policy and investment across different sectors to support decarbonisation efforts. However, the jurisdiction must develop a feasible decarbonisation policy targeting the industrial sector [131]. This can be attributed to existing technological and financial barriers that hinder the implementation of effective decarbonisation measures in industries. To overcome these challenges, further global research and development efforts are necessary to foster the development of better decarbonisation solutions for the industrial sector. Such advancements would help address the barriers and shift cost curves downward, making decarbonisation more economically viable.

In collaboration with organisations and stakeholders, the UAE government's initiatives aim to promote environmental protection, public health, and sustainable development to benefit current and future generations. The focus on green technologies, renewable energy, and the transition to a low-carbon economy demonstrates the commitment to addressing environmental challenges while fostering economic growth and maintaining a high quality of life.

#### 4.4.1 Outcome of Discussion of Survey Result with Literature Review

The survey results, supported by the literature review, provide valuable insights into the success factors of the UAE's nuclear programme. Strong state involvement, collaboration with stakeholders, adherence to international standards, and integration of environmental protection measures are vital aspects that contribute to the programme's achievements. The government's proactive approach, guided by well-defined policies and plans, ensures the programme's success, and fosters public acceptance and trust through transparency, public engagement, education, and awareness programmes.

The UAE's focus on green technologies, renewable energy, and sustainable development aligns with national initiatives such as UAE Vision 2021, UAE Green Growth Strategy, and UAE Energy Strategy 2050. These initiatives drive economic growth, energy security, and environmental sustainability. However, challenges remain in decarbonising the industrial sector, necessitating further research and development efforts. The UAE's nuclear programme is an exemplary model for balancing economic development, environmental protection, and public health with a commitment to achieving sustainable development for current and future generations.

The convergence of survey results and literature findings strengthens our understanding of the UAE's nuclear programme. It highlights the significance of strong state involvement, collaboration, public acceptance, and adherence to international standards in ensuring the programme's success. By integrating green technologies, promoting renewable energy, and implementing sustainable development strategies, the UAE demonstrates its commitment to a greener future while maintaining economic prosperity and environmental well-being.

### **4.5 Success Factors in the UAE's Nuclear Programme**

The success of the UAE's nuclear programme can be attributed to several key factors, as discussed in this section. These factors are based on a comprehensive thesis analysis, conceptual frameworks proposed by Sovacool and Valentine, survey results, cross-cutting analysis, the Literature Review (Chapter 2), and the UAE's programme development and management capabilities. The following success factors have been identified:

1. Strong Government Commitment and Support:

The unwavering commitment and strong support from the UAE government have provided a solid foundation for the success of the nuclear programme. The government's dedication is evident through implementing policies, plans, and strategies that prioritise the development and management of the programme. This commitment has fostered the nuclear sector's stability, continuity, and long-term vision.

2. Effective Governance and Regulatory Framework:

Establishing a robust governance and regulatory framework is crucial for the success of a nuclear programme. The UAE's independent nuclear regulator, the Federal Authority for Nuclear Regulation (FANR), is vital in ensuring nuclear facilities' safe and secure operation and compliance with international standards and regulations. FANR's oversight, licensing, and enforcement activities contribute to the programme's credibility and public confidence.

3. Public Acceptance and Engagement:

Emphasising public acceptance and engagement has been a significant success factor for the UAE's nuclear programme. The government's efforts to promote awareness, education, and transparency and address public concerns have built public support and trust for the programme. Regular communication, public consultations, and proactive engagement initiatives have facilitated the public's positive perception of nuclear energy.

4. Technological Expertise and Innovation:

The UAE's focus on developing technological expertise and fostering innovation has played a crucial role in the success of its nuclear programme. Investments in education, training, and research and development have enabled the country to build a skilled workforce and leverage advanced technologies in the nuclear sector. Continuous learning, knowledge transfer, and technological advancements improve operational efficiency, safety, and competitiveness.

***Additional Factors***

In addition to the factors identified by Sovacool and Valentine, the following success factors have also been identified:

1. International Cooperation and Collaboration:

The UAE's proactive approach to international cooperation and collaboration has been instrumental in the success of its nuclear programme. Engaging with international organisations, signing agreements, and seeking technical assistance and best practices have allowed the UAE to benefit from global expertise and ensure the programme's alignment with international standards. International cooperation facilitates knowledge sharing, regulatory harmonisation, and access to specialised resources.

2. Environmental Considerations and Sustainable Development:

Integrating environmental considerations and a commitment to sustainable development have been critical success factors. The UAE's vision for a green economy, promotion of clean energy, and efforts to reduce carbon emissions align with global sustainability goals and contribute to the programme's success. Environmental stewardship, resource efficiency, and minimising the programme's environmental impact are prioritised.

3. Effective Project Management and Risk Mitigation:

The UAE's ability to effectively manage projects, mitigate risks, and overcome challenges has been essential for the success of the nuclear programme. Careful planning, coordination with stakeholders, and implementation of best practices have ensured the timely and efficient execution of the programme. Robust project management methodologies, risk assessment frameworks, and contingency plans have contributed to the programme's resilience and adaptability.

4. National Capabilities and Resources:

The UAE's capabilities and resources, including financial, technical, and human resources, have been instrumental in the success of the nuclear programme. The country's strategic vision, long-term planning, and infrastructure investment have provided the foundation for the programme's development and management. National expertise, local talent development, and financial stability enable the UAE to overcome challenges and sustain the programme's growth.

5. Establishment of a group-think approach with broad participation in integrated activities:

The UAE's vision of a collaborative and inclusive approach involving the public, industry, and governmental organisations fosters collective decision-making, shared responsibility, and a sense of ownership. The government should facilitate open dialogue, establish mechanisms for public input, and involve diverse stakeholders in the decision-making process. This approach encourages innovation, ensures transparency, and strengthens the programme's resilience against potential challenges. (Refer to question 4 & 25 of the survey and section 8 above (at 4.4)).

These success factors collectively demonstrate the UAE's comprehensive and strategic approach to developing and managing its nuclear programme. By leveraging strong government commitment, effective governance, international collaboration, public engagement, technological expertise, environmental considerations, effective project management, and national capabilities, the UAE has achieved notable success in its nuclear endeavours.



## 4.6 Chapter Outcome

Chapter 4 analyses the survey results in-depth to uncover critical findings about the UAE's nuclear programme. The chapter explores various aspects, starting with the strong state involvement in guiding economic development. It highlights the government's crucial role in implementing strategies and plans that contribute to the success of the nuclear programme, focusing on the methods employed by government organisations.

The centralisation of national energy planning is another crucial theme discussed in the chapter. It examines how the coordination and collaboration between government organisations and stakeholders enhance the effectiveness of the nuclear programme. The chapter emphasises the role of government plans such as UAE Vision 2021, UAE Green Growth Strategy, and UAE Energy Strategy 2050 in aligning energy planning with national objectives and ensuring economic development.

The influence of technocratic ideology on policy decisions is also explored, emphasising the importance of technical expertise and education in the nuclear sector. The survey findings shed light on the challenges related to technical skills within organisations and highlight the efforts made to address these challenges. The chapter underscores the significance of incorporating technocratic perspectives in decision-making processes, promoting nuclear safety, and the advantages of nuclear energy.

Furthermore, the chapter discusses the subordination of challenges to political authority. It explores the trust placed in the government's ability to overcome obstacles and deliver a reliable energy programme by influential organisations. The chapter also addresses the role of civic activism, highlighting the low levels of civic activism in the UAE compared to the West and how it has facilitated the smooth implementation of the national nuclear energy plan. Maintaining public acceptance and trust through campaigns, public engagement, and education programmes is emphasised.

The survey findings align with the literature review, emphasising the significance of regulatory authorities and public outreach in the success of the nuclear programme. The chapter concludes by acknowledging the similarity between the identified success factors in the literature and their utilisation in driving the development of the Barakah Nuclear Power Plant. It also recognises the growing recognition of climate change and its impact on shaping perceptions of nuclear energy. These findings will inform the design of a new conceptual framework for implementing the UAE's National Nuclear Plan.

## Chapter 5: Interview Analysis

### 5.1 Introduction

This chapter presents the results of the face-to-face interviews conducted as part of the research methodology, complementing the questionnaire results discussed in Chapter 4. Semi-structured interviews were conducted with 14 individuals, both before and after the availability of the questionnaire results, to explore further and clarify the questionnaire responses. The integration of these two types of results demonstrates how the interview findings reinforced and enriched the questionnaire results. Triangulation was employed, incorporating relevant literature to support the claims made by the interviewees and the questionnaire results.

Given the overlapping findings and themes across both data collection methods, the results are categorised into two sections (survey and interview).

Findings from the survey questionnaires: The survey questionnaires provided quantitative insights into the opinions and experiences of participants. These findings contribute to fulfilling the following objectives:

Objective 1: Defining the factors necessary for developing a new conceptual framework for the UAE in the context of national activities, policies, and priorities.

Objective 2: Exploring the evolving socio-political-economic circumstances in the Emirates and applying the new conceptual framework to predict the potential success of commissioning and operating a nuclear power plant within the next ten years.

Objective 3: Develop an operational framework for the nuclear programme based on the expanded success factors and consider the socio-political-economic circumstances.

Objective 4: Predict the shifts in public perception of nuclear energy in the Emirates as the nuclear plant was commissioned for energy generation through planned fieldwork.

Findings from the interview sessions: The face-to-face interviews offered qualitative insights and a deeper understanding of the participants' perspectives. These findings contribute to fulfilling the following objectives:

Objective 5: To compare the expanded conceptual framework with the actual implementation of plans and operational activities and refine the operational framework based on the findings.

Thorough Analysis and Discussion: The findings from the survey questionnaires and the face-to-face interviews will be thoroughly analysed and discussed in the subsequent sections of this chapter. The integration of qualitative and quantitative data provides a comprehensive understanding of the participants' perspectives and enriches the overall findings of the research.

By aligning the interview results chapter with the research objectives, readers will better understand how the interviews contribute to the development of the operational framework and the overall success of the UAE nuclear energy programme. Integrating qualitative and quantitative data ensures a robust and comprehensive analysis, enhancing the validity and reliability of the research findings.

## **5.2 Discussion of Results**

The research aimed to develop, test, and utilise an operational framework to guide the implementation of the Emirates' nuclear energy programme. The research examined regional activities, policies, and priorities while building upon the success factors identified by Sovacool and Valentine. It also considered other relevant factors specific to the national and regional situation.

The research aimed to establish a new conceptual framework explicitly tailored for the UAE and the surrounding region, considering the transitional nature of the nuclear programme, with construction starting in 2010, commissioning in 2017, and operational energy production beginning in 2020. The research project started in 2017 and is expected to be completed in 2023.

The developed conceptual framework serves as a guide to success in the UAE's nuclear programme and potentially in other modern new-entrant civil nuclear programmes. It considers the evolving socio-political-economic circumstances in the Emirates and neighbouring states. The framework predicts the degree of success in the Emirates' commissioning and operation of a nuclear power plant in the recent past and the next ten years.

The research also explores the challenges in implementing international agreements and obligations related to civil nuclear power and export control in the Emirates. It considers the necessary changes in governance and the author's involvement in the nuclear programme through employment in ENEC export control since 2010.

The research context includes the Emirates' industrial base and how it overcame barriers to ensure the sustainability and security of its diverse energy sources. It considers business development, climate change obligations, their effects on energy planning, and the provision of skilled national staff to safely operate the nuclear power plant.

### 5.2.1 Thematic Analysis

The analysis of the interview transcripts using NVivo software revealed several themes from the discussions. These themes provide valuable insights into various aspects of the UAE's nuclear programme. The themes identified are as follows: (i) state involvement in guiding economic direction, (ii) the centralisation of national energy planning, (iii) campaigns to link technological progress to national revitalisation, (v) the influence of a technocratic ideology, (iv) the subordination of challenges to political authority, (iiv) the low levels of civic activism, (iiiv) state contribution to lower global warming initiative. Also, they discussed the state's contribution to lower the global warming initiative. They explained that, currently, these are the factors helping shape the execution of the national nuclear energy plan in the UAE.

To some extent, the questions in **Table 5** lead naturally to this analysis. However, The NVivo analysis further revealed sub-themes within these central themes, providing a more nuanced understanding of the interview data. These themes and sub-themes shed light on the factors influencing the execution of the national nuclear energy plan in the UAE. The NVivo Coding is attached at the Appendices.

#### **Theme 1: State Involvement in Guiding Economic Development**

The interview data emphasised the state's crucial role in guiding the UAE's economic direction. Participants acknowledged the government's proactive approach and strategic planning as key factors contributing to the success of the nuclear programme.

Participants recognised that the state has a heavy involvement and responsibility for the economic growth of the UAE. They attributed the Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy as a clear demonstration of state-driven initiatives.

There was unanimous agreement among participants that the effective execution of the policy would only be possible with strong government backing. They also highlighted the establishment of efficient and reliable regulatory bodies in relevant fields as a contributing factor to the government's success. These regulatory bodies have played a vital role in ensuring compliance, safety, and building trust in the industry.

The participants emphasised that the government's ability to define the scope and responsibilities of each organisation while minimising overlap has been instrumental in achieving sustainable success. This structured approach has facilitated organised and regular

frameworks for political, economic, and social activities, fostering collaboration among all stakeholders towards common goals.

Overall, the interview data emphasised the significant role of state involvement in guiding economic development and highlighted its importance in successfully implementing the UAE's nuclear energy programme.

All interviewees, especially Western Region Municipality representatives, support this theme by stating: 'There are main bases for this programme which are collaboration, partnership, coordination, and support. Since there is a partnership, all related organizations are responsible for gathering to achieve the government's aim to deliver energy from a clear source to protect the environment', 'The responsibilities from all government plans and directions are distributed to organizations based on their scope and responsibility. The municipality is more into implementers rather than a regulator. They do their responsibilities-based instruction and request. They helped ENEC to register the site and prepare it for construction. Also, they assist and advise ENEC to solve any unforeseen issues. Site evocation was one of their responsibilities. Also, they help and guide how to coordinate with related stakeholders.

### **Theme 2: Centralisation of National Energy Planning**

The interviews revealed the importance of centralisation in national energy planning. The coordination and collaboration between government organisations and stakeholders were discussed as crucial for effectively implementing the nuclear programme.

The interview data highlighted the centralisation of national energy planning as another significant theme. Participants discussed the UAE's approach to centralisation despite its federal system of government, which allows for some level of autonomy among federating units.

As alluded to in Theme 1, the government applies a rigid monitoring approach (via specialised regulators) to ensure compliance with each organisation's legal obligations. However, it is a fundamental notion, accepted worldwide (via IAEA) that the organisations responsible for energy supply should be independent of the regulator, and vice-versa. In national energy planning, the UAE adopts the centralisation method of implementing requirements and obligations, to ensure energy supply alongside compliance with national and international regulations and requirements.

The participants acknowledged the government's success in defining the scope of each organisation without overlapping responsibilities. This clear delineation of roles and responsibilities has allowed each organisation to focus on its specific scope while promoting

efficient collaboration and coordination. This approach has enabled organisations to contribute effectively to implementing the government's plans and strategies. The degree of agreement among interviewees from various sectors, including energy supply, regulation, supply chain, contractors, and designers, is remarkable.

Overall, centralising national energy planning emerged as a critical theme, reflecting the UAE's approach to ensuring energy supply while adhering to national and international regulations and requirements. The government's clear definition of roles and responsibilities has facilitated effective collaboration among stakeholders and contributed to the success of the UAE's nuclear programme.

All interviewees, especially the Ministry of Energy and Infrastructure representative, support this theme by stating: 'They are the ones who develop renewable energy mix investment, which is documented on UAE Energy Strategy 2050. They keep revising the strategy every few years. The first draft was issued in 2017. It is under revision during 2021-2022. They update the strategy based on status circumstances and technical expertise feedback. Basically, this is part of our scope' and 'How we manage the development and revise the strategy is in collaboration with local stakeholders. They meet and outreach with energy sector stakeholders regularly. They do workshops and exercises with the stockholders collaboratively. They collect the requirements from local stakeholders. Also, if a directive comes from the government, they convey it to the stakeholders and agree on a mechanism to achieve these targets. There is a very active level of engagement with stakeholders. They have a different venue for discussion; they work in other groups together. They have a planning and operation committee that meets regularly. Also, there is an executive committee that joins the leaders of the sectors quarterly. These are the formal meetings they have.'

### **Theme 3: Campaigns to Link Technological Progress to National Revitalisation**

Participants emphasised the importance of campaigns that link technological progress, particularly in the nuclear sector, to national revitalisation. These campaigns create awareness and promote the positive impact of technological advancements on the country's development. The interview data highlighted the importance of campaigns that link technological progress, particularly in the nuclear sector, to national revitalisation. Participants discussed the UAE's efforts to promote the integration of nuclear energy as part of its technological advancement and overall development. [78]

Throughout the 1970s, 80s and 90s, the leadership of the UAE had been consistent with its legal framework improvement, and technological advancements were at the heart of it. The

objective of adding nuclear energy into the mix is justified because the UAE's level of progress requires a renewable energy source, such as nuclear energy.

Participants recognised the government's active role in raising awareness about nuclear energy through various channels, including nuclear organisations, television, public events, and social media. These campaigns have aimed to inform the public about the benefits and opportunities associated with nuclear energy and its contribution to the country's progress. The government's focus on public education and awareness has been evident in its support for nuclear subjects at universities, ensuring a skilled workforce and maintaining credibility in handling nuclear technology. That not only helped the public to be familiar with nuclear technologies but, also supported the programme (evidence was shown in the national polls) [149].

The government also began to encourage nuclear subjects at universities, which helped maintain the country's credibility in handling nuclear technology (refer to section 2.7). Furthermore, the government has allocated sufficient budgets to organisations for training, benchmarking best practices, and improving internal operational processes. Encouragement to join international nuclear organisations has provided opportunities to learn from global best practices and enhance the programme's effectiveness [142].

The campaign to link technological progress to national revitalisation has played a crucial role in promoting and gaining acceptance for the UAE's nuclear energy programme. The government's focus on awareness, opportunities, and education, along with adequate funding and international collaboration, has contributed to the success of the programme and its integration into the country's overall development strategy.

This theme is supported by all interviewees especially the Security representative by stating: 'So the blessing here in the UAE is once the government has decided to do something I don't know that anybody here would ever oppose', 'you get the indication and awareness credit for the public support so I think there would have been public support around here no matter', 'awareness and education play a good role in gaining public support for nuclear development, especially when the people find out it will improve their environment by lowering carbon emissions' and 'they see Sheikh Mohammed bin Zayed out of the power plant on the news or when they get on YouTube, and they see that, and they see the strong government leadership of the leaders they love being fully acceptable this walking around in the plant walking around in the control room meeting with our leaders'.

#### **Theme 4: Influence of Technocratic Ideology**

The interview data highlighted the influence of a technocratic ideology on the UAE's nuclear programme. Participants emphasised the importance of technical expertise and education in the nuclear sector and the incorporation of technocratic perspectives in decision-making processes.

The interview data revealed a significant influence of the technocratic ideology on the UAE's nuclear programme. Participants, mainly from specialist organisations, highlighted the reliance on recognised and credible experts in decision-making processes. Decision-makers in the government, public, and private sectors tend to seek the input and expertise of these individuals before making important decisions. That required the government to provide a considerable investment in technical skills and technological skills to promote and implement the policies, particularly the nuclear energy policy. Hence the presence of international expertise in key organisations and the support of known nuclear contractors (by contracting with Korean contractor KEPCO (refer to section 2.1)).

Participants also emphasised the importance of continued investment in technical education and technology to meet the future needs of the nuclear policy and overall economic development plan. The technocratic ideology has played a significant role in positioning the UAE's nuclear programme as a role model on a global scale. How long this will continue to be so powered is hard to evidence. But for now, technocratic ideology is accepted by the senior management of all involved organisations. During the UAE prime minister's speech in Dec 2004 at Arab Strategic Conference, he stated "All decision-makers have to accept the changes and move toward development otherwise they will be changed". He also presented the development road map for the UAE and shared it with other nations as model [193].

Overall, the influence of the technocratic ideology has played a significant role in shaping the UAE's nuclear programme and establishing it as a leading example in the global nuclear industry. The government's investment in technical expertise and its reliance on expert input in decision-making processes have been key factors in the programme's achievements.

All interviewees, especially Security representatives, support this theme by stating: 'fulfilling the requirements of the policy, laws, and regulations. Can I clarify one point, go ahead. Regarding decision-making processes, do you follow technocratic approach. We always reply on SME feedback. You mean technical expertise. Yes.' and 'This is the conflict between provisions



between different regulators. It isn't easy to make a decision. The missing gap here is to have a third party make the decision. The methods ENEC using are close coordination, outreach to different stakeholders and building agreed goals.'

Also supported by NAWAH CEO representative by stating : 'international organizations I would refer mainly to two international organizations we are dealing with mostly first is WANO and the second is the IAEA and the most crucial thing is but the worth of the information these two organizations have what every nuclear programme so when it comes to operating experience they are sharing that operating experience from the new clear units around the world there's a very important success element within any nuclear programme so the lessons learned concept the operating experience from around the world is very important key to any nuclear programme second is we benefit from this organization is where we don't need to reinvent the wheel as they say, these organizing have years of experience where they have seen everything around the world it's not when our programme only they have seen different programmes from different continents around the globe so involving them into your programme also from the beginning to come and assess and provide recommendations suggestions to your programme where they see it '.

#### **Theme 5: Subordination of Challenges to Political Authority**

The interview data highlighted the subordination of challenges and obstacles to political authority in the UAE's nuclear programme. Participants acknowledged the trust placed in the government's ability to overcome challenges and deliver a reliable energy programme.

Participants emphasised the total subordination of the organisations responsible for implementing the nuclear programme to the government's ultimate authority. While some degree of autonomy exists in the governance system, the political authority has the final say in ensuring society's continued progress, particularly in the nuclear industry. This arrangement allows the government to support its organisations in developing, implementing, and maintaining established plans and strategies.

The participants agreed that the government effectively manages its organisations by defining their scope based on specialisation, maintaining oversight of implementation and operational progress, and ensuring compliance with requirements and standards through independent regulators. They also highlighted the importance of financial support provided to these organisations to help meet government expectations.

It is important to note that there was minimal discussion about democratic routes for political objection during the interviews. While this sub-theme did not emerge prominently, it is worth considering in relation to the overall topic. However, there is very little evidence in the media of a desire for such opportunities (in the author's opinion). This leads to theme 6.

The subordination of challenges to political authority has facilitated the smooth implementation of the UAE's national nuclear energy plan. The government's oversight, support, and management of its organisations have played a significant role in the programme's success.

This theme is supported by all interviewees especially the Financial Department representative by stating: 'OK, I will talk first about organizations and the finance they are well integrated within the organizations to show that it delivers exactly what the leadership and the policies of the UAE have been set for the nuclear. the organizations even our promises have been set in the minimum requirements. However, our organizations are set the targets up to max for the safety of the organizations and the quality of the reliability of the unit itself. this is where it is well structured within the finance to support these policies and activities within the organizations to ensure the organizations' support to meet the country's big picture. This is where you will see that sometimes we spend much more to ensure that it is aligned, and it will give the value already set for the organizations to meet the country's policy.' And ' the policy of the UAE is huge and we already set exactly our target vision-mission of the plant itself to be one of the top operators in the future, this is a previous vision to be part of the top five operators it has been changed now these days however the target for the excellence that is built up within the organizations and most of our policies procedure to ensure that maximize the excellence within each of these departments functions and integrated policy within all these functions to ensure to maximize the outcome and fruitful for these integrations.'

### **Theme 6: Low Levels of Civic Activism**

The interview data revealed low levels of civic activism in the UAE compared to Western countries. This has contributed to the successful implementation of the nuclear programme, as there is less opposition and fewer obstacles from the public.

Participants noted a virtual absence of opposition among Emirati citizens to the national nuclear energy plan and its implementation. While there is a level of freedom of the press, the media has worked closely with the UAE government to promote the execution of the nuclear energy plan.

The media has played a significant role in shaping public perception and acceptance of nuclear energy.[149].

The survey results further emphasised the importance of the media in various aspects related to nuclear acceptance and promotion. The media contributed to:

1. Create a campaign to link technological progress to national revitalisation.
2. Used to analyse and evaluate nuclear acceptance by the public.
3. Used to maintain nuclear acceptance by the public.
4. Used to promote the 'UAE Vision 2021'.
5. Support energy transition from fossil fuel to renewable sources and nuclear.

As a result, respondents unanimously agreed that civic activism is low in the UAE, which has been a vital factor in achieving the country's nuclear ambitions. They attributed this low level of activism to the government's outreach and awareness efforts, which have effectively communicated the benefits of nuclear energy, such as:

- Help protect the environment.
- Provide job opportunities.
- Provide business opportunities.
- Improve the country's reputation internationally.

Overall, the low levels of civic activism have contributed to the smooth implementation of the nuclear programme in the UAE, with the government's communication efforts and media support playing significant roles in garnering public support for nuclear energy.

This theme is supported by all interviewees especially Emirates Nuclear Energy Cooperation by stating: ' If we go back to the policy paper, the policy paper has one of the critical factors principles: transparency and complete operational transparency. That has been translated to the public (citizen and residence). Full access to what we plan to do, what we think will be done, and when. We are fully committed to full operational transparency throw out the programme. The regulator also publishes quarterly bases of all their findings, areas of improvement, and strengths systematically and transparently. And the public has full access to this information, including the regulation. The regulator provides free consultation to the public as part of its transparency. When the regulator drafts a rule, they send it to their stakeholders for review and comments and post it on their website for the public for review to collect comments and feedback. The UAE programme

is all based on full operational transparency. That made UAE nuclear programme has much public acceptance. Also, they are proactive in engaging the public.

One of the challenges is mess information from media, movies or random roamers and untrusted YouTube channels. One of the success factors is that we took the essential scientific knowledge and shared it with the public. This mothed is contributed and very successful for gaining public acceptance. Thank God, the UAE citizens are very qualified and educate people, and they can easily navigate between meth and scientific information. That's why we manage social acceptance, which is a credibility factor in the UAE.; we have a very high educated young generation who have based their knowledge on information and facts.'

### **Theme 7: State Contribution to Lower Global Warming Initiative**

The interview data highlighted the UAE's significant contribution to lowering the global warming initiative through its nuclear programme. Participants discussed how the programme aligns with sustainability goals and the country's commitment to reducing carbon emissions.

In the transcript of the interview data (i) state that contribution to lowering global warming and (ii) lowering gas emissions were very clear reasons why the country went for nuclear power. Participants emphasised that the state is actively investing in clean energy and positioning itself as a model for state contributions to global warming reduction initiatives. The UAE's nuclear power programme is expected to reduce CO<sub>2</sub> emissions by 18 million metric tons per year, which accounts for 25% of the country's targeted emissions reduction by 2030 as part of its nationally determined contribution (NDC) under the Paris Agreement (nationally determined contribution (NDC) filed as part of the Paris Agreement[194]).

According to NDC, the country set a target of reducing annual GHG emissions by 23.5% from its business-as-usual scenario for 2030, which would have been 310 million mt. The nuclear units reduce nearly 72 million mt/year [195]. According to the interviewees, NDC requirements were mentioned in the UAE Vision 2021 and the UAE Green Growth Strategy. The main reason is that the country is trying to preserve its environment for future generations. Another reason is that the country wants to be a role model and global hub for sustainable development.

The government's encouragement of its organisations to enhance their policies and functions to align with these plans reflects its proactive approach to tackling climate change and reducing carbon emissions. Overall, the state's contribution to lowering the global warming initiative

through its nuclear programme was a prominent theme in the interview data, highlighting the UAE's commitment to sustainability and its role as a leader in clean energy solutions.

This theme is supported by all interviewees especially by the environmentalist Marwan Al Kindi who is taking the lead on ensuring Environment Agency requirements at implemented by stating : ‘So when it comes to the public concern you know the top two things that people think about nuclear problems is the impact on the environment and the public during regular operation and during emergency operation so we know we are involved with both of those things especially on the normal operation side and we have used that in terms of supporting our communication team to talk about this or give them a lot of talking points whenever they go out recently the spotlight happened in terms of carbon emissions so you know we keep emphasizing that BNPP is going to produce 25% of the power in the UAE and scope to be 0 carbon emission so that is something that we are taking credit for and we are using that to get the public support so you're like during the forums you are showing how nuclear power plants will benefit the environment yeah on one side we offer the benefit which is you know zero carbon energy on the other side we are saying this is safe and we are doing a lot of good things for the environment as well that's really good so they have environment team from ENEC at the forums to explain to the public that the benefits which will go to the environment that's correct and to maintain social acceptance you need to focus on the educate people and awareness maybe all through the for example one of the tools as social media yeah if you open all social media will see a lot of posters regarding the environmental side of things that we do with the rest of the environment. ‘and ‘do you believe that the nuclear benefit benefits to the environment consider being a factor by itself yes, I think this is one of the main reasons why UAE decided to build a nuclear power plant even though it's a gas-rich country think it has the foresight to see that the near future they're going to have to go to zero carbon. This project that it's on is a big part of that effort, so This is why our government just last month declared that we are going to be carbon neutral by 2050, so let say 30 years from now, if we don't have BNPP, I don't think they will say they would have been able to make it this kind of promise. Hence, they made a promise, and they made a plan to achieve that promise. Therefore, one of the solutions was to have a nuclear power plant; correct was at the COP conference in 2005 when the UAE announced that they would comply with the international initiatives to reduce the carbon emission. I'm not talking about exactly what happened in 2005 maybe you're right, yeah OK.’

### 5.2.2 Thematic Analysis Summary: Key Factors of Nuclear Programme

The thematic analysis of the interview data has provided valuable insights into the factors and dynamics shaping the UAE's nuclear programme. These findings complement the results obtained from the questionnaire survey and contribute to the development of a comprehensive conceptual framework for the programme. The analysis revealed several key themes that shed light on various aspects of the UAE's nuclear programme. These themes include:

**State's Involvement in Guiding Economic Development:** The interviews emphasised the crucial role of the state in guiding the UAE's economic direction. Proactive strategic planning, clear policies, and the establishment of efficient regulatory bodies have contributed to the success of the nuclear programme. The government's ability to define the scope of each organisation and foster collaboration among stakeholders has been instrumental in achieving sustainable success.

**Centralisation of National Energy Planning:** The centralisation of energy planning emerged as a significant theme, highlighting the UAE's approach to ensuring energy supply while adhering to national and international regulations. The government's method of implementing requirements and obligations, along with the successful coordination and collaboration between government organisations and stakeholders, has facilitated the effective implementation of the nuclear programme.

**Campaigns Linking Technological Progress to National Revitalization:** Campaigns promoting the positive impact of technological advancements, particularly in the nuclear sector, on national revitalisation were recognised as important. The government's efforts to raise awareness through various channels, support nuclear education at universities, and allocate budgets for training and benchmarking best practices have contributed to public acceptance and support for the nuclear energy programme.

**Influence of Technocratic Ideology:** The influence of a technocratic ideology was evident in the UAE's nuclear programme. The reliance on technical expertise and the incorporation of technocratic perspectives in decision-making processes have played a significant role in ensuring nuclear safety and advancing the advantages of nuclear energy.

**Subordination of Challenges to Political Authority:** Challenges and obstacles in the nuclear programme are subordinated to political authority, enabling the smooth implementation of the programme. The government's oversight, support, and management of its organisations and the clear delineation of roles and responsibilities have contributed to the programme's success.

**Low Levels of Civic Activism:** The interviews revealed low levels of civic activism in the UAE compared to Western countries. The absence of opposition to the nuclear programme among Emirati citizens can be attributed to the government's outreach efforts, media support, and effective communication of the benefits of nuclear energy. The public support nuclear energy due to its positive environmental impact, job and business opportunities, and improved international reputation.

**State's Contribution to Lower Global Warming Initiative:** The UAE's nuclear programme has significantly contributed to lowering global warming. The programme aligns with sustainability goals and the country's commitment to reducing carbon emissions. Reducing CO<sub>2</sub> emissions through nuclear power helps the UAE meet its targets under the Paris Agreement and positions the country as a leader in sustainable development.

These themes provide a comprehensive understanding of the factors influencing the UAE's nuclear programme and its successful implementation. The government's proactive approach, emphasis on technical expertise, clear policies, and effective communication efforts have played crucial roles in achieving the programme's objectives and positioning the UAE as a global leader in the nuclear industry.

### **5.3 Cross-Cutting Analysis of Interview Result**

The interview themes were divided into seven sections. A cross-cutting analysis was carried out over all sections. Cross-cutting methods are techniques of policy analysis that can be used at any stage in the analysis. They include but are not limited to interviewing for policy data, quick surveys, basic data analysis and communicating the analysis [196]. The traditional cross-cutting analysis focuses on commonalities and differences between the results of interview sections, surveys, or analytic tests. Some interesting points are being noticed, as follows:

**Theme 1: State Involvement in Guiding Economic Development**

The cross-cutting analysis of Theme 1 reveals a consensus among participants regarding the state's involvement in guiding economic development in the UAE. The key findings include:

**Government oversight:** Participants acknowledge that the government closely monitors the development and implementation of policies, plans, and strategies through regulatory organisations. This highlights a strong level of government oversight in driving economic growth.

**Trust in government competence:** There is a high level of trust among participants in the government's ability to establish and enhance specialised organisations, including regulatory bodies. This recognition of government competence in setting up effective institutions supports economic development.

**Efficient organisation and coordination:** Participants express trust in the government's ability to define the scope and responsibilities of each organisation while minimising overlap between them. This efficient organisation and coordination contribute to successfully implementing development plans and strategies.

The findings from Theme 1 underscore the importance of the state's role in guiding economic development in the UAE. The government's proactive monitoring, establishment of specialised and efficient organisations contribute to sustainable success in implementing development plans and strategies. These findings align with the results from the questionnaire survey, confirming the significance of the state's ability to guide economic development, as recognised by Sovacool and Valentine in their earlier work for development in the 1950s, 1960s and 1970s.

**Theme 2: Centralisation of National Energy Planning**

The cross-cutting analysis of Theme 2 reveals several points of agreement among participants regarding centralising national energy planning in the UAE. These points shed light on the following key aspects:

Firstly, participants highlighted the autonomy of federating states, which enables specialised local organisations to develop and implement their energy plans without undue influence from the federal government. This approach allows regional considerations and priorities to be considered in energy planning.

Secondly, participants recognised the role of the Ministry of Energy in developing the overall energy strategy. This strategy provides a framework for each state to plan and implement its



methods, utilising its respective local organisations. This decentralised approach ensures that regional needs and circumstances are adequately addressed.

Participants also emphasised the importance of maintaining the independence of various regulatory organisations involved in energy planning. This independence ensures impartiality and effective oversight in enforcing legal obligations related to energy planning and implementation.

There is a strong trust among participants in the government's ability to ensure compliance with legal obligations through these regulatory organisations. This trust reflects confidence in the robustness of the regulatory framework and its enforcement mechanisms.

Furthermore, participants expressed trust in the government's oversight of energy projects, ensuring accountability and alignment with the overall national energy strategy. This oversight helps to maintain consistency and progress in achieving energy-related goals.

Efficient collaboration and coordination among the energy planning and implementation organisations were also crucial. This collaboration enables effective decision-making, resource allocation, and alignment of efforts across different stakeholders.

The findings from Theme 2 reinforce the evidence seen in Theme 1, highlighting the high level of trust in the government's ability to establish and control a macro-organisational structure. The centralisation of national energy planning, combined with the autonomy of federating states and efficient collaboration, supports a framework that allows all parties to coexist and work towards shared objectives.

Moreover, the emphasis on clean energy production and addressing climate change aligns with the modern framework's focus on sustainability and environmental considerations. This indicates a forward-thinking approach recognising the importance of transitioning to cleaner and more sustainable energy sources.

The insights gained from the cross-cutting analysis of Theme 2 provide a comprehensive understanding of the centralisation of national energy planning in the UAE. They highlight the significance of regional autonomy, effective coordination, and trust in regulatory processes. These findings contribute to the overall understanding of the success factors influencing the UAE's energy planning and implementation efforts.

### **Theme 3: Campaigns to Link Technological Progress to National Revitalisation**

The cross-cutting analysis of Theme 3 reveals participants' agreement on several key points regarding campaigns that link technological progress to national revitalisation in the UAE's nuclear programme. These points include:

1. Learning from international best practices: Participants emphasised the importance of continued learning from global best practices and guidelines, particularly those provided by the International Atomic Energy Agency (IAEA). This focus on learning and adopting international standards contributes to the success of the nuclear programme.
2. Significance of improvements in governance systems and technological advancements: Participants recognise the significance of advances in governance systems and technological advancements since the 1970s. The UAE's progress in these areas has laid the foundation for successfully implementing the nuclear programme. This distinguishes the current work from the evidence provided by Sovacool and Valentine, whose research is now about 50 years old. The use of modern communication media has proven valuable in educating both nuclear professionals and the public in the UAE.
3. Allocation of sufficient budgets: Participants highlighted the importance of allocating sufficient budgets to organisations involved in the nuclear programme. Adequate financial resources enable these organisations to enhance operations, provide staff training, and develop new functions. With proper budgets, the activities and roles of these organisations would have been positively affected.
4. Membership in international nuclear operation organisations: Participants recognise the value of joining international organisations such as the World Association of Nuclear Operators (WANO) and the Institute of Nuclear Power Operations (INPO). Membership in these organisations allows the UAE to benefit from and implement best practices in nuclear operations.

The interviewees also suggest that promoting the programme is important in creating success. That is:

5. Promoting nuclear energy as a clean source for future demand (on media and at events).
6. Promote business and job opportunities for the public from the new industry.

This includes:

7. Providing nuclear subjects at universities helped maintain the country's credibility in handling nuclear technology.

Here, item 2 sets the current work apart from that of Sovacool and Valentine, whose evidence is about 50 years old. The combination of learning from international best practices, advancements in governance and technology, adequate budgets, and promotional efforts have been crucial in the UAE's successful nuclear programme. Modern communication media has played a significant role in educating professionals and the public. While the impact of budgets on achieving similar success in other states with more limited resources remains an open question, the UAE has established a working model in the modern world.

#### **Theme 4: Influence of Technocratic Ideology**

The cross-cutting analysis of Theme 4 reveals strong agreement among participants regarding the influence of technocratic ideology in the UAE's nuclear programme. Several key points of agreement are highlighted:

Firstly, participants acknowledge the massive influence of technocratic ideology as the UAE continues to advance technologically. Decision-makers rely on specialised experts and technical skills to inform their decision-making processes. This emphasis on expertise contributes to the success of the nuclear programme.

Secondly, the government invests significantly in technical and technological skills, including modern media for educational purposes, to promote and implement policies, particularly in the nuclear energy sector. This investment ensures the availability of skilled professionals and supports disseminating knowledge and awareness among the public.

The technocratic ideology has also been crucial in establishing the UAE's nuclear programme as a role model worldwide. The government's reliance on specialised experts and its commitment to technological advancements have contributed to its credibility and recognition on the global stage.

Furthermore, education and awareness initiatives have been instrumental in gaining and maintaining public acceptance of the nuclear programme. By providing information, promoting transparency, and emphasising the benefits and safety of nuclear energy, the government has garnered support from the public.

Interestingly, international recognition, job opportunities, and business opportunities influence public support for nuclear energy. These aspects highlight the pride and credibility associated with the ethical and technological achievements of the state and all those involved in the nuclear programme. This expanded framework considers the state's perception, which can be influenced by media reporting and public awareness. [197]

The influence of technocratic ideology and education and awareness initiatives reveals new aspects that Sovacool and Valentine should have explicitly addressed. These aspects highlight the significance of public pride in the ethical and technological accomplishments associated with the nuclear programme. This pride extends beyond the UAE, encompassing worldwide respect and credibility. While historical evidence from the post-WW2 development era of the 1950s, 1960s, and 1970s highlights different facets of credibility, a modern framework must consider the state's perception shaped by media reporting and public awareness.

The influence of technocratic ideology emerges as a substantial factor in the UAE's nuclear programme. The reliance on specialised expertise, investment in technical skills, education and awareness initiatives, and international recognition collectively contribute to the programme's success. By considering these factors, the enhanced framework provides a comprehensive understanding of the role of technocratic ideology in shaping the UAE's nuclear programme and global perception.

### **Theme 5: Subordination of Challenges to Political Authority**

The cross-cutting analysis of Theme 5 reveals several points of agreement among participants regarding the subordination of challenges to political authority in the UAE's nuclear programme. The key agreements are as follows:

1. **Defined scope and responsibilities:** The government effectively manages its organisations by clearly defining the scope and responsibilities of each organisation based on its specialisation, minimising overlap. This efficient organisation and coordination contribute to successfully implementing approved plans and strategies.
2. **Government oversight and assistance:** The government continues to oversee and support the implementation and operation progress of its organisations involved in the nuclear programme. This oversight ensures that the organisations adhere to requirements and standards and receive the necessary assistance to meet expectations.

3. Compliance with requirements and standards: Through the organised society, such as independent regulators, the government ensures compliance with requirements and standards related to the nuclear programme. This emphasis on compliance fosters a safety culture and adherence to established regulations.
4. Financial support: The government provides financial support to its organisations to help them meet expectations and successfully implement the approved plans. This financial support enables the organisations to carry out their responsibilities effectively.

Items 1-4 are consistent with existing literature, where the public accepts the government's strategy [49]. They indicate that the UAE's nuclear programme operates within a framework of effective governance and regulatory oversight. This, in turn, leads to public support as observed in the following aspects:

5. Implementation of international obligations: The government demonstrates determination in implementing international obligations, such as the Kyoto Protocol, through organised plans. The support from nuclear companies further reinforces this commitment.
6. Early engagement of organisations: The government engages its various organisations at early stages and seeks their input during developing and drafting plans. This collaborative approach ensures the organisation's expertise is utilised, leading to better-informed decision-making.
7. Distribution of responsibilities: The government distributes the responsibilities of implementing approved plans among its organisations. Each organisation takes on tasks based on its scope, and the government provides adequate support to ensure successful implementation.
8. Promotion through media and events: The government recognises the nuclear programme as the best solution for fulfilling the country's promises to lower greenhouse gas emissions. It actively promotes the programme to the public through media channels and events, and the public has largely accepted and supported these efforts [198].

Theme 5 supports the conclusions drawn from Themes 1 to 4, emphasising the importance of effective governance, cooperation among organisations, and the role of education and media in fostering positive civic activism. It also aligns with the findings of Theme 6, highlighting the significance of education and media in promoting positive civic activism (i.e., not negative, or anti-establishment activism).

**Theme 6: Low Levels of Civic Activism**

The cross-cutting analysis of Theme 6 provides insights into the low levels of civic activism in the UAE's national nuclear energy plan. Several key points of agreement among participants are highlighted:

Firstly, participants believe there needs to be more opposition among Emirati citizens regarding implementing the national nuclear energy plan. This suggests a high level of acceptance and support for the plan among the population. The lack of significant opposition indicates a favourable environment for the successful execution of the plan.

Secondly, the media has played a supportive role in promoting the implementation of the nuclear energy plan. This indicates that the UAE government has utilised media channels to educate the public and generate positive awareness about the plan. The government's media use for communication and education has shaped public perception and minimised opposition.

Furthermore, the UAE government is actively monitoring and taking steps to ensure public satisfaction with civil nuclear development. This demonstrates the government's commitment to addressing any concerns or issues raised by the public and maintaining a positive perception of the plan. By actively addressing public satisfaction, the government fosters an environment of trust and collaboration.

Evidence of the government's use of media to educate the public are contained in survey questions 8 and 17. The evidence of the government's use of media to educate the public and the belief in the low level of civic activism against the plan further support the findings of Theme 6, also contained in section 7 and question 8 of the survey. The positive side of civic activism is also acknowledged, as indicated in the responses to question 18.

Theme 6 suggests general acceptance and support for the national nuclear energy plan among Emirati citizens, with low levels of opposition or activism. The government's efforts in utilising media channels, addressing public concerns, and ensuring satisfaction have contributed to the positive perception and limited civic activism surrounding the plan. This highlights the importance of effective communication and proactive engagement with the public in shaping public opinion and fostering a supportive environment for implementing national plans.

**Theme 7: State Contribution to Lower Global Warming Initiative**

The cross-cutting analysis of Theme 7 highlights the UAE's state contribution to lower global warming initiatives. Participants show agreement on several key points, which collectively demonstrate the UAE's commitment to addressing climate change:

Firstly, there is a strong commitment within the UAE to reduce greenhouse gas emissions. This commitment reflects the recognition of the urgent need to combat climate change and mitigate its impacts.

Secondly, the UAE government is actively investing in clean energy and developing strategic plans to become a model for contributing to global warming initiatives. This proactive approach indicates their determination to transition to sustainable energy sources and reduce dependence on fossil fuels.

Thirdly, the UAE incorporates international initiatives into its plans and strategies, highlighting its commitment to aligning with global efforts to combat climate change. This demonstrates the importance of international cooperation in addressing the global challenge of global warming.

Furthermore, preserving the environment for future generations is a priority in the UAE. This extends beyond the natural environment and includes maintaining the physical infrastructure, business, and financial environment necessary for sustainable development.

The UAE aspires to be a role model for sustainable development and a global hub for initiatives focused on addressing climate change. This ambition reflects their intention to lead by example and inspire others to take similar actions in combating global warming.

Additionally, the UAE government actively supports organisational enhancement, encouraging organisations to align their policies and functions with the plans and strategies for lowering global warming. This coordinated approach emphasises the importance of collaboration among various entities in achieving climate-related goals.

The cross-cutting analysis of Theme 7 highlights the UAE's commitment to addressing climate change and contributing to lower global warming initiatives. Their investments in clean energy, incorporation of international initiatives, prioritisation of environmental preservation, and aspiration to be role models collectively demonstrate their dedication to sustainable development and their desire to inspire positive change on a global scale.

### 5.3.1 Outcome of Cross-Cutting Analysis of Interview Result

The cross-cutting analysis of the interview results across all seven themes reveals several key findings that highlight the UAE's focus on climate control, sustainable development, and addressing global warming, as well as the use of media and awareness to maintain public acceptance and support. The following summarises the main outcomes:

Regarding the state's involvement in guiding economic development, participants recognise the government's strong oversight in driving economic growth. There is trust in the government's ability to establish effective institutions, and efficient organisation and coordination contribute to the successful implementation of development plans and strategies.

The centralisation of national energy planning in the UAE allows for regional considerations and prioritisation while ensuring the independence of regulatory organisations. This approach facilitates compliance with legal obligations and effective coordination in the energy sector.

Campaigns that link technological progress to national revitalisation have played a significant role in the UAE's nuclear programme. The country has learned from international best practices, improved governance systems, and allocated sufficient budgets. Promotional efforts, such as emphasising nuclear energy as a clean source and providing education in the field, have helped maintain public acceptance.

The influence of technocratic ideology is evident in the UAE's technological advancements and reliance on specialised experts. The government's investment in technical skills, education, and awareness initiatives has further supported public acceptance. International recognition, job opportunities, and business opportunities also contribute to the overall success of the nuclear programme.

The UAE has effectively subordinated challenges to political authority in its nuclear programme through various means. These include effective governance, government oversight, compliance with requirements and standards, financial support, implementation of international obligations, early engagement of organisations, distribution of responsibilities, and promotion through media and events.

The UAE's national nuclear energy plan has low levels of civic activism. The absence of opposition, media support, and government efforts to ensure public satisfaction contribute to this situation.



The UAE demonstrates a strong commitment to lower global warming initiatives. This commitment is evident through reducing greenhouse gas emissions, investment in clean energy, incorporation of international initiatives, prioritisation of environmental preservation, aspiration to be a role model, and government support for organisational enhancement.

Overall, the cross-cutting analysis emphasises the importance of climate control and sustainable development as driving forces behind the UAE's nuclear programme. The UAE has recognised the global climate change challenge and the public's desire to maintain safe and healthy living conditions. The nuclear programme is driven by a commitment to economic growth, technological progress, public acceptance, education enhancement, and environmental preservation while adhering to international standards and incorporating global initiatives. The UAE aims to serve as a model for other countries in achieving sustainable development and combating climate change.

#### **5.4 Cross-Cutting Analysing of the Interview with Literature and Survey**

This cross-cutting analysis examined the literature review, interview, and survey data findings to identify common themes and patterns. The analysis confirmed a strong state involvement in implementing the UAE's National Nuclear Energy Plan, with a high agreement among respondents regarding the substantial-state involvement. This finding is consistent with previous studies conducted in China and France, highlighting the importance of government support in successfully implementing national nuclear energy plans. The cross-cutting analysis further reinforces the understanding that state involvement is a key driving force behind the UAE's nuclear programme. [16, 20, 21, 169]

##### **Analysis of Theme 1: Strong State Involvement in Guiding Economic Development**

The analysis of Theme 1 reveals a strong consensus among interviewees regarding the significant role of the state in guiding economic development in the UAE. The government's active involvement through regulatory organisations, efficient coordination, and minimised overlap has successfully introduced civil nuclear power. This finding aligns with previous studies and highlights the importance of government support in successfully implementing nuclear energy plans.

The interviewees emphasised that the government's ability to define the scope and responsibilities of each organisation has led to efficient coordination and minimised overlap. This structured approach has created organised frameworks for political, economic, and social activities, facilitating collaboration and progress towards common goals.

The unanimous agreement among interviewees highlights the crucial role of strong state involvement in the effective execution of the UAE's national nuclear energy plan. This finding is consistent with similar studies conducted in other countries, underscoring the significance of government leadership and commitment to driving economic development through nuclear energy.

The government's active participation and support provide a solid foundation for implementing the national nuclear energy plan, ensuring its effective execution and alignment with broader economic goals and strategies.

The analysis confirms the consensus among interviewees regarding the strong state involvement in guiding economic development in the UAE. The government's active participation, particularly through regulatory organisations, efficient coordination, and minimised overlap, is vital in successfully implementing the national nuclear energy plan.

### **Analysis of Theme 2: Centralisation of National Energy Planning, Development, and Implementation**

The analysis of Theme 2 reveals a strong consensus among interviewees and survey respondents regarding the centralisation of national energy planning, development, and implementation in the UAE. Key agencies such as FANR, ENEC, and NAWAH are responsible for planning and implementation, contributing to the centralisation of the nuclear energy strategy.

The interviewees acknowledge the government's success in defining each organisation's scope and establishing clear roles and responsibilities, avoiding overlap. This focused approach enables efficient collaboration and coordination among the organisations, ensuring effective contributions to implementing the government's plans and strategies. Both the questionnaire survey results, and interview responses support the agreement on centralisation, with participants expressing their support for the centralisation of nuclear energy planning and collaboration with the government. This centralised approach facilitates efficient governance, coordination, and decision-making, allowing for a streamlined and unified approach to implementing the national nuclear energy plans. The high degree of agreement among the interviewees reflects the success factors observed in the UAE's energy development approach. Despite being a new entrant country guided by the International Atomic Energy Agency (IAEA) and drawing from existing knowledge from previous successes, the UAE has demonstrated effective centralisation in its national energy strategy.

The analysis confirms the significance of centralisation in the UAE's national energy strategy. It provides a framework for effective coordination, governance, and decision-making, contributing to the successful execution of the nuclear energy programme and alignment with the government's broader energy goals and strategies.

### **Analysis of Theme 3: Campaigns to Link Technological Progress to National Revitalization**

The analysis of Theme 3 reveals that nuclear energy is being promoted as an alternative to fossil fuels in the UAE, driven by economic and technological advancements. However, challenges related to technical knowledge, education, managerial expertise, and adapting to government requirements have been identified.

The interview and survey respondents agree on the need to address the lack of technical knowledge in nuclear energy and improve education and knowledge in this area. The absence of subjects focusing on nuclear education indicates the importance of enhancing educational programmes to bridge the knowledge gaps. Challenges related to managerial expertise, availability of nuclear operators, difficulties adapting to government requirements changes, and the absence of new entrants have also been identified. These challenges highlight the need for developing administrative expertise, professionalism, and changes in public behaviour to effectively promote technological progress and its link to national revitalisation through nuclear energy. To address these challenges, efforts should focus on enhancing educational programmes, providing training opportunities, and bridging knowledge gaps at various levels. By improving education and training, the UAE can strengthen the promotion of nuclear energy as a driver of technological progress and national revitalisation.

The analysis emphasises the importance of continuous improvement in education and training to overcome challenges and ensure the successful integration of nuclear energy into the UAE's technological advancements and overall development. The government's focus on awareness, opportunities, and education, along with adequate funding and international collaboration, has played a crucial role in promoting and gaining acceptance for the UAE's nuclear energy programme.

#### **Analysis of Theme 4: Influence of Technocratic Ideology on Policy Decisions**

The analysis of Theme 4 reveals that a technocratic ideology influences the UAE's nuclear programme, emphasising the reliance on recognised experts and investment in technical skills. This approach has contributed to the programme's success and positioned the UAE as a global role model.

Participants in the interview and survey emphasised the importance of seeking input and expertise from credible experts in the decision-making processes of the nuclear programme. The government's commitment to engaging renowned nuclear contractors (such as KEPCO) and international experts further highlights the reliance on technical knowledge and experience. The government has significantly invested in technical education and technology to implement the programme. This commitment to continuous development ensures that the UAE is equipped to meet the future needs of the nuclear policy and overall economic development plan. Senior management's acceptance of the technocratic ideology across organisations is evident, as demonstrated by the prime minister's speech emphasising the country's roadmap for development as a model to be shared with other nations. The influence of the technocratic ideology has played a crucial role in establishing the UAE's nuclear programme as a global role model. The government's investment in technical skills, reliance on expert input, and commitment to continuous development have contributed to the programme's success.

To ensure the continued success of the nuclear programme, it is important to address the need for more local experts by enhancing expertise within the UAE. Efforts should also focus on education and public awareness to maintain and preserve public acceptance of nuclear energy. The high level of trust in the government's ability to manage nuclear waste and the low level of civic activism against nuclear energy indicates a favourable environment for successfully implementing the UAE's nuclear energy plan.

#### **Analysis of Theme 5: Subordination of Challenges from the Government to Responsible Organisations**

The analysis of Theme 5 reveals a high level of agreement among participants regarding the subordination of challenges from the UAE government to responsible organisations involved in

the nuclear programme. This indicates that the government effectively delegates authority and supports these organisations.

The interview and survey participants express confidence in the government's ability to overcome obstacles and maintain its authority in implementing the nuclear programme. They acknowledge that the government has delegated authority and responsibility to the relevant organisations, allowing them to address challenges related to nuclear development effectively. This demonstrates the government's proactive approach to supporting and facilitating the successful implementation of the programme. The participants also express mutual agreement and trust in the UAE government's leadership, recognising its capability to withstand or prevent challenges to its authority and responsible organisations. This reflects a belief in the government's ability to navigate and overcome potential obstacles or opposition that may arise during the implementation of the nuclear programme. Furthermore, the participants demonstrate high confidence in the government's capacity to deliver a firm and reliable energy programme for the national economy. They trust the government will maintain its credibility and trustworthiness about the nuclear programme and other energy initiatives over the next five years. The analysis also indicates that participants believe the UAE government will continue to support the implementation of nuclear energy projects. This reflects the expectation that the government will provide ongoing support and resources to ensure the successful implementation of nuclear energy initiatives.

The analysis highlights the strong subordination of challenges from the UAE government to responsible organisations and the participants' confidence in the government's ability to support and lead the implementation of the nuclear programme. This alignment and cooperation contribute to the overall success and effectiveness of the programme.

### **Analysis of Theme 6: Low Levels of Civic Activism and Support for the Nuclear Programme**

The analysis of Theme 6 reveals low levels of civic activism in the UAE, particularly in opposition to the national nuclear energy programme. This indicates a favourable environment for implementing the programme and general acceptance and support among Emirati citizens.

Participants in both the interview and survey agree that there needs to be more significant opposition or activism against the nuclear programme in the UAE. There is no known record of serious protests or opposition groups capable of significantly impeding or derailing the

programme. This suggests that there needs to be more widespread public opposition or resistance to the nuclear programme in the country. The low level of civic activism can be attributed to several factors. Firstly, the government's supportive stance and commitment to the programme significantly foster a positive environment. The government's efforts in utilising media channels and conducting effective communication and education campaigns have shaped public perception and acceptance of nuclear energy. Public acceptance and support for the nuclear programme are driven by a positive perception of the benefits and safety of nuclear energy. The government's emphasis on nuclear energy's environmental, economic, and reputational advantages has influenced public opinion and contributed to the low levels of opposition or activism. The low levels of civic activism do not indicate a lack of public engagement or awareness. Public acceptance and support for the nuclear programme can thrive without extensive civic activism. The analysis suggests that the absence of significant opposition or activism has contributed to the smooth and successful implementation of the nuclear programme in the UAE.

The low levels of civic activism indicate a positive perception and acceptance of nuclear energy among Emirati citizens in the UAE. The government's efforts in utilising media, fostering public awareness, and emphasising the benefits of nuclear energy have likely played a significant role in creating a supportive environment for the nuclear programme.

### **Analysis of Theme 7: State's Contribution to Lowering Global Warming Initiatives and Gas Emissions**

In Theme 7, the analysis highlights the significant role of governmental organisations in the UAE in contributing to the country's goals of lowering global warming initiatives and reducing gas emissions. These organisations actively work towards achieving a Sustainable and Diversified Economy as outlined in the UAE Vision 2021. They contribute to this vision by developing low-carbon technologies and promoting eco-efficient production and consumption methods. The analysis confirms that organisations in the UAE have made valuable contributions to sustainability through internal policy amendments, demonstrating their commitment to aligning their operations with sustainability goals.

The analysis reveals that those organisations in the UAE benchmark best practices from other organisations, both domestically and internationally, indicating their dedication to learning from successful initiatives and improving their environmental performance. They also consider

government initiatives related to climate change and align their efforts with national priorities in addressing global warming. The transition from fossil fuels to renewable sources, including nuclear energy, is identified as a significant contribution to reducing gas emissions. Governmental organisations actively benchmark best practices to enhance their efforts in this area. Efficient coordination with responsible organisations and continuous learning are important strategies for achieving energy transition goals.

The analysis underscores the UAE's commitment to sustainable development and the transition to cleaner energy sources. The state's contribution to lowering global warming initiatives and reducing gas emissions relies on the active involvement of governmental organisations in policy development, benchmarking best practices, and coordination with other entities. This highlights the UAE's unwavering dedication to sustainability and its efforts to contribute to global environmental goals.

#### 5.4.1 Outcome of Cross-Cutting of the Interview with Literature and Survey

The cross-cutting analysis of the interview results across all seven themes reveals several key findings that highlight the UAE's focus on climate control, sustainable development, and addressing global warming, as well as the use of media and awareness to maintain public acceptance and support. The following summarises the main outcomes:

Regarding the state's involvement in guiding economic development, participants recognise the government's strong oversight in driving economic growth. There is trust in the government's ability to establish effective institutions, and efficient organisation and coordination contribute to successfully implementing development plans and strategies.

The centralisation of national energy planning in the UAE allows for regional considerations and prioritisation while ensuring the independence of regulatory organisations. This approach facilitates compliance with legal obligations and effective coordination in the energy sector.

Campaigns that link technological progress to national revitalisation have played a significant role in the UAE's nuclear programme. The country has learned from international best practices, improved governance systems, and allocated sufficient budgets. Promotional efforts, such as emphasising nuclear energy as a clean source and providing education in the field, have helped maintain public acceptance.

The influence of technocratic ideology is evident in the UAE's technological advancements and reliance on specialised experts. The government's investment in technical skills, education, and awareness initiatives has further supported public acceptance. International recognition, job opportunities, and business opportunities also contribute to the overall success of the nuclear programme.

The UAE has effectively subordinated challenges to political authority in its nuclear programme through various means. These include effective governance, government oversight, compliance with requirements and standards, financial support, implementation of international obligations, early engagement of organisations, distribution of responsibilities, and promotion through media and events.

The UAE's national nuclear energy plan has low levels of civic activism. The absence of opposition, media support, and government efforts to ensure public satisfaction contribute to this situation.

The UAE demonstrates a strong commitment to lower global warming initiatives. This commitment is evident through reducing greenhouse gas emissions, investment in clean energy, incorporation of international initiatives, prioritisation of environmental preservation, aspiration to be a role model, and government support for organisational enhancement.

The cross-cutting analysis emphasises the importance of climate control and sustainable development as driving forces behind the UAE's nuclear programme. The UAE has recognised the global climate change challenge and the public's desire to maintain safe and healthy living conditions. The nuclear programme is driven by a commitment to economic growth, technological progress, public acceptance, education enhancement, and environmental preservation while adhering to international standards and incorporating global initiatives. The UAE aims to serve as a model for other countries in achieving sustainable development and combating climate change.

### **5.5 Triangulation Result**

In this triangulated cross-cutting analysis, the convergence of information from the literature review, interview data, survey responses, and feedback from nuclear organisations, major stakeholders, and other stakeholders provides a comprehensive understanding of the factors influencing the implementation of the UAE's national nuclear energy plan. By incorporating multiple perspectives and data sources, valuable insights emerge regarding state involvement,



centralisation, technological progress, technocratic ideology, subordination of challenges, low levels of civic activism, and the state's contribution to global warming initiatives.

The analysis confirms the significant role of state involvement in guiding economic development, with the government actively supporting and driving the implementation of the national nuclear energy plan. The feedback from nuclear organisations, major stakeholders, and other stakeholders further strengthens this understanding, highlighting the collaboration and partnership between the government and nuclear organisations in achieving common goals.

Centralisation is critical in implementing the UAE's national nuclear energy strategy. The feedback from major stakeholders, other stakeholders, and nuclear organisations supports the benefits of centralisation in promoting efficient governance, decision-making, and collaboration among key agencies responsible for nuclear energy planning.

The influence of technocratic ideology on policy decisions is evident in the UAE's nuclear programme, with input from recognised experts and various stakeholders shaping informed decision-making. The feedback from nuclear organisations, major stakeholders, and other stakeholders emphasises the significance of technical expertise and continuous education and training for professionals in the nuclear sector.

The subordination of challenges to political authority reflects the government's proactive approach to overcoming obstacles and ensuring the smooth implementation of the programme. Effective communication and collaboration between the government, nuclear organisations, and other stakeholders are vital in addressing challenges.

Moreover, the analysis highlights the state's contribution to lowering global warming initiatives and gas emissions through the active development of low-carbon technologies and alignment with government initiatives. The feedback from major stakeholders, other stakeholders, and nuclear organisations underscores the government's commitment to sustainable development and the transition to cleaner energy sources.

Based on these findings and stakeholder feedback, a revised conceptual framework can be proposed to implement the UAE's national nuclear energy plan. This framework should consider the identified success factors, additional drivers, and stakeholder perspectives to ensure a comprehensive and inclusive approach to the programme's development. By incorporating these insights, the UAE can strengthen its efforts to promote sustainable development, address climate change, and engage stakeholders in the nuclear energy sector.

This triangulated analysis provides a comprehensive understanding of the UAE's nuclear programme, emphasising the importance of government support, centralisation, technological progress, technocratic ideology, subordination of challenges, low levels of civic activism, and the state's contribution to global warming initiatives. The revised conceptual framework based on these findings will enhance the UAE's efforts in sustainable development, climate change mitigation, and stakeholder engagement in the nuclear energy sector.

### **5.6 Proposed Conceptual Framework for the UAE Nuclear Programme**

This proposed conceptual framework for the UAE nuclear programme is based on the aims, objectives, and findings from this thesis, incorporating key success factors identified in previous research while integrating additional drivers derived from the research conducted in this study. The framework aims to provide a strategic approach for enhancing the implementation of the national nuclear energy strategy, considering the unique context and challenges faced by the UAE. Government Support and State Leadership are essential components of the framework. The UAE government provides support, guidance, and strong leadership for implementing the national nuclear energy plan. This includes allocating resources, establishing regulatory frameworks, and developing policies that facilitate the development and operation of nuclear projects. The government's central role in policy development, oversight, and coordination ensures effective alignment with broader economic goals and strategies. Through their active involvement and commitment, the government drives the nuclear programme forward, providing its success and contributing to the UAE's position as a global leader in clean and reliable energy.

State Involvement is another critical factor in the framework. The active involvement of the state is essential in guiding economic development and ensuring the successful implementation of the nuclear programme. The government coordinates and aligns efforts among relevant organisations and stakeholders to achieve the programme's goals.

Centralisation of Energy Planning and Implementation is emphasised. Centralisation is a critical factor in successfully implementing the nuclear energy plan. Centralised energy planning, development, and implementation ensure effective coordination, cooperation, and alignment with the government's energy strategy.

Technological Progress and Expertise are critical drivers in the framework. Continuous technological advancements and an eco-design approach for sustainable development are recognised. Investment in developing local expertise and talent in nuclear technology and

management is essential. Education, training, and knowledge transfer programmes are vital in building technocratic expertise. Modern media and communication channels educate and inform the public about nuclear energy, promoting public acceptance and trust.

Subordination of Challenges is an essential aspect of the framework. The UAE government proactively addresses and overcomes challenges during the nuclear programme's implementation. Effective communication, collaboration, and subordination of challenges to political authority are vital for maintaining progress and ensuring success.

State's Contribution to Global Warming Initiatives is highlighted in the framework. The UAE government actively contributes to lowering global warming initiatives and reducing greenhouse gas emissions. The development of low-carbon technologies and alignment with government initiatives promote sustainable development and the transition to cleaner energy sources.

Education, awareness, public education, and media engagement are pivotal in ensuring the success and social acceptance of the UAE's nuclear programme. Comprehensive educational programmes and public awareness campaigns are implemented to foster public understanding and support for nuclear energy, providing the public with a clear understanding of nuclear energy and its associated benefits. Transparent communication efforts are prioritised, with the media playing a crucial role in supporting the development of nuclear projects and facilitating public comprehension. Accurate and reliable information is disseminated through various communication channels, raising awareness, and enabling informed decision-making.

This factor underscores the significance of public education, awareness, and media engagement in cultivating public acceptance and support for the nuclear programme. Additionally, the framework acknowledges the low levels of civic activism surrounding the nuclear programme. The favourable environment, characterised by minimal opposition or activism, is recognised. This can be attributed to the government's supportive stance and effective communication efforts, which have played a vital role in shaping public perception and fostering acceptance of nuclear energy.

Stakeholder Engagement and Coordination are vital aspects of the framework. Proactive engagement with stakeholders and effective coordination are essential. The government actively involves stakeholders in decision-making processes and ensures transparent communication to address their concerns and maintain legitimacy and trust. Public feedback and concerns are incorporated into decision-making, enabling stakeholders to actively participate and contribute to the programme's effectiveness. The media and communication channels serve as platforms for

disseminating accurate information, raising awareness, and facilitating public understanding. This factor highlights the significance of stakeholder engagement and coordination in fostering public acceptance, enhancing transparency, and optimising the overall success of the nuclear programme. Institutional Collaboration and Capacity Building are crucial in the framework. Collaboration and coordination among governmental organisations, regulatory bodies, research institutions, and industry stakeholders are emphasised. Effective governance, streamlined implementation, and capacity-building initiatives are essential. Training programmes and knowledge-sharing platforms support the development of capabilities and expertise within organisations involved in nuclear energy development. Continuous assessment and improvement of institutional frameworks, policies, and procedures ensure adaptability to evolving challenges and international best practices. Sustainable Development and Global Commitments are integrated into the framework. The alignment of the UAE nuclear programme with global commitments and initiatives to reduce greenhouse gas emissions, combat climate change, and promote sustainable development is emphasised. Integration of nuclear energy into a diversified and sustainable energy mix is crucial. Eco-design principles, resource efficiency, and environmental protection are integrated throughout the nuclear energy lifecycle to ensure a sustainable and environmentally responsible approach. Risk Management and Safety Culture are prioritised in the framework. Safety, security, and risk management are crucial in all aspects of the nuclear programme. Robust safety protocols, regulatory oversight, and continuous monitoring and assessment of potential risks and hazards are critical. Developing a safety culture fosters accountability, transparency, and a proactive approach to identifying and mitigating risks.

Economic Viability and Job Creation are considered in the framework. The economic feasibility and cost-effectiveness of nuclear energy projects are evaluated. Long-term economic benefits and local job creation potential are considered. Collaboration with industry partners, international stakeholders, and local businesses maximises participation, technology transfer, job creation, and economic growth.

By adopting this proposed conceptual framework, the UAE can strengthen its efforts in implementing the national nuclear energy strategy. The framework provides a strategic roadmap for state leadership, technological progress, stakeholder engagement, collaboration, sustainability, safety, and economic viability. It integrates the success factors identified by previous research while incorporating additional drivers that emphasise sustainable development and media

engagement. This comprehensive approach will contribute to the successful and sustainable development of the UAE nuclear programme, positioning the country as a global leader in clean and reliable energy.

### **5.7 Outcome**

The cross-cutting result analysis conducted in Chapter Five provides valuable insights into implementing the UAE's national nuclear energy strategy. The analysis confirms the importance of strong state involvement, centralisation of national energy planning, and the role of government support in the successful development of nuclear energy. The influence of technocratic ideology on policy decisions and the subordination of challenges to political authority are also significant factors. Moreover, the low levels of civic activism in the UAE contribute positively to the successful implementation of the nuclear programme.

The analysis highlights the state's contribution to lowering global warming initiatives and gas emissions as a crucial aspect of achieving sustainable and diversified ambitions. It emphasises integrating eco-design principles and media use for effective communication and public engagement. By adopting environmentally friendly approaches, the UAE can minimise the environmental impact of nuclear energy and address climate change challenges. Utilising media channels helps educate the public, build trust, and foster positive perceptions and support for the nuclear programme.

The findings provide a comprehensive conceptual framework for the UAE's national nuclear energy programme. The framework emphasises strong government support, effective centralisation, technological progress, consideration of technocratic ideology, subordination of challenges, low levels of civic activism, and a focus on eco-design and media communication. By implementing this framework, the UAE can promote sustainable development, address climate change, and effectively engage the public in the nuclear energy sector.

Adopting a holistic approach is crucial to implement the national nuclear energy plan successfully. This includes robust government support, centralised planning, continuous technological advancements, education, public acceptance of nuclear energy, effective management of challenges, low levels of civic activism, and a commitment to eco-design and media communication. By implementing this comprehensive framework, the UAE can advance towards a sustainable and diversified energy future, mitigate environmental concerns, and garner public acceptance and support for the nuclear programme.

## **Chapter Six: Discussion**

### **6.1 Introduction**

The discussion chapter critically analyses the results obtained from the research and aims to refine the operational framework developed for implementing the Emirates nuclear energy programme. This chapter focuses on understanding the factors influencing social acceptance and support for the programme within the UAE and beyond. Furthermore, it provides insights and operational guidance based on the findings. The conceptual framework is presented in section 6.2, followed by the operational framework in section 6.3, and its refinement in section. The objectives fulfilled in this chapter include the following:

Objective 1: Defining the factors necessary for developing a new conceptual framework for the UAE.

In section 6.2, the conceptual framework is presented and discussed. The factors identified through the research are examined, considering national activities, policies, and priorities. This analysis helps refine our understanding of the contextual factors contributing to the successful implementation of the Emirates nuclear energy programme.

Objective 2: Exploring the evolving socio-political-economic circumstances in the Emirates.

Section 6.2 also addresses the evolving socio-political-economic circumstances within the Emirates. The findings from the research are used to predict the potential success of commissioning and operating a nuclear power plant in the next ten years. This analysis provides valuable insights into the alignment of the conceptual framework with the changing landscape of the Emirates.

Objective 3: Develop an operational framework for the nuclear programme.

Section 6.3 presents the operational framework developed based on the expanded success factors and considering the socio-political-economic circumstances. The framework aims to provide practical guidance for implementing the UAE's nuclear energy programme, considering the unique context of the Emirates and the surrounding region.

Objective 5: Comparing the expanded conceptual framework with implementing plans and operational activities.

Section 6.4 critically analyses the implementation of plans and operational activities in the Emirates' nuclear energy programme. It identifies any discrepancies between the expanded

conceptual framework and the actual implementation, assesses the framework's effectiveness, and evaluates the alignment of operational activities with the principles outlined in the framework. The findings from this analysis contribute to refining the operational conceptual framework.

By accomplishing these objectives, the research aims to provide a comprehensive operational framework that effectively guides the UAE's successful nuclear energy programme implementation. The discussion chapter plays a vital role in refining the operational framework, ensuring it accounts for the socio-political-economic circumstances and supports the long-term sustainability and success of the programme. In the subsequent sections of this chapter, the conceptual framework, operational framework, and refinement will be discussed in detail, further enhancing the understanding of the research findings and their implications.

## **6.2 Conceptual Framework for Nuclear Energy Plan Implementation**

The conceptual framework for implementing the UAE's national nuclear energy plan offers a comprehensive approach to successfully integrating nuclear energy into the country's energy landscape. It incorporates traditional success factors and includes other factors that have been apparent in the UAE's success. The critical components of the conceptual framework which support objectives 1 and 2 are as follows:

### 1. Government Support:

- The UAE government is pivotal in providing support and guidance for implementing the national nuclear energy plan.
- This includes allocating resources, establishing regulatory frameworks, and developing policies that facilitate the development and operation of nuclear projects.

Government support ensures institutional backing and resources to drive the programme's success.

### 2. State Involvement:

- The active involvement of the state is essential in guiding economic development and ensuring the successful implementation of the nuclear programme.
- The government coordinates and aligns efforts among relevant organisations and stakeholders to achieve the programme's goals.

State involvement provides a strategic direction and enables effective coordination among various entities involved in the nuclear energy sector.

### 3. Centralisation of Energy Planning and Implementation:

- Centralisation is a critical factor in successfully implementing the nuclear energy plan.

- Centralised energy planning, development, and implementation ensure effective coordination, cooperation, and alignment with the government's energy strategy.

This centralised approach helps streamline decision-making processes and facilitates the integration of nuclear energy into the broader energy sector.

#### 4. Technological Progress and Expertise:

- Technological advancement and expertise are critical drivers of the UAE's nuclear programme.
- Emphasising continuous education, training, and professional development ensures the integration of technical skills and knowledge within the nuclear sector.

Fostering technological progress and expertise enables the country to leverage cutting-edge technologies, enhance safety measures, and achieve operational excellence.

#### 5. Addressing Challenges:

- The UAE government proactively addresses and overcomes challenges during the nuclear programme's implementation.
- Effective communication, collaboration, and addressing challenges with political authority are vital for maintaining progress and ensuring success.

By addressing challenges promptly and decisively, the government maintains public confidence and paves the way for the programme's smooth implementation.

#### 6. Low Levels of Civic Activism:

- The favourable environment of low opposition or activism against the nuclear programme is acknowledged.
- The government's supportive stance and effective communication efforts shape public perception and acceptance of nuclear energy.

This favourable environment facilitates the implementation process and minimises potential hurdles related to public opposition.

#### 7. State's Contribution to Global Warming Initiatives:

- The UAE government actively contributes to global warming initiatives and reducing greenhouse gas emissions.
- Developing low-carbon technologies and aligning with government initiatives promote sustainable development and the transition to cleaner energy sources.

The nuclear energy programme aligns with the country's commitment to combat climate change and contribute to global environmental goals.

#### 8. Education, Awareness, and Media Engagement:



- Comprehensive educational programmes, public awareness campaigns, and transparent communication foster public acceptance, informed decision-making, and stakeholder engagement.
- The role of the media in supporting nuclear development and facilitating public understanding is emphasised.

These initiatives help dispel misconceptions, promote accurate information, and create an informed public discourse.

9. International Cooperation and Collaboration:

- The UAE engages in international cooperation and collaboration to leverage best practices, share experiences, and ensure adherence to international standards and obligations.
- Collaboration with international organisations and other countries pursuing nuclear energy contributes to knowledge sharing and global initiatives for nuclear safety, security, and non-proliferation.

International cooperation strengthens the UAE's nuclear programme by benefiting from the collective wisdom and experiences of the global nuclear community.

10. Monitoring, Evaluation, and Continuous Improvement:

- A robust monitoring and evaluation system is established to assess the performance and effectiveness of the nuclear programme.
- Regular assessments, feedback mechanisms, and continuous learning contribute to ongoing improvement and optimisation.

By monitoring the programme's progress, identifying areas for improvement, and implementing necessary adjustments, the UAE ensures the programme's long-term success and adaptability to changing circumstances.

Considering these factors and stakeholder perspectives, the conceptual framework provides a comprehensive approach to implementing the UAE's national nuclear energy plan. It ensures government support, efficient coordination, technological progress, informed decision-making, public acceptance, and sustainable development, leading to the successful integration of nuclear energy into the country's energy landscape.

### **6.3 Operational Framework for Nuclear Energy Plan Implementation**

The operational framework for implementing the UAE's national nuclear energy plan translates the conceptual framework into actionable steps and strategies. It outlines the operational components that enable the successful integration of nuclear energy into the country's energy landscape. The critical elements of the operational framework which support objective 3 include:

1. Government Support:

a) Allocate Resources:

- The UAE government ensures the allocation of adequate financial, human, and technological resources to support the implementation of the national nuclear energy plan.
- This includes budgetary provisions, skilled personnel, and necessary infrastructure to facilitate the development and operation of nuclear projects.

b) Establish Regulatory Frameworks:

- The government establishes robust regulatory frameworks that govern all aspects of the nuclear programme, including safety, security, and non-proliferation.
- These frameworks adhere to international standards, promote transparency, and provide clear guidelines for nuclear activities.

c) Develop Policies:

- The government develops policies that facilitate the implementation of the national nuclear energy plan, ensuring alignment with broader energy and environmental goals.
- These policies address licensing, waste management, emergency preparedness, and public engagement issues.

2. State Involvement:

a) Coordinate Efforts:

- The government coordinates and aligns efforts among relevant organisations and stakeholders involved in the nuclear programme.

- This includes regular communication, collaboration, and coordination to achieve the goals and objectives of the programme.

This aspect relies on clear boundaries and lines of responsibility established, understood, and complied with. New organisations and functions must be generated within the UAE's legal and governmental systems without undue conflict. An example is the establishment of specialised nuclear organisations, as shown in the following chapters:

The literature review chapter (Chapter 2), 'Regulatory Challenges' and 'Geopolitical Challenges' sections, highlights the UAE government's improvement of internal organisation and its international coordination (to overcome regulatory and geopolitical challenges). This required establishing a robust institutional structure and coordination between regulatory and operator organisations to ensure nuclear plants' safe and secure operation while meeting international safety, security, and safeguards standards [2, 19, 118]. In 'Emirates-Level Strategies and Policies' section, the UAE government's strategies, and policies to reduce greenhouse gas (GHG) emissions at both domestic emirate and federal levels are discussed. This required intensive coordination at all levels to shift towards nuclear and renewable energy, which may take medium to long-term efforts to achieve meaningful reforms. This transition from traditional energy sources to renewables involves systemic changes that require careful planning and coordination [22, 42, 128, 137, 139].

In the methodology chapter (Chapter 3), 'Technocratic Ideology' section, the UAE government's lesson learned from the Fukushima disaster emphasises the importance of coordination and communication between nuclear operators, regulators, and the government to mitigate the risk of similar incidents [166, 180, 181].

In the survey analysis chapter (Chapter 4), question 13 examines the government's board of directors' selection method (i.e., for organisations to improve collaboration and coordination among different organisations). For example, each member represents a major stakeholder who influences the organisation's scope of work, contributing to achieving the economic development plan associated with the Barakah Nuclear Power Plant programme. Questions 14 and 15 highlight the importance of improving project management and coordination to address staff's need for more administrative knowledge. Questions 25 and 26 demonstrate the government's utilisation of close coordination between responsible governmental organisations to implement the UAE Vision 2021 and achieve a sustainable and diversified economy. This includes developing low-carbon technology and adopting eco-efficient production and

consumption methods. The ‘Cross Cutting Analysis of the Survey Result’ section shows how the government succeeded in centralising national energy planning, development, and implementation. The government enables effective resource planning and alignment with aims and objectives by facilitating organisational collaboration and coordination. Also, the government can plan, organise, and distribute responsibilities between organisations involved in the nuclear programme to ensure seamless coordination and efficient operations. Comparing the survey results with the literature review findings in ‘Discussion of Survey Result with Literature Review’ section, the comparison demonstrates that organisations supported government decisions through collaboration and coordination with various stakeholders to achieve economic development plans. This method helps overcome challenges faced by different organisations [131]. The ‘Outcome’ section from Chapter 4 highlights that the UAE's ability to manage projects, mitigate risks, and overcome challenges effectively has been essential for the success of the nuclear programme.

In the face-to-face interview chapter, Chapter 5, participants emphasised the importance of close collaboration and coordination. Theme 2 discusses the significance of centralisation in national energy planning, with coordination and cooperation between government organisations and stakeholders considered crucial for effective programme implementation. The participants recognised the government's success in defining the scope of each organisation without overlapping responsibilities. This clear delineation of roles and responsibilities allows each organisation to focus on its specific scope while promoting efficient collaboration and coordination. The ‘Thematic Analysis Summary’ section in Chapter 5 highlights key factors influencing the UAE's nuclear programme, demonstrating that the government's method of implementing requirements and obligations, along with successful coordination and collaboration between government organisations and stakeholders, has facilitated effective programme implementation. The ‘Cross-Cutting of Interview Results’ section in Chapter 5 sheds the light on key findings, including efficient cooperation and coordination among the involved organisations. Participants expressed trust in the government's ability to define the scope and responsibilities of each organisation while minimising overlap. This efficient organisation and coordination contribute to successfully implementing development plans and strategies, enabling effective decision-making, resource allocation, and alignment of efforts. The face-to-face interviews revealed that the efficient coordination and collaboration between organisations contributed to the success of the UAE's nuclear programme.

b) Stakeholder Engagement:

- The government engages key stakeholders in decision-making processes and implementation activities, including government entities, regulatory bodies, local communities, environmental organisations, and the public.
- Stakeholders are provided with opportunities for input, feedback, and participation in shaping the direction and outcomes of the nuclear programme.

3. Centralisation of Energy Planning and Implementation:

a) Centralized Planning:

- The government ensures centralised energy planning, development, and implementation of the nuclear programme.
- This involves the establishment of a central authority or coordinating body responsible for strategic planning, coordination of activities, and monitoring progress.

b) Collaboration and Cooperation:

- The centralised approach encourages collaboration and cooperation among relevant organisations, such as regulatory bodies, nuclear energy organisations, research institutions, and industry stakeholders.
- Regular communication, sharing of best practices, and joint decision-making facilitate the effective implementation of the nuclear programme.

4. Technological Progress and Expertise:

a) Education and Training:

- The government invests in education and training programmes to develop a skilled workforce capable of managing and operating nuclear facilities.
- This includes partnerships with universities, research institutions, and international experts to provide comprehensive training and knowledge transfer.

b) Research and Development:

- The government promotes research and development initiatives to drive technological progress in the nuclear sector.
- This includes supporting innovation, encouraging collaborations with industry and academia, and fostering a culture of continuous improvement and learning.

5. Subordination of Challenges:

a) Effective Communication:

- The government ensures effective communication channels and mechanisms to address and resolve challenges arising during the nuclear programme's implementation.
- This includes regular updates, stakeholder consultations, and transparency in decision-making processes.

b) Collaborative Problem-solving:

- The government encourages collaborative problem-solving by involving relevant organisations, experts, and stakeholders in identifying and overcoming challenges.
- Solutions are sought through collective efforts, ensuring a coordinated and cooperative approach.

6. Low Levels of Civic Activism:

a) Public Awareness and Engagement:

- The government implements comprehensive public awareness campaigns to promote understanding and acceptance of nuclear energy.
- This includes disseminating accurate information, addressing concerns, and fostering public dialogue on nuclear energy's benefits, safety, and environmental advantages.

b) Stakeholder Participation:

- The government actively engages stakeholders, including local communities, environmental organisations, and the public, in the decision-making processes related to the nuclear programme.
- Opportunities for input, public hearings, and consultation forums are provided to ensure meaningful participation and address concerns or objections.

7. State's Contribution to Global Warming Initiatives:

a) Low-Carbon Technologies:

- The government prioritises developing and deploying low-carbon technologies within the nuclear sector.
- This includes investing in research and development of advanced nuclear technologies, such as Generation IV reactors, and promoting their integration with renewable energy sources.

b) Sustainable Development Goals:

- The government aligns the implementation of the nuclear programme with sustainable development goals, including reducing greenhouse gas emissions and mitigating climate change.
- Measures are taken to minimise environmental impacts, promote energy efficiency, and optimise the use of resources throughout the nuclear programme.

8. Education, Awareness, and Media Engagement:

a) Educational Programmes:

- The government implements comprehensive educational programmes at various levels to promote knowledge and understanding of nuclear energy.
- This includes integrating nuclear-related topics into school curricula, organising workshops, and supporting public lectures and seminars.

b) Media Engagement:

- The government works closely with media organisations to ensure accurate and balanced coverage of nuclear energy-related topics.
- Regular press releases, media briefings, and opportunities for journalists to visit nuclear facilities contribute to informed public discourse and understanding.

9. International Cooperation and Collaboration:

a) Knowledge Sharing:

- The government actively engages in international cooperation and collaboration to exchange best practices, experiences, and lessons learned in nuclear energy.
- This includes participating in international conferences, sharing research findings, and collaborating with other countries pursuing nuclear energy programmes.

b) Adherence to International Standards:

- The government ensures compliance with international standards, obligations, nuclear safety, security, and non-proliferation agreements.
- Cooperation with international organisations, such as the International Atomic Energy Agency (IAEA), facilitates adherence to global norms and enhances the credibility of the UAE's nuclear programme.

10. Monitoring, Evaluation, and Continuous Improvement:

a) Performance Assessment:

- The government establishes a robust monitoring and evaluation system to assess the performance and effectiveness of the nuclear programme.
- Key performance indicators are defined, and regular assessments are conducted to measure progress against predefined goals and targets.

b) Feedback Mechanisms:

- Feedback mechanisms, such as surveys, stakeholder consultations, and internal reviews, are implemented to gather input and suggestions for improvement.
- Lessons learned from previous experiences and external feedback are considered in shaping future strategies and actions.

c) Continuous Learning and Optimization:

- The government promotes a culture of continuous learning and optimisation within the nuclear programme.
- Knowledge sharing, research and development initiatives, and benchmarking against international best practices contribute to the ongoing improvement and optimisation of the programme.

By operationalising the conceptual framework through the operational framework, the UAE can effectively implement its national nuclear energy plan. The operational framework addresses critical components such as government support, state involvement, centralisation of energy planning and implementation, technological progress and expertise, subordination of challenges, low levels of civic activism, the state's contribution to global warming initiatives, education, awareness, and media engagement, international cooperation and collaboration, and monitoring, evaluation, and continuous improvement. The framework provides actionable steps and strategies to ensure the successful integration of nuclear energy into the UAE's energy landscape while considering sustainability, stakeholder engagement, and adherence to international standards.



## **6.4 Development of a Refined Operational Framework**

In this section, the researcher focuses on refining the initial conceptual and derived operational frameworks into an operational framework, one that is based on a critical analysis of the research findings. The goal is to make the framework more practical and applicable to real-world scenarios by incorporating key insights and recommendations from the analysis.

The refined operational framework highlights the modifications to address strengths, weaknesses, opportunities, and challenges. The researcher provides a clear rationale for each modification, justifying the changes and ensuring the refined framework is built on a solid foundation grounded in research findings. This refinement supports objective 5. The development of the refined operational framework bridges the gap between theory and practice. It provides practical guidance and a roadmap for implementing the national nuclear energy plan.

Stakeholder engagement and collaboration are emphasised as essential in implementing the operational framework. Involving key stakeholders throughout the development and refinement process incorporates their perspectives and expertise, increasing stakeholder ownership and buy-in. This participatory approach enhances the framework's effectiveness and promotes successful implementation.

Developing the refined operational framework is crucial in translating the conceptual framework into actionable guidance for implementing the UAE's national nuclear energy plan. Through careful analysis, adjustments, and alignment with the specific context of the Emirates, the operational framework becomes a practical tool to navigate challenges and capitalise on opportunities. Stakeholder involvement ensures that their contributions are integrated, enhancing the framework's effectiveness, and setting the stage for successful implementation.

The refined operational framework is valuable for decision-makers and stakeholders in the UAE's nuclear programme. It provides a clear roadmap to guide their actions and achieve the programme's objectives. It is a valuable roadmap for other new entrant countries seeking to emulate the UAE's success.

### **6.4.1 Factors of Social Acceptance and Support for the Nuclear Programme**

The importance of well-designed public awareness campaigns is emphasised as they educate the public about nuclear energy's benefits, safety measures, and environmental advantages. Research findings and relevant literature suggest that educational initiatives increase public

knowledge and understanding, influencing public opinion. For example, in ‘Extension of the Framework for the Emirates’ section in Chapter 2, it was shown that the Emirates has invested in and developed an advanced education system to support the idea of modernisation, becoming a model of development in the Middle East. This successful vision has led to campaigns linking technological progress to national revitalisation, resulting in low civic activism against nuclear energy [16, 20, 21, 32]. Another example is in ‘Challenges on the Creation of the Emirates Nuclear Programme’ section in Chapter 2, where FANR reported a significant challenge in developing a trained and competent workforce capable of working at diversified organisations. FANR and ENEC collaborated with the Ministry of Higher Education to develop nuclear subjects, establishing the Gulf Nuclear Energy Infrastructure Institute (GNEII), which provides nuclear subjects at Khalifa University and develops educational courses in schools. These programmes are promoted at various educational events focusing on safety awareness, encouraging students to participate [19, 22, 106, 118, 119, 121]. At ‘Emirate Energy Sector and Greenhouse Gas Emissions’ Section, It was highlighted the implementation of educational programmes by power authorities to raise awareness about energy conservation and the importance of sustainable practices, encouraging individuals and businesses to adopt energy-efficient measures [42, 128, 137, 139]. The Survey questions 14 and 15 (chapter 4) reveal participants' emphasis on the lack of a nuclear subject education system, which affects national human resources during the early stages of the programme. This highlights the importance of enhancing education and awareness. Questions 16 and 18 demonstrated how organisations have created campaigns to link technological progress to national revitalisation, utilising education, career fairs, scholarships, and sponsorship. This approach aims to raise awareness and promote the benefits of technological progress to a wider audience, inspiring interest and highlighting potential career opportunities associated with technological advancements. These findings underscore the recognised importance of educational initiatives in promoting and sustaining public acceptance of nuclear energy. Question 23 indicates that the government has maintained social acceptance of nuclear energy development through intensive education programmes. The ‘Cross Cutting Analysis of Survey Results’ section in chapter 4 reveals that the government, with the support of its organisations, effectively addressed defined challenges, with education and awareness playing a significant role in developing technical skills and maintaining public acceptance. These findings demonstrate that education and awareness are crucial for linking technological progress to national revitalisation. Theme 4 at ‘Discussion of Results’ section in Chapter 5, the participants emphasise the importance of technical expertise and education in the nuclear sector as influential factors in decision-making processes. They

also highlight the significance of continued investment in technical education to meet future nuclear and economic development needs.

The role of the media in disseminating accurate information and promoting balanced coverage of nuclear-related topics is explored. Research findings and relevant literature highlight the impact of media engagement on public perception. By providing accurate and objective information, the media can be crucial in shaping public attitudes towards the nuclear programme. An example is in 'Nuclear Governance within Emirates Conceptual Framework' section, where FANR adopted the IAEA recommendation by participating through social media and national TV channels to promote awareness and understanding of the nuclear safety culture [71, 82].

In the survey chapter (Chapter 4), it was reported in questions 16, 17, and 23 that organisations utilised printed material, media, and press/TV conferences to create campaigns linking technological progress to national revitalisation by promoting the benefits of nuclear energy. These efforts helped shape public perception, increase visibility, and highlight the impact of technological progress on national revitalisation. The 'Cross Cutting Analysis of the Survey Result' section shows that media provided education and awareness to the public, contributing to gaining and maintaining public acceptance.

In the face-to-face data analysis in 'Discussion of Results' section in Chapter 5, the participants recognised the government's active role in raising awareness about nuclear energy through various channels, including nuclear organisations, TV, events, and social media. This resulted in the following contributions:

1. Create a campaign to link technological progress to national revitalisation.
2. Analyse and evaluate nuclear acceptance by the public.
3. Maintain nuclear acceptance by the public.
4. Promote the 'UAE Vision 2021'.
5. The support energy transition from fossil fuel to renewable sources and nuclear.

Transparency is emphasised as a crucial factor in building public trust and confidence in the nuclear programme. Research findings and relevant literature suggest that transparency in decision-making processes, access to information, and stakeholder engagement contribute to fostering social acceptance and support. This is shown in 'Collaboration with IAEA' section in Chapter 2, where ENEC enhanced transparency and provided information to the public by offering an interactive nuclear programme roadmap on its website. This

roadmap provides comprehensive details about the UAE's nuclear implementation programme, ensuring that stakeholders and the public have access to information about the progress and milestones of the nuclear programme [91, 93, 94].

Sections from Chapter 2 such as 'International Atomic Energy Agency', 'Policy and Planning for Nuclear Power in the UAE' and 'UAE Policy on Peaceful Nuclear Energy' highlight that the UAE designed its nuclear policy based on international safety, transparency, and security standards, positioning the UAE as a civil nuclear role model for the world [18, 19, 22, 96]. In Chapter 4, the survey results in question 21 indicate that the government supported its organisations in overcoming challenges by developing nuclear organisations with clear and transparent communication. Question 24 reveals that transparency is associated with addressing public concerns, which is done through the Federal National Council, official social media interaction, and press coverage of government decisions. In Chapter 5, the face-to-face interview at Theme 3, the participants agreed on government efforts to interact with the public to raise awareness and be open to hearing their concerns that support transparency.

Public concerns, potential barriers, and strategies to address them are considered to promote a positive societal attitude towards the nuclear programme. Common concerns raised by the public, such as safety, waste management, and environmental impact, are identified and discussed. Research findings and relevant literature provide insights into strategies to address these concerns, including implementing robust safety measures, effective communication of risk assessments, and establishing stringent regulatory frameworks.

Research findings and relevant literature suggest that stakeholder engagement contributes to building trust, fostering support, and ensuring the long-term success of the nuclear programme.

Strategies and initiatives to enhance social acceptance and support are essential. These include targeted communication campaigns, community involvement programmes, public consultations, and efforts to address concerns and misinformation. By thoroughly examining the factors influencing social acceptance and support for the nuclear programme, the researcher provides valuable insights and recommendations for promoting a positive societal attitude towards nuclear energy in the UAE.

#### 6.4.2 Examination of Stakeholder Engagement

The researcher delves into the influence of key stakeholders on decision-making processes. Examining how these stakeholders contribute to policy formulation, strategic planning, and developing regulations and guidelines is crucial for effective decision-making and achieving a consensus-based approach. It was proven that the highest authority in the UAE, the Federal Supreme Council, ensures effective decision-making regarding nuclear development and being well-informed about nuclear benefits and risks. This knowledge enables them to make informed decisions that shape the UAE's approach to nuclear development [46, 65].

In Chapter 2, 'Challenges on the Creation of the Emirates Nuclear Programme' section, it is highlighted how the government overcomes geopolitical challenges to develop its nuclear programme, with a commitment to being a role model [19, 22, 25, 26, 32, 118]. The same chapter in section 'Socio-Political Economy Conceptual Framework' shows that the UAE government signed MOUs with NSG to ensure international technical assistance to its organisations. Section 'Nuclear Governance within Emirates Conceptual Framework' demonstrates that early public engagement through events and awareness campaigns enhanced the effectiveness of the decision-making process. Although there are no formal requirements for public consultations, the government found it easier to plan its policies. In Chapter 4, the survey supports this result in question 14. The survey results, specifically question 10, show that organisations continually evaluate public input and consider their opinions to build public trust and ensure a transparent decision-making process. Question 13 reveals that the government improved collaboration and coordination among different organisations by developing a board of directors' selection method. This method involved major stakeholders who influenced the organisation's scope of work to achieve the economic development plan associated with the Barakah Nuclear Power Plant programme. Scientists and technical experts also play a role in shaping policy direction. Question 16 demonstrates how collaboration and close coordination between organisations improve the decision-making process, while question 18 indicates that the strong alignment between the government's technocratic decision-making approach and public sentiment reinforces the success and acceptance of the nuclear energy programme. Question 21 mentions that the government supported its decisions with a high budget to support the nuclear programme.

From the 'Cross Cutting Analysis of Survey Results' section in Chapter 4, it is evident that the survey results emphasise the role of technocratic ideology in shaping policy decisions and the need for public awareness campaigns to maintain public acceptance of nuclear energy. In the

face-to-face interviews in theme 4, the participants emphasise the importance of technical expertise and education in the nuclear sector and the incorporation of technocratic perspectives in decision-making processes.

Strategies for effective stakeholder engagement are discussed, highlighting the importance of collaboration, consultation, and participation. The researcher explores mechanisms for fostering meaningful engagement, such as regular communication channels, stakeholder forums, public consultations, and advisory committees. These strategies promote transparency, inclusivity, and open dialogue, ensuring that decision-making considers diverse viewpoints. For example, in ‘Success Factors in the UAE Nuclear Power Programme’ section in Chapter 2, it is mentioned that public engagement and awareness played crucial roles in the success of the UAE's nuclear programme [106]. According to ‘Policy and Planning for Nuclear Power in the UAE’ section in Chapter 2, the UAE government is dedicated to ensuring transparency in all aspects of its nuclear energy programme, providing open access to information, and fostering public awareness and engagement [18, 22]. In ‘Regulatory Challenges’ section, it is highlighted that FANR engaged with IAEA and participated in the International Nuclear Safeguards Engagement Programme (INSEP) to enhance their safeguards programme and knowledge-sharing [19, 118, 121]. The ‘Nuclear Governance within Emirates Conceptual Framework’ section emphasises the importance of public consultation in the UAE's constitution, despite no formal requirements for it. The UAE government engaged the public through awareness and education campaigns via events and social media [22, 128].

From the survey analysis chapter (Chapter 4), questions 10 and 13 demonstrate that organisations consider and evaluate public needs and expressions to support decision-making. Questions 14 and 17 prove that public engagement is an essential task and was taken care of during the early stages of the programme through various means. Question 22 demonstrates that there needs to be more civic activism regarding public engagement in nuclear development. Questions 23 and 24 show that the government implemented diverse methods to maintain public acceptance, such as education programmes, stakeholder engagement, participation in events and forums, transparency, promotion of sustainability and benefits, job creation, international recognition, and trade alliances. The ‘Cross Cutting Analysis of Results’ section (Chapter 4) demonstrates that the UAE government maintains social acceptance of nuclear energy development through public engagement at events and forums. This is in addition to education programmes, awareness campaigns on social media and TV, promotion of sustainability in energy, and the provision of job opportunities. From the analysis of face-

to-face interviews in ‘Cross-Cutting Analysing Result of Interview with Literature and Survey’ section in Chapter 5, one of the main findings is that the government's active engagement, efficient coordination, and clear delineation of responsibilities have been instrumental in successfully implementing the nuclear programme.

The impact of stakeholder engagement on social acceptance, support, and the overall success of the nuclear programme is examined. The researcher explores how engagement activities build trust, address concerns, and foster a positive societal attitude towards nuclear energy. The findings emphasise the role of stakeholder engagement in promoting informed decision-making, enhancing public perception, and creating a sense of ownership and shared responsibility.

Examples of successful stakeholder engagement initiatives, from the Literature Review Chapter presented in ‘Enhancing Safety Measures in Nuclear Plant Design’ section as design modification recommendation from IAEA, ‘Considerations for New Entrant States’ section as lessons learned from new entrant states, and ‘Challenges on the Creation of the Emirates Nuclear Programme’ section as operational lessons learned from WANO & INPO, illustrate best practices and lessons learned. The researcher discusses the positive outcomes that can be achieved through effective stakeholder engagement, such as increased public acceptance, improved regulatory compliance, enhanced project design, and greater social and environmental benefits.

Throughout the discussion, the researcher emphasises the need for continuous stakeholder engagement throughout the lifecycle of the nuclear programme. By integrating stakeholder perspectives, values, and feedback into decision-making processes, the programme can be aligned with societal needs and expectations, leading to increased support and long-term sustainability.

#### 6.4.3 Critical Examination of Discrepancies and Challenges

This section critically examines the discrepancies and challenges between the expanded conceptual framework and implementing plans and operational activities in the UAE's national nuclear energy programme. The researcher identifies these discrepancies and evaluates the effectiveness of the operational framework in guiding practical implementation.

For example, ‘Constraints on Nuclear Revitalization: Challenges and Emerging Factors’ section discusses challenges and emerging factors that constrain nuclear revitalisation. These challenges include increased nuclear accidents, proliferation, security, and new emerging

factors such as import and export control restrictions. The International Energy Agency reported that while nuclear revitalisation is possible, it cannot occur overnight. The UAE overcomes these challenges by leveraging international relations and learning from international nuclear organisation experiences. Sovacool and Valentine also emphasised the importance of international collaboration and coordination in their conceptual framework.

Survey questions (Chapter 4) prove that the UAE utilises international experiences and tools to develop its nuclear programme. Question 6 shows the UAE's nuclear programme's use of expats with international nuclear experiences. An example of the UAE's emphasis on international expertise is the appointment of Mr Christer Viktorsson<sup>5</sup> as DG of FANR, who has extensive experience in nuclear regulation and safety from his previous roles. Question 8 highlights the development of an independent regulator recognised internationally by the IAEA. Questions 9 and 10 indicate the critical role of international treaties in driving a successful nuclear programme. The UAE's adherence to international agreements strengthens its credibility and demonstrates its commitment to nuclear safety and non-proliferation. Question 13 reveals the UAE's utilisation of political agreements with the UN and IAEA to achieve its objectives. Question 15 demonstrates the UAE's commitment to following IAEA advice and recommendations to ensure compliance. Questions 19 and 23 provide evidence of international recognition motivating other countries to support the UAE's nuclear programme through information sharing and technical assistance.

Chapter 5, specifically in the 'Discussion of Results' section, highlights several themes. Theme 2 emphasises the importance of adopting a centralisation method to implement international regulations and requirements. Theme 3 underscores the contribution of international collaboration to the programme's success and integration into the country's overall development strategy. Theme 4 emphasises the significance of international expertise in supporting nuclear developments within critical organisations. Theme 6 suggests that the UAE's low levels of civic activism contribute to an improvement in its international reputation. The face-to-face interview findings support government focus on public education and awareness, particularly in supporting nuclear subjects at universities, to ensure a skilled workforce and maintain credibility in handling nuclear technology (theme 3). Interviewees also emphasise the continued investment in technical education and technology to meet the future needs of the nuclear policy and overall economic development plan (theme 4). The 'Cross Cutting Analysis of Interview Results' section highlights the government's substantial

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<sup>5</sup><https://www.fanr.gov.ae/en/Lists/PressKits/Attachments/6/FANR%20Director%20General%20Biography%20EN.pdf>



investment in technical and technological skills, including modern media for education, to promote and implement policies and maintain public acceptance of the nuclear programme. Furthermore, this section discusses the challenges encountered during implementation and their impact on the programme's progress and success. Feedback from stakeholders involved in the implementation and operation of the programme is analysed to gain insights into their perspectives and experiences.

Next, the effectiveness of the operational framework in guiding practical implementation is evaluated. The researcher examines how well the operational framework aligns with the programme's objectives, addresses key challenges, and provides actionable guidance for decision-making and operational activities.

For example, 'Challenges on the Creation of the Emirates nuclear Programme' section highlights the importance of education and awareness in maintaining public acceptance and addressing challenges in modern communication and the education of the new operational nuclear fleet. At same section, FANR reports significant nuclear programme challenges [19, 30, 118]. In their conceptual framework, Sovacool and Valentine underscore the significance of education and awareness in modern communication. A major challenge identified is the development of a trained and competent workforce capable of working in diverse organisations. FANR collaborated with the Ministry of Higher Education, the Korean Institute for Nuclear Safety, and the US Nuclear Regulatory Commission to develop nuclear subjects. This collaboration led to the establishment of the Gulf Nuclear Energy Infrastructure Institute (GNEII), which provides nuclear subjects at Khalifa University [106, 118, 119, 121].

In Chapter 4, questions 14 and 15 highlight the lack of a nuclear subject education system, which has implications for national human resources during the early stage of the programme. This underscores the importance of enhancing education and awareness. Questions 16 and 18 demonstrate how organisations have created campaigns to link technological progress to national revitalisation through education, career fairs, scholarships, and sponsorship. This approach focuses on raising awareness and promoting the benefits of technological progress to a broader audience, inspiring interest, and highlighting potential career opportunities associated with technological advancements. These initiatives underscore the importance of educational efforts in promoting and sustaining public acceptance of nuclear energy. Question 23 reveals that the government has maintained social acceptance of nuclear energy development through intensive education programmes. The 'Cross Cutting Analysis of Survey Results' section indicates that the government effectively addressed the defined challenges with the support of its organisations. Education and awareness played a significant role in developing technical

skills and maintaining public acceptance. The findings demonstrate that education and awareness are crucial for linking technological progress to national revitalisation. This evaluation helps identify the strengths and weaknesses of the operational framework and its contribution to the successful implementation of the programme.

The discussion at Chapter 2 in sections ‘Nuclear Revitalization: Addressing Constraints, Opportunities, and Driving Forces’ section, ‘Nuclear Revitalization Challenges’ section, ‘Challenges on the Creation of the Emirates Nuclear Programme’ section, and at Chapter 4 in ‘Section 6: Subordination of Challenges to Political Authority’ section focuses on the challenges faced during the implementation of the nuclear programme. The researcher analyses these challenges, including technical, regulatory, environmental, economic, or social factors. The impact of these challenges on the programme's progress, timelines, and overall success is assessed.

Feedback from stakeholders involved in the implementation and operation of the programme is analysed to gain a deeper understanding of their perspectives and experiences. This feedback can come from government entities, regulatory bodies, industry representatives, local communities, environmental organisations, and other relevant stakeholders.

Through this critical examination of discrepancies, the effectiveness of the operational framework, challenges faced, and stakeholder feedback, the researcher gains valuable insights into the real-world implementation of the UAE's national nuclear energy programme. These insights can inform future adjustments to the conceptual and operational frameworks, identify areas for improvement, and guide decision-making to overcome challenges and ensure the programme's long-term success.

### **6.5 Refinement of the Operational Framework**

This section focuses on refining and improving the operational framework of the UAE's national nuclear energy programme based on the identified discrepancies and challenges discussed in the previous section.

The section begins by offering recommendations for refining and improving the operational framework. These recommendations are based on insights from critically examining discrepancies, challenges, and stakeholder feedback. The researcher has identified specific operational framework areas requiring adjustments or enhancements to address the identified differences and challenges. These recommendations aim to strengthen the framework's ability to guide practical implementation, ensure alignment with the programme's objectives, and enhance its effectiveness in navigating complex operational dynamics.

The section explores the opportunities associated with enhancing social acceptance and support for the nuclear programme. The researcher highlights the potential benefits of public education, which is crucial in increasing public awareness and understanding of nuclear energy. Public education initiatives can address misconceptions and foster a more informed public discourse by providing accurate and accessible information about nuclear energy's benefits, safety measures, and environmental advantages. Furthermore, community involvement presents a valuable opportunity to engage local communities in decision-making processes, address their concerns, and create a sense of ownership and pride in the nuclear programme. As discussed in 'Cross-Cutting Analysis of Survey Result' section in Chapter 4, social acceptance of nuclear energy development in the UAE is maintained through public engagement at events and forums. Education programmes, awareness campaigns on social media and TV, promotion of energy sustainability, and job opportunities supplement this. Therefore, the operational framework needs refinement to accommodate regional and local needs. For example, countries like Jordan and KSA, which share similarities with the UAE regarding geopolitical factors, may benefit from a similar operational framework. On the other hand, countries like Nigeria and Cyprus, with different geopolitical challenges, would require tailored operational frameworks.

Success strategies may involve clarifying roles and responsibilities, streamlining decision-making processes, improving coordination among relevant stakeholders, and incorporating feedback mechanisms to facilitate continuous improvement and adaptation. Furthermore, the researcher delves into how the refined operational framework can address the challenges encountered during implementation and improve programme effectiveness. The discussion centres on leveraging the refined framework to overcome technical, regulatory, environmental, economic, and social challenges. For example, this leverage in the UAE was gained by the Emiratis' desire to support their leaders to implement development plans such as nuclear programmes. This was shown in the 'Results' section at Chapter 4 and 'Cross Cutting Analysis of Interview Results' section in Chapter 5.

The recommendations for refinement and improvement, along with the strategies to enhance alignment and address challenges, collectively contribute to strengthening the operational framework of the UAE's national nuclear energy programme. One possible refinement for the immediate future is ensuring that the heads of organisations have leadership skills which can inspire not only their subordinate but also all stakeholders and customers. The phrase '*the greater good*' should be applied to them.

Next, the discussion focuses on the challenges associated with social acceptance and support for the nuclear programme. At Chapter 2 in ‘Assessing Readiness and Incorporation Societal Concerns’, ‘Nuclear Revitalisation Challenges’ section, ‘Nuclear Power Milestones’ section, ‘Decarbonisation Challenges’ section, ‘Socio-Political Economy Conceptual Framework’ section, ‘Nuclear Governance within Emirates’ Conceptual Framework’ section, and supported by Chapter 5 in ‘Cross-Cutting Analysis of Results of Interview with Literature and Survey’ section, the researcher addresses potential concerns that the public may have, such as safety, environmental impact, waste management, and long-term sustainability. Acknowledging and addressing these concerns through transparent communication, credible risk assessment, and robust safety measures is essential. Misinformation and societal resistance can pose challenges to social acceptance and support. The researcher emphasises the need to counter misinformation with accurate information and proactive communication strategies. This was achieved by transparently providing precise information on organisation websites and answering public questions at events conducted by concerned organisations. This helped maintain public support and trust in government planning and developments. This was shown at Chapter 4 in ‘Cross-Cutting Analysis of Survey Result’ section and Chapter 5 in ‘Cross-Cutting Analysis of Interview Result’ section. Additionally, societal resistance can arise due to cultural, ideological, or emotional factors, requiring careful engagement and dialogue to build trust and understanding.

Furthermore, collaboration with local communities, environmental organisations, and relevant stakeholders can help build a strong social acceptance and support foundation. This was evident in survey results where participants emphasised the importance of maintaining public support, protecting the environment, and promoting coordination and collaboration among stakeholders, as reflected in Chapter 5 in ‘Cross-Cutting Analysis of Results of Interviews with Literature and Survey’ section.

The UAE's national nuclear energy programme can foster social acceptance and support by capitalising on the opportunities, addressing the challenges, and implementing the proposed strategies. This, in turn, contributes to the programme's success, sustainability, and integration into the broader energy landscape of the country.

## **6.6 Application of the Refined Operational Framework**

The importance of clearly defining the roles and responsibilities of relevant stakeholders involved in executing the framework has been emphasised. The researcher identifies key stakeholders and discusses their specific roles in the implementation process. This includes government entities, regulatory bodies, industry stakeholders, local communities, and the public. A clear understanding of each stakeholder's responsibilities ensures collaboration, coordination, and accountability throughout the implementation phase.

Potential challenges that may arise while implementing the refined operational framework have been identified and discussed. The researcher examines various factors that can impact the effective execution of the framework, such as technical complexities, resource allocation, regulatory compliance, public perception, and stakeholder engagement. Strategies to mitigate these challenges are explored, including contingency planning, regular monitoring and evaluation, continuous improvement mechanisms, and proactive communication with stakeholders. These strategies are designed to anticipate and address potential obstacles, ensuring the smooth implementation of the operational framework.

Adaptability and flexibility in implementing the refined operational framework are emphasised. As the nuclear energy landscape evolves, the framework should be dynamic enough to accommodate emerging technologies, regulatory changes, and societal shifts. The discussion has explored strategies to ensure the framework's long-term viability and sustainability, including periodic reviews, incorporating lessons learned, and staying up to date with advancements in the field. This adaptability ensures that the operational framework remains relevant and effective in implementing the national nuclear energy plan over time.

## **Chapter 7: Conclusion**

### **7.1 Introduction**

The primary aim was to develop and apply an operational framework to guide the UAE's national nuclear energy program. This research's objectives provided a structured approach to analysing and evaluating findings, with iterative exploration through literature review, surveys, interviews, and the author's professional insights, particularly focusing on the nuclear plant at Barakah. The qualitative and quantitative dimensions facilitated the development of a comprehensive operational framework for the UAE's national nuclear energy program.

### **7.2 Recapitulation of Research Aim and Objectives**

The study achieved its objectives. A novel conceptual framework integrates key elements for developing a sustainable nuclear program in the new-entrant country, informed by a broad literature review and practical fieldwork. In-depth analysis of the UAE's socio-political-economic landscape revealed factors uniquely shaping its nuclear program. An operational framework was formulated, offering practical guidance specific to the UAE, but also demonstrating its relevance in similar regional contexts. This study has underscored the significance of public perception and social acceptance, emphasizing the role of communication strategies and community engagement. Comparative analysis between the conceptual framework and actual implementation practices led to operational framework refinements, affirming its utility for civil nuclear power development.

### **7.3 Progress in Framework Development**

This research achieved substantial progress in the development of both the conceptual and operational frameworks. The conceptual framework was pivotal. It amalgamates diverse factors necessary for a sustainable nuclear energy programme. Through extensive literature review, coupled with both qualitative and quantitative data analysis, the study synthesized factors spanning technical, regulatory, environmental, economic and social concerns, to produce a comprehensive framework. One which reflects a balance between historical precedents and modern-day considerations. The nuanced approach of this conceptual framework marks a significant advancement in nuclear energy research. Breadth and depth of the conceptual framework laid a strong foundation for the subsequent development of the operational framework. Focusing on the UAE's specific needs, the operational framework transformed theoretical concepts into actionable strategies. This part of the framework encompasses governance, stakeholder engagement, safety protocols, and environmental considerations, validated through a comparative analysis with the UAE's current practices.

## 7.4 Reflection on Research Process

Creation of comprehensive conceptual and operational frameworks represents a major achievement. These frameworks provide valuable tools for policymakers and stakeholders. The research successfully delved into the socio-political-economic circumstances in the Emirates, enhancing understanding of the unique context within which the UAE's nuclear program operates. This has facilitated the customization of the operational framework to the Emirates' specific needs and circumstances. The study has effectively investigated the factors influencing public perception and social acceptance of nuclear energy in the UAE. Through various methods, including stakeholder interviews and surveys, the research has provided insights that are critical for enhancing social acceptance and understanding public perception, both locally and globally. Furthermore, critical examination of the gaps between the conceptual framework and the actual implementation of the nuclear program led to significant improvements in the operational framework, ensuring effectiveness of the nuclear program implementation.

The research encountered several challenges and limitations. The dynamic and rapidly evolving landscape of nuclear energy presented challenges in capturing the complete picture within the confines of the research. Availability and accessibility of comprehensive, up-to-date data posed significant challenges. This limitation, particularly noted in the 'Policy Change in Energy Transitions' section, required a reliance on a mix of primary and secondary data sources. These issues were offset to some extent by the credibility of the interviewees, their roles and the number and breadth of organisations represented. While focused on the UAE's national nuclear energy program, the specificities of its context may limit the applicability of the findings to other global nuclear energy programs.

Despite these challenges, the study's findings contribute significantly to existing knowledge, offer practical guidance for program implementation, and highlight areas for future improvement. The balance of success and challenge encountered during this research journey underscores the complexity and dynamic nature of nuclear energy policy and implementation.

## 7.5 Recommendations for Operational Activities

### 7.5.1 Recommendations for UAE's National Nuclear Energy Programme

The research offers specific recommendations for enhancing the UAE's nuclear energy programme:

1. **Enhanced Stakeholder Engagement:** continuously prioritize and strengthen engagement with all stakeholders, including government agencies, regulatory bodies, industry partners, local communities, environmental organizations, and the public. Implement effective

communication, regular consultations, and inclusive participation mechanisms to foster a culture of transparency and trust.

2. **Public Education and Awareness:** develop comprehensive education and awareness campaigns to deepen public understanding of nuclear energy. Address misconceptions, highlight safety measures, and emphasize environmental benefits, leveraging diverse platforms like media, educational institutions, and community events for broader outreach.
3. **Commitment to Safety and Environmental Stewardship:** uphold stringent safety standards and environmental protection practices throughout the nuclear programme. Regularly enhance safety protocols and monitoring practices, and invest in advanced safety technology. Ensure adherence to international waste management standards for safe and responsible nuclear waste handling.
4. **Robust Regulatory Framework:** maintain and continuously update a strong regulatory framework to govern the nuclear programme effectively. Ensure its independence and transparency, aligning with technological advancements and international norms. Provide clear guidelines for licensing, inspection, and enforcement to uphold regulatory compliance and accountability.
5. **International Cooperation and Best Practices:** actively pursue international partnerships and collaborations, tapping into the expertise of global nuclear energy leaders. Engage in knowledge exchange, participate in international forums, and contribute to the development of global nuclear energy standards and practices.

#### 7.5.2 Recommendations for Global Nuclear Energy Programmes

Logical extension of 7.5.1 to other States suggests that programme developers should emphasize stakeholder engagement through all stages of development and operation. By fostering transparent communication, meaningful consultation and an inclusive decision-making process, credibility is enhanced. When customizing public education campaigns to reflect the State's cultural, social, and economic context, the clarity of the safety message is important in gaining public acceptance and support. People need to know that the developer and future operator will prioritize safety in all design and operational facets, ensuring ongoing staff training, and updating safety protocols based on emerging lessons and technological progress; overviewed by an independent regulator. People need to know that the operator and Regulator will regularly evaluate and enhance technical and management processes in line with international standards and best practices; and encourage global collaboration and knowledge sharing among nuclear countries.



## 7.6 Future Research Opportunities

### 7.6.1 Potential Areas for Longitudinal Studies

Longitudinal studies are invaluable for understanding the enduring impacts and sustainability of national nuclear energy programs. Key areas for such studies include:

- **Socio-Economic Impacts:** Investigate the long-term socio-economic effects of nuclear energy programs, such as job creation, economic growth, and regional development. Focus on how these programs influence local industries, supply chains, and investment patterns over time.
- **Environmental Monitoring:** Conduct ongoing environmental assessments to gauge the ecological impacts of nuclear energy. This includes monitoring changes in air quality, water resources, and biodiversity, and evaluating the effectiveness of environmental protection measures.
- **Public Perception and Acceptance:** Explore how public attitudes towards nuclear energy evolve over time, considering the influence of significant events, policy shifts, and technological advancements. Assess the impact of various communication strategies and educational initiatives on shaping public opinion.

### 7.6.2 Expanded Research Domains

Future investigations can explore related critical areas. For example: examine how nuclear energy programs affect geopolitical stability; investigate how nuclear programs can adapt to rapid changes in the geopolitical landscape (e.g. altered alliances and trade policies); or explore the long-term economic implications of sustained government investment in nuclear programs. See Appendix 'Future Opportunities' for a fuller list.

## 7.7 Overall

The study achieved its aim of creating a comprehensive operational framework for the UAE's national nuclear energy programme, offering significant contributions to the field. The new conceptual and operational frameworks, insights into public perception, and the recommended strategies provide a foundation for future policy-making in nuclear energy.

### 7.7.1 Summary of Key Findings

1. Successfully developed an advanced conceptual framework, tailored to the UAE's unique socio-political-economic context, establishing a new benchmark for nuclear program implementation in the 21st century.

2. Presented a refined, dynamic operational framework, serving as a comprehensive guide for practical implementation, aligning with the UAE's strategic goals and addressing real-world challenges.
3. Highlighted the pivotal role of stakeholder engagement (and public perception and social acceptance), underscoring their influence on the program's success.
4. Identified the impact of strategies for enhancing public support, such as targeted education, community engagement, and transparent communication, while also addressing potential challenges like misinformation and societal concerns.
5. Addressed the gap between the theoretical framework and practical application, emphasizing the need for continuous refinement and stakeholder feedback.

#### 7.7.2 Significance and Contribution to the Field

This research significantly advances the understanding of nuclear energy implementation and societal acceptance, particularly in the context of countries new to nuclear power. It offers a novel and tested approach, considering the unique experiences of the UAE, a pioneering new-entrant in the 21st century; and yet, one with particular energy and environmental policies and concerns. This thesis presents a new conceptual framework for civil nuclear power development in new entrant countries, which is a significant advance on recent frameworks based on programmes developed long ago. The new conceptual framework has considered the senior-level experiences in the ONLY new-entrant country of the twenty-first century with a non-existent starting position. This thesis also presents an operational framework with insight into practice.

#### 7.7.3 Implications for the UAE's National Nuclear Energy Programme

The operational framework serves as a strategic roadmap, offering actionable guidance for decision-makers, enhancing public acceptance, and ensuring the long-term success of the UAE's nuclear program.

#### 7.7.4 Closing Remarks

This study serves as a valuable resource for policymakers, industry experts and researchers. It sets a precedent for future nuclear energy initiatives in UAE, while serving as a guide for new nuclear programs locally and globally.

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## Appendices

### Future Opportunities

#### Expanded Research Domains

Future investigations can explore several critical areas:

- **Global and Regional Stability:** Examine how nuclear energy programs, like the UAE's, affect global and regional geopolitical stability, particularly in light of current international tensions.
- **Adaptation to Geopolitical Shifts:** Investigate how nuclear programs can adapt to rapid changes in the geopolitical landscape, including altered alliances and trade policies.
- **Economic Impact of Government Support:** Explore the long-term economic implications of sustained government investment in nuclear programs, especially under fluctuating global economic conditions.
- **Technological Advancements and Cybersecurity:** Research the cybersecurity aspects of nuclear infrastructure, focusing on the challenges and solutions in a technologically advanced landscape.
- **Socio-Political Dynamics and Civic Activism:** Study the evolving socio-political context of nuclear energy, considering various cultural, political, and social perspectives.
- **Climate Change and Nuclear Energy:** Delve into the role of nuclear programs in addressing climate change, analysing their sustainability as an alternative energy source.
- **Media Influence in Crisis Situations:** Assess the impact of media and public education on nuclear energy perception during international crises.
- **International Collaboration:** Explore the dynamics of international cooperation in nuclear energy amid changing political scenarios, focusing on emerging alliances.
- **Monitoring and Evaluation:** Evaluate the effectiveness of monitoring and evaluation systems within nuclear programs under dynamic conditions.
- **Resilience to Geopolitical Tensions:** Investigate how nuclear programs withstand international tensions and challenges such as trade restrictions or diplomatic issues.
- **Education and Workforce Development:** Examine strategies for developing a skilled workforce in nuclear energy, considering global talent migration and international expertise exchange.
- **Impact of Global Policies:** Analyse the influence of global environmental policies and climate change agreements on local nuclear program strategies.
- **Environmental Ethics:** Investigate the ethical considerations in sustainability practices within nuclear energy development and operations.

Future research should integrate these areas within the existing conceptual framework, examining how nuclear energy programs respond to and evolve with broader global shifts. This holistic approach will provide a comprehensive, up-to-date understanding of nuclear energy programs in a rapidly changing world.

### **Comparative Analysis of Stakeholder Engagement Approaches**

A comparative analysis of stakeholder engagement in various nuclear energy programs is critical for developing best practices:

- **Governance Models:** Investigate different governance models and regulatory frameworks to understand their impact on stakeholder engagement.
- **Public Participation Mechanisms:** Evaluate the effectiveness of public participation methods, such as public hearings and advisory committees, across different cultural and social contexts.
- **Stakeholder Communication Strategies:** Assess the communication strategies in different nuclear energy programs, focusing on their effectiveness in building trust and understanding.

### **Evolving Perceptions and Attitudes Towards Nuclear Energy**

Research into changing perceptions and attitudes is essential:

- **Shifting Energy Landscapes:** Study how changes in the energy landscape, including the rise of renewable energy, affect attitudes towards nuclear energy.
- **Social and Cultural Influences:** Delve into the impact of social and cultural factors on public perceptions of nuclear energy.
- **Communication of Risk and Safety:** Explore strategies for effectively communicating risks and safety information to the public.

These future research areas are crucial for advancing our understanding of nuclear energy, shaping policy decisions, and fostering the development of sustainable, socially accepted nuclear energy programs.

## Introduction to INVIVO

The INVIVO part is a collection of data and analysis that supports the conceptual framework for implementing the UAE's national nuclear energy programme. The data was collected from various sources, including literature reviews, interviews, and surveys.

The data of the thesis is from three sections. The first section provides an overview of the UAE's nuclear energy programme and the critical success factors identified in previous research. The second section presents the new conceptual framework for implementing the UAE's nuclear energy programme, which incorporates the essential factors of success from last research and additional factors specific to the UAE's national and regional context. The third section provides a detailed analysis of the data collected from the literature reviews, interviews, and surveys.

The data analysis validates the identified success factors' significance and applicability to the UAE's nuclear energy programme. The appendix provides a comprehensive and evidence-based foundation for the conceptual framework, which can be used to guide the implementation of the UAE's nuclear energy programme and ensure its success.

The appendix is an essential contribution to the field of nuclear energy policy. It provides a new conceptual framework that can be used to implement nuclear energy programmes in other countries. The appendix also provides a valuable resource for policymakers and stakeholders interested in the UAE's nuclear energy programme.

### The role of NVIVO in the research

NVIVO is a qualitative data analysis (QDA) software package used to analyse the data collected for this research. NVIVO allows users to organise, analyse, and find insights in unstructured or qualitative data like interviews, open-ended survey responses, journal articles, social media, and web content.

The data collected for this research was analysed using thematic analysis, a qualitative method for identifying, analysing, and reporting patterns (themes) within data. The data was coded and categorised using NVIVO, which helped identify patterns and relationships.

The research findings were validated using various methods, including member checking, peer review, and triangulation of data sources. The research findings provide new insights into the factors influencing the successful implementation of nuclear energy programmes.

### Appendix A – NVivo Coding Process – Files & Partial Project Map

Files

Name	Codes	References
11 Nov MOFA	24	67
12 Oct ENEC Legal	23	115
12 Oct ENEC Security	24	93
12 Sep 2021, MOEI	22	46
14 Oct 2021 Barakah One	25	69
14 Oct ENEC Legal Gaven	24	103
16 Nov ENEC envi	23	76
17 Oct ENEC Fin	23	73
17 Oct Nawah CEO	24	100
19 Oct Jassim NAWAH licensing	21	39
20 Oct Communication copy	24	97
23 9 2021 western municipality	24	111
26 Oct Nawah Legal	25	99
27 9 2021 ENEC CEO	23	54

SPE 13 7 2023

Add Associated Items

### Appendix B – NVivo Coding Process – Codes & Theme Formulations

Name	File	Refer
Absence of Opposition and	14	49
Smooth Implementation of t	14	68
Importance of Media	13	20
Government Outreach and A	13	29
Subordination of Challenges to P	0	0
Political Authority and Trust	14	42
Government Oversight and	14	55
Smooth Implementation of t	14	77
Governance Category	0	0
Centralisation of National Energy	1	1
Importance of Centralisation	14	61
Clear Delineation of Roles an	14	58
Promoting Compliance and E	14	51
State Involvement in Guiding Eco	0	0
Government's Role and Appr	14	56
Regulatory Bodies and Comp	14	92
Organizational Structure and	14	31
Public Engagement Category	0	0
Influence of technocratic ideolog	0	0
Global Example and Benchm	14	48
Government's Role and Acce	14	69
Investment in Technical Educ	14	41

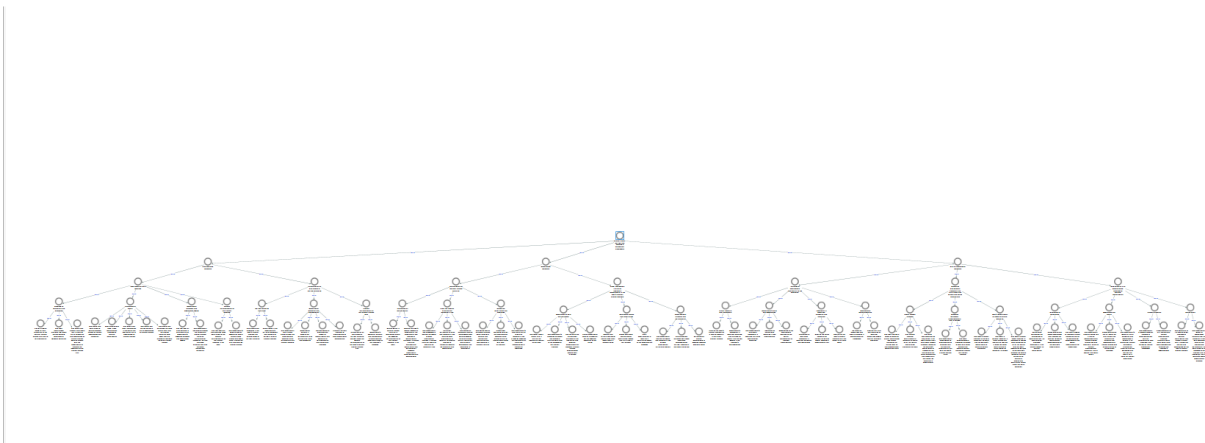
Add Associated Items

### Appendix C – NVivo Coding Process – Codes & Theme Formulations

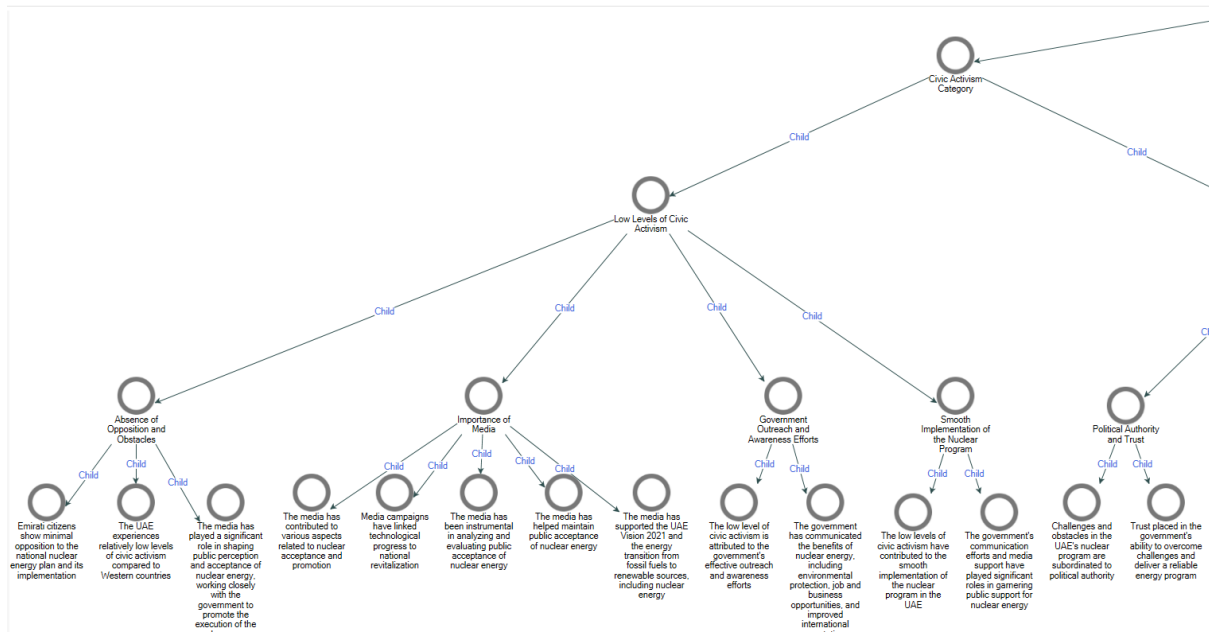
Name	File	Refer
<input type="radio"/> Promoting Compliance and E	14	51
<input type="radio"/> State Involvement in Guiding Eco	0	0
<input type="radio"/> Government's Role and Appr	14	56
<input type="radio"/> Regulatory Bodies and Comp	14	92
<input type="radio"/> Organizational Structure and	14	31
<input type="radio"/> Public Engagement Category	0	0
<input type="radio"/> Influence of technocratic ideolog	0	0
<input type="radio"/> Global Example and Benchm	14	48
<input type="radio"/> Government's Role and Acce	14	69
<input type="radio"/> Investment in Technical Educ	14	41
<input type="radio"/> Technocratic Decision-Makin	11	29
<input type="radio"/> Promoting environment protecti	0	0
<input type="radio"/> Green Growth Strategy	14	53
<input type="radio"/> Proactive Approach, Encoura	14	47
<input type="radio"/> UAE's Commitment to Loweri	14	39
<input type="radio"/> Campaigns to Link Technological	0	0
<input type="radio"/> Awareness and media	14	31
<input type="radio"/> Coordination	14	35
<input type="radio"/> Importance of Campaigns	13	34
<input type="radio"/> Budget Allocation	11	25

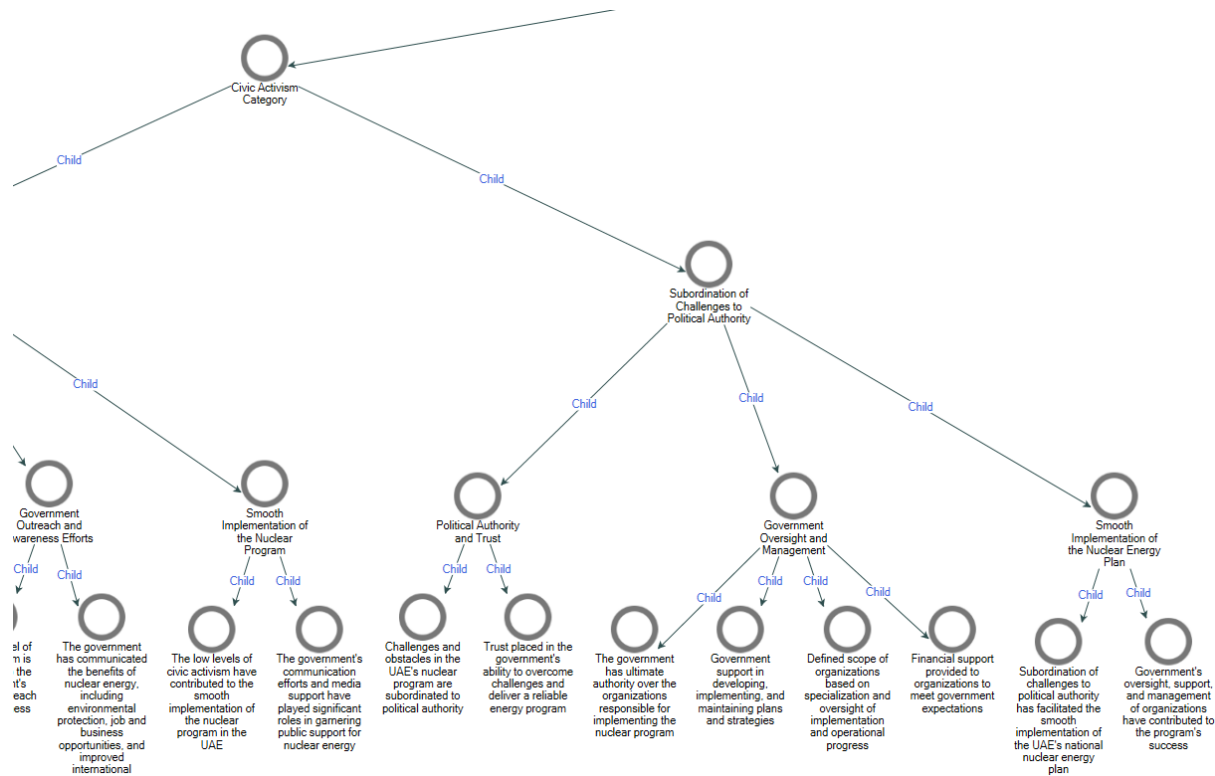
### Appendix D – NVivo Coding Process – Coding & Themes



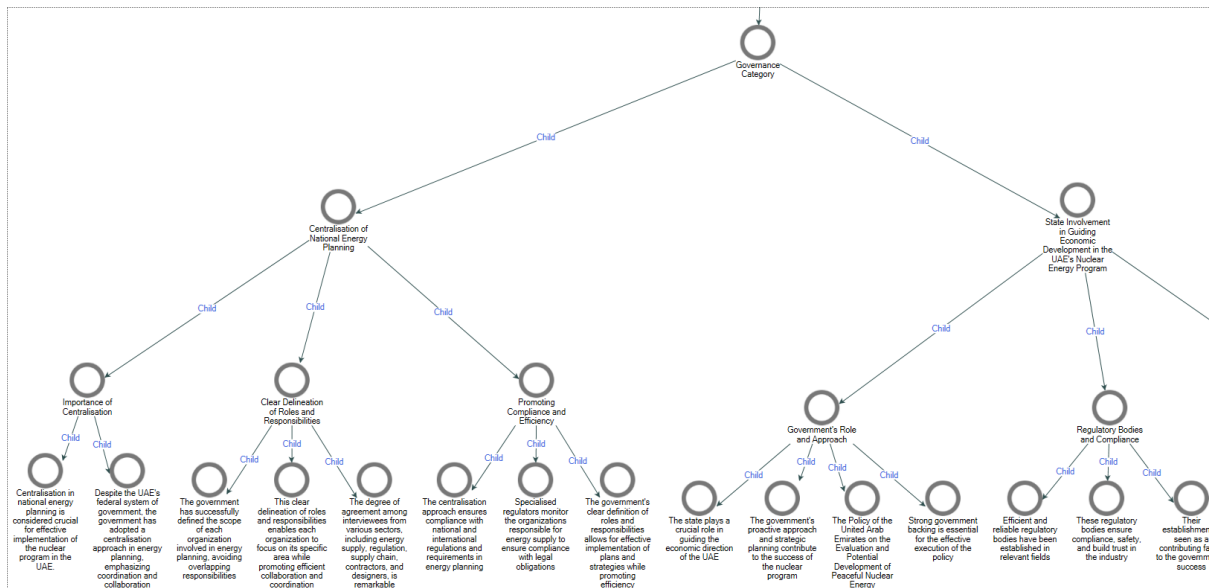
Appendix E1 – NVivo Coding Process – Civic Activism



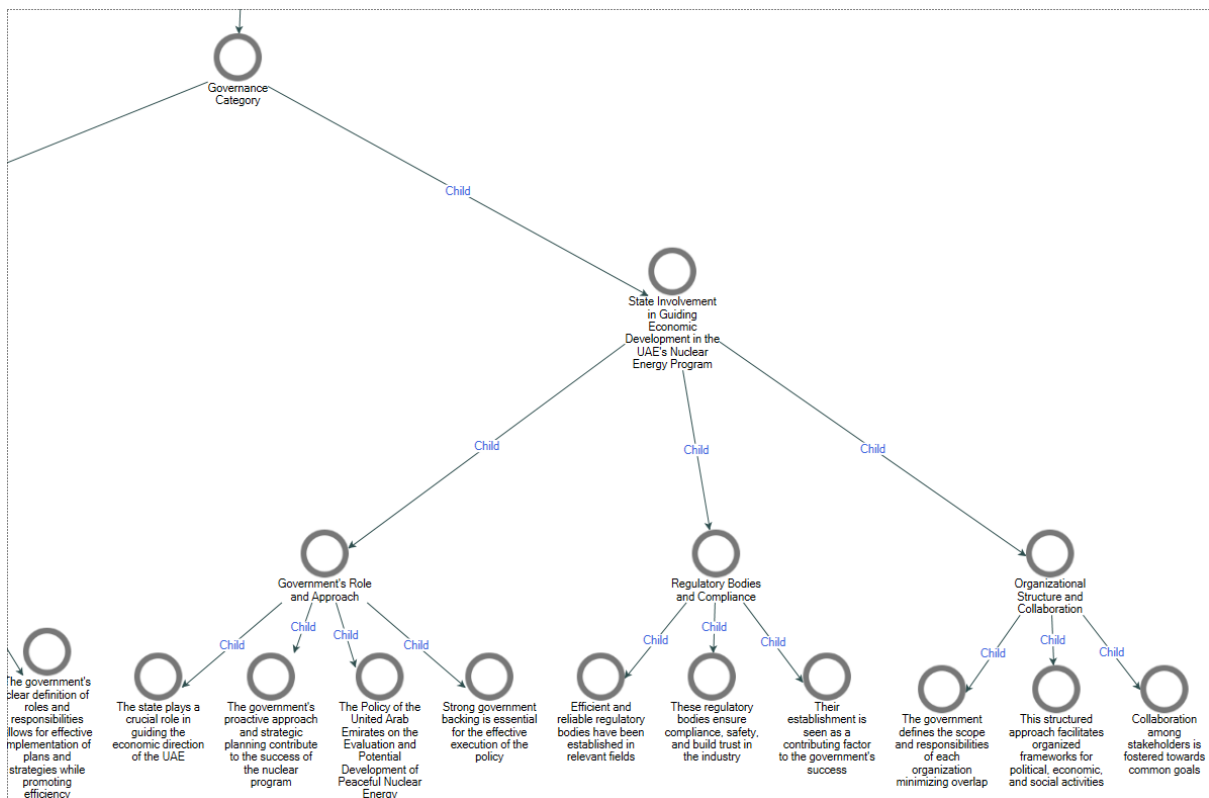
Appendix E2 – NVivo Coding Process – Civic Activism



Appendix F1 – NVivo Coding Process – Governance Category

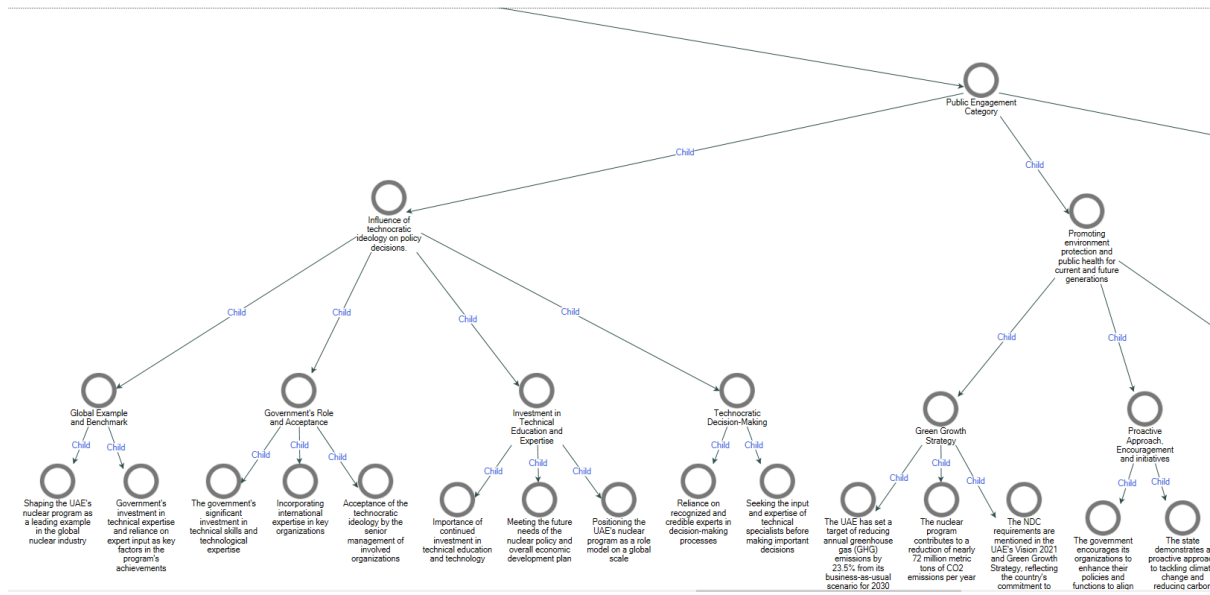


Appendix F2 – NVivo Coding Process – Governance Category

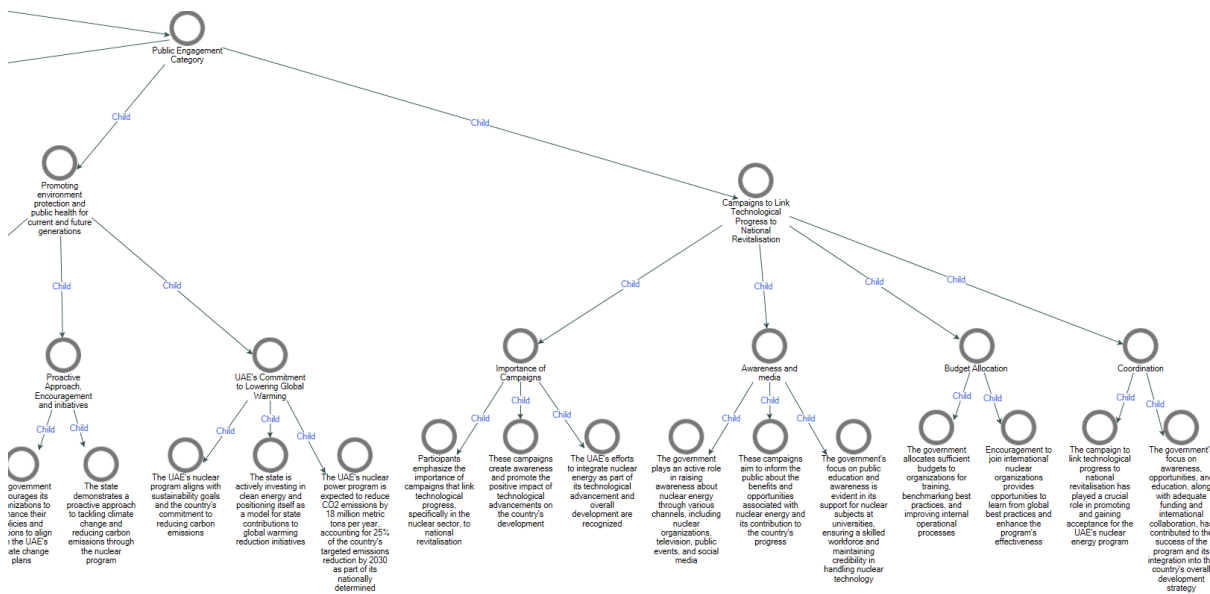




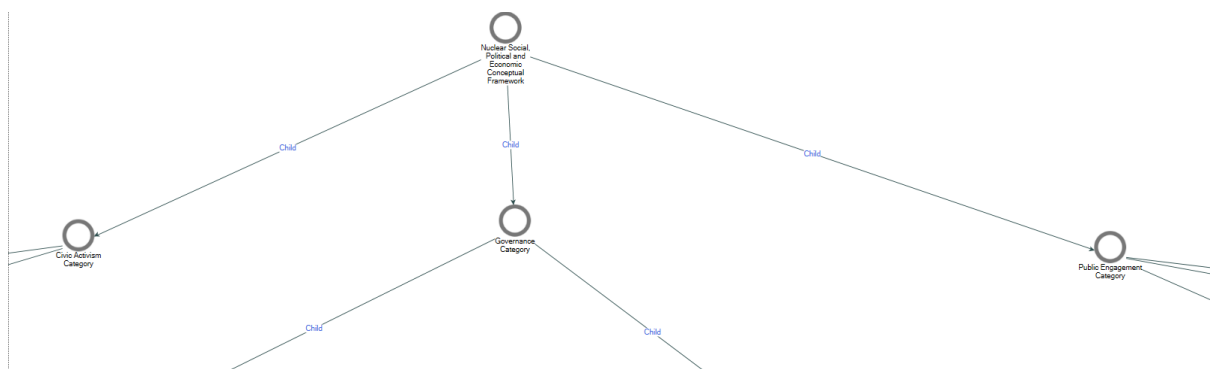
Appendix G1 – NVivo Coding Process – Public Engagement Category



Appendix G2 – NVivo Coding Process – Public Engagement Category



Appendix H – NVivo Coding Process – Main Themes



**Contributions to the field**

This research makes a significant contribution to the field of nuclear energy policy. It provides a new conceptual framework for implementing nuclear energy programmes, which can be used to guide the implementation of these programmes in other countries. The research also provides valuable insights into the factors influencing the successful implementation of nuclear energy programmes.

The research findings are also relevant to other fields, such as energy policy, public policy, and organisational studies. The research findings can inform decision-making in these fields and improve the implementation of complex programmes.

**Conclusion**

The INVIVO appendix is a valuable resource for policymakers, stakeholders, and researchers interested in the UAE's nuclear energy programme. The appendix provides a comprehensive and evidence-based foundation for the conceptual framework for implementing the UAE's nuclear energy programme. The appendix also provides valuable insights into the factors influencing the successful implementation of nuclear energy programmes.

## Methodology Workflow

