# Developing a Framework for Implementing Public Private Partnerships in a Research Reactor Project in the United Arab Emirates

## تطوير آلية لتنفيذ مشروع مفاعلات بحوث نووية في دولة الإمارات العربية المتحدة من خلال الشراكات الاستثمارية بين القطاعين العام والخاص

**By**

**Khalid Almarri**

**A thesis submitted in fulfilment**

**of the requirements for the degree of**

**DOCTOR OF PHILIOSOPHY**

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**June 2015**

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**Professor Bassam Abu-Hijleh**

**Approved for award:**

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# ABSTRACT

Public private partnerships (PPP) procurement instruments have been very popular tools for developing projects around the world. This is largely due to their success in bringing quality, efficiency, innovation, funds, experience, and most importantly risk sharing to the projects they are involved in.

The UAE is currently developing a peaceful nuclear energy program in response to the future demands. Research is required to support nuclear energy generation projects in order to maximize their performance. Research of this type will require a research reactor to be developed, which will also benefit other industries such as transportation, health services, construction, petro chemicals, in addition to technical colleges and R&D facilities. Collaborations between government and private parties through public private partnerships (PPP) can maximize the benefits expected from the adoption of a research reactor project.

The aim of this research is to develop a framework for establishing a research reactor (RR) project in the UAE through the utilisation of public private partnerships (PPP). The aim of this study was arrived at in three steps. The first step was thorough literature research of detailed investigative works to identify the best practices in PPP implementation globally and customizing it for the establishment of a generic PPP framework for the UAE. Through the qualitative content analysis approach, assisted by Nvivo software, a five-stage generic framework was produced. Second, a questionnaire was used to draw data for the establishment of the PPP critical success factors for the UAE, in which data was collected from 30 participants from the UAE and 62 participants from the UK. The participants were PPP practitioners or researchers. This

enabled the comparative analysis process to add a local dimension to the generic framework. Finally, semi-structured interviews conducted with 10 experts in the field of research reactors, using grounded theory method, established the success factors for research reactors. These factors would be unique in the sense that they complement the implementation of the PPP framework in the research reactor project while staying within the UAE context.

The findings of the comparative analysis of the two samples between the UAE and the UK showed a significant similarity in PPP practice trends between the two in the three areas analysed; attractive factors, value for money factors, and the critical success factors.

The core phenomenon that impairs the success of research reactors was identified to be underutilization. Causal conditions that stemmed from project initiation work were found to be the main sources of said underutilization. This included the reduction of government intervention to help mitigate the risk of underutilization. The contextual conditions responsible for creating these circumstances were of both local and regional contexts and viability.

The practical implications of this research are mainly related to the development of the first PPP framework for the UAE, and more specifically for a research reactor project. The contributions of this research to the body of knowledge are related to the highlighted similarities and differences in the practice between the UAE and the UK, which opened areas for future consideration. In the research reactor field, the identified causal, intervening, and contextual conditions opened new areas for future research.

Keywords: Public Private Partnerships (PPP); Research Reactors (RR); Grounded Theory (GT)

## نبذة مختصرة

تنفذ دولة الإمارات العربية المتحدة برنامجًا نوويًا سلميًا لتوليد الطاقة الكهربائية لتغطية الطلب المحلي المتنامي على الكهرباء، واستجابة لمتطلبات الرؤى الاقتصادية للبلاد والمتضمنة تقليل الاعتماد على الوقود الأحفوري.

ونظرًا لأهمية توفير المتطلبات الرئيسية لإنجاح مشاريع توليد الطاقة الكهربائية من الطاقة النووية، فإن الحاجة تصبح ملحة لإقران هذه المشاريع بمشروع مفاعل أبحاث يقوم على رفع كفاءتها من خلال توفير التدريب والتجارب والأبحاث اللازمة، بالإضافة إلى ما تسهم به مفاعلات الأبحاث بشكل عام في النمو الاقتصادي وخصوصًا في قطاعات الصحة، الإنشاءات، البتروكيماويات، والبحث العلمي. يتطلب تطوير مفاعلات الأبحاث استثمارات مالية وبشرية كبيرة وينطوي على تطويرها مخاطر كثيرة في حال عدم توافر الخبرة والمهارات اللازمة لإدارتها، بالإضافة إلى تكاليف التشغيل والصيانة الباهظة. فيما لو تم توظيفها على الطريقة المثلى فإنها تكون عاملاً مؤثرًا في النمو الاقتصادي بعيد المدى.

إن التعاون فيما بين الحكومات والقطاع الخاص من خلال الشراكات الاستثمارية، يؤدي إلى زيادة الاستفادة من مشاريع مفاعلات الأبحاث. لقد أصبحت الشراكات الاستثمارية بين الحكومات والقطاع الخاص آلية مفضلة لتنفيذ مشاريع البنية التحتية حول العالم؛ لما تتميز به من رفع للكفاءة، والابتكار، والخبرة، وتوفير الأموال اللازمة لتنفيذ المشاريع. لذلك فإنه يُتوقع في حال تسخير هذه الشراكات في تنفيذ مفاعلات الأبحاث، بأن ترفع سقف الاستفادة منها.

إن أهداف هذه الدراسة تتمحور في معظمها في وضع تصوّر للمشاريع المشتركة بين الجهات العامة والخاصة في دولة الإمارات العربية المتحدة، مع التركيز بوجه خاص على برامج مفاعلات الأبحاث. هذه الأهداف تتطلب اتباع نهج متوازن للتقييم المتعمق للأبحاث في هذا المجال بالإضافة إلى أساليب التحليلين البحثيين؛ النوعي والكمي.

إن الغاية من هذا البحث والمتمثلة في وضع إطار لتنفيذ الشراكات بين القطاعين العام والخاص في تنفيذ مفاعلات الأبحاث في دولة الإمارات العربية المتحدة، قد تحققت في ثلاث خطوات. الأولى من خلال استخدام المؤلفات والأبحاث في تحديد أفضل الممارسات العالمية في مجال الشراكات بين الحكومات والقطاع الخاص؛ لتصميم آلية لتنفيذ هذه الشراكات في دولة الإمارات العربية المتحدة. وأَعقب ذلك استخدام أساليب البحوث الكمية مع مشاركين من الإمارات العربية المتحدة والمملكة المتحدة، للقيام بعملية التحليل المُقارَن والذي أضاف الطابع المحلي لتنفيذ هذه المشاريع. تلا ذلك تطبيق منهجية بناء النظرية من خلال مقابلات مع خبراء في مجال مفاعلات الأبحاث النووية؛ لتحديد عوامل النجاح لهذه المشاريع لتضاف بذلك إلى العوامل الأخرى التي تم تحديد تأثيرها مسبقًا على تنفيذ المشاريع المشتركة بين الحكومة والقطاع الخاص في الإمارات؛ لتكتمل بذلك الأهداف من هذا البحث.

لقد أظهرت نتائج التحليل المقارن للعينتين من دولة الإمارات العربية المتحدة والمملكة المتحدة، تشابهًا كبيرًا في ممارسة الشراكات الاستثمارية بين البلدين. فيما يتعلق بالعوامل الجاذبة لتطبيقها، خلصت النتائج إلى تطابق أهم أربعة عوامل في البلدين. هذه العوامل هي: الاستفادة من مهارات القطاع الخاص وخبرته، التمويل، القيمة مقابل المال، تحميل المخاطر للمستثمرين. وفيما يتعلق بتحقيق أهداف هذه الشراكات والمتمثلة في القيمة مقابل المال، فقد تم اختيار نفس العوامل الأربعة كأهم عوامل تحقق هذه الغاية في البلدين أيضًا، وهي التقاسم الأمثل للمخاطر، طرح

المناقصات بآلية تضمن التنافسية، تحسين الخدمات المقدمة للمجتمع، والتوصيف الفني لمخرجات الأداء. وأخيرا وفيما يتعلق بعوامل نجاح تطبيق آلية الشراكة الاستثمارية فقد تطابقت العوامل التسعة الأهم في عينتي البلدين، وهي: التزام الجهات العامة والخاصة بتحقيق أهداف المشروع، التقاسم الأمثل للمخاطر، القدرة الإشرافية للجهة العامة المختصة بتنفيذ الشراكات، الشفافية في التنفيذ، قدرة التحالف المنفذ للمشروع، التنافسية في تنفيذ المشروع، الدعم السياسي، الدراسات التفصيلية للتكلفة مقابل العوائد المرجوة، والحوكمة المثالية.

وأخيرًا تم التوَصّل في هذا البحث إلى أن أهم ظاهرة تقوّض نجاح مفاعلات الأبحاث هي ضعف الإقبال على خدماتها. ومن خلال تحليل المقابلات مع الخبراء النوويين، تم تحديد الظروف المسببة لهذه الظاهرة والتي تتعلق في مجملها بخلل في تنفيذ خطوات عملية التخطيط الاستراتيجي لتنفيذ هذه المشاريع. كما تم تحديد التدخلات الحكومية كظروف متداخلة تزيد من تأثير الظروف المسببة لهذه الظاهرة، وخصوصًا فيما يتعلق بالرغبة في تحقيق إنجاز على المستوى الدولي، أو حدوث تغير في التوجهات السياسية، والتي تؤثر في القدرة التشغيلية، أو من خلال تشديد الإجراءات المتعلقة بالأمن والسلامة. وأخيرًا تم تحديد السياق الظرفي لضعف الاستخدام والذي تمثل في السياقين المحلي والإقليمي بالإضافة إلى القدرة التنافسية، وذلك فيما يختص بالاعتماد المطلق على: الدعم الخارجي، تنافسية الخدمات المستحدثة بالنسبة إلى البدائل الحالية، ومعدلات الاستخدام المتوقعة.

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# 1. INTRODUCTION

The United Arab Emirates (UAE) is currently developing a peaceful nuclear energy program to respond to future demands identified in Abu Dhabi's 2030 Vision and the Dubai Integrated Energy Strategy 2030 to sustain the requirements of anticipated economic growth, in addition to the plans for reducing dependency on fossil fuels (Namatalla, 2009).

Given the amount of benefits inherent to the adoption of peaceful nuclear energy generation and the safeguards and agreements already signed with the International Atomic Energy Agency (IAEA), the UAE is encouraged to pursue research activities to compliment the energy generation project. Such research will require the development of a research reactor project, which will not only benefit research to support nuclear power plant operations, but also all industries identified in the UAE's growth strategies. These industries include transportation, health services, construction, petro chemicals, technical colleges, and R&D facilities (ADUPC, 2014; IAEA, 2014b).

The primary uses of research reactors are mainly focused on two areas; first is training and education, such as reactor physics and engineering, operator training, radiation shielding, and nuclear analytical methods; and second, products and services for the society, such as radioisotope production for medical services, Boron capture therapy, neutron imaging, geochronology, and material and fuel testing (Bode, 2014; IAEA, 2014b; Ridikas, 2010).

A research reactor requires a heavy, upfront investment and poses heavy risks to governments due to the lack of skills, experience, and high operation and maintenance expenses (IAEA, 2014a; Peld & Ridikas, 2014). However, if utilized properly, it could become a player in the long-term economic growth of the country, and it is here where the private sector can play a vital role. The collaboration between governments and private parties through public private partnerships (PPP) can maximize the benefits expected from the adoption of a research reactor project (Alfen, 2010; IAEA, 2012).

PPPs have become very popular mechanisms for procuring public works around the globe due to their high success rate in bringing quality, efficiency, innovation, funds, experience, and, most importantly, risk sharing to developed projects (Alfen, 2010). Therefore, PPPs are expected to maximize the benefits sought after in the adoption of a research reactor project as "PPPs are long-term relationships involving the private sector in the provision of public services that in many cases had previously been entirely the responsibility of the public sector" (Broadbent & Laughlin, 2004, p. 4). PPPs terminology was first introduced in the UK in 1997. Prior to 1997, other arrangements of this collaborative form of engaging the private sector fell within the private finance initiative (PFI), which was launched in 1992 as a project finance mechanism by the UK's conservative government (Broadbent & Laughlin, 2003, 2004).

Four main types of PPPs have emerged since the launching of this engagement form, and they are BOT (build operate transfer) BOO (build own operate), BOOT (build own operate transfer), and DBFO (design build finance operate) (Broadbent & Laughlin, 2004). To date, there is no systematic approach for developing PPP projects in the UAE which can be utilized as a model to deliver an efficient and effective research reactor project. It was estimated that there were less than 10 PPP projects awarded in the UAE prior to 2010 (Dulaimi, Alhashemi, Ling & Kumaraswamy, 2010). There are also no studies regarding the implementation of a research reactor project in the UAE.

## 1.1 Significance of the study and rationale

In light of the above, developing a framework for implementing PPPs in the UAE will help standardize the practice. Such standardization comes with many benefits to the local economy. The main benefits of standardization as reported by Robinson, Austin and Gibb (2011) include reliability, improved quality and efficiency, lower costs, and improved processes. The UK's treasury highlighted the aim of standardizing PFIs, which is "to provide guidance on the key issues that arise in PFI projects in order to promote the achievement of commercially balanced contracts and enable public sector procurers to meet their requirements and deliver best value for money" (HMT, 2007, p. 1).

While there are considerable studies conducted on PPP applications, more is required to develop the most suitable framework for implementation in the UAE, taking into consideration the local nature and complexities, such as the political and institutional system, local financial framework and markets, lack of interest/ implementation of PPPs, and transparency and governance (Dulaimi et al., 2010). On the other hand, this study will contribute to the commercialization of research reactors, which are mostly developed through government funds. PPPs are expected to improve the utilization of research reactors through the efficiency they bring to the developed project. Goldman, Adelfang, Alldred and Mote (2008, p. 18) in their study 'Progress in Promoting Research Reactor Coalitions' stated that in order to improve the utilization of research reactors, "[P]ublic-private partnerships need to be pursued." This study will highlight the benefits of sharing risks and, equally, the financial benefits between the public and private sectors to maximize the outcome of a research reactor, which include the production of the isotopes needed for medical and industrial purposes, the neutron beam research for non-destructive material testing, and the research and training procedures for nuclear power generation staff and research and development (R & D) researchers (IAEA, 2010). Therefore, the rationale of this study is to develop a framework for establishing a research reactor project in the UAE through the utilisation of public private partnerships, which will be the first framework for PPPs in general in the UAE. In addition, this study will produce a framework for implementing PPPs in research reactor project, which, from this researcher's review of the body of knowledge and the contact with concerned parties, was never developed before.

A research reactor project is a major undertaking that requires meticulous preparation and investment planning. The project must follow strict safeguards and will require full awareness of nuclear safety, security, and control of nuclear materials handling. The decision to undertake a research reactor project should be based on identified outcomes of adopting such a complex and sensitive project. This also includes compliance to the international treaties and conventions governing safety, security, and safeguards for nuclear programs and facilities. The government, to discharge such responsibilities, must provide a sustainable infrastructure that provides legal, governmental, technical, industrial, and administrative support for the life cycle of the research reactor project (Peld & Ridikas, 2014; Ridikas et al., 2010; Shokr, Abou Yehia, Adelfang, Alldred & Ridikas, 2012)

Governments can share the cost and risks with the private sector to ensure the efficient and effective operation of research reactor projects. However, this will require a commitment to be part of all stages of the project. Therefore, before inviting the private parties to be part of the project's development consortium, governments must first have in place the planning and funding mechanisms for regulating, operating, decommissioning, and management of spent fuel and waste. Research reactors also require supporting infrastructure to enable them to work efficiently. Infrastructure includes all activities required for the development and operation of the RR, such as physical plants and equipment associated with the RR, the logistics of handling nuclear materials, and the management of spent fuel and radioactive waste. It also includes the regulatory framework and the financial and human resources needed to ensure safety, security, and the efficient and safe development and utilisation of the RR throughout the life cycle of the reactor. There must be a solid justification for adopting a research reactor project based on national or regional needs for its services, the alternatives available, and the financial and human resources available (Bignan, 2014; Bode, 2012; Peld & Ridikas, 2014; Shokr et al., 2012). This research takes the initiative to highlight for the authorities the benefits that research reactors can produce to justify the adoption of an RR project in the UAE. Previous experiences have demonstrated that research reactors would most likely require some sort of public funding support throughout their lifetime. Such funding includes planning cost, bid process, construction, commissioning and decommissioning, operation, disposal of spent fuel and radioactive waste, and facility maintenance. Therefore, the financial commitment of the public party is likely to run for decades and will require meticulous planning and careful assessment before the commencement of the project (Bignan, 2014; IAEA, 2012; Peld & Ridikas, 2014).

Research reactors require a significant financial commitment; such commitment ranges from several million dollars for small reactors to hundreds of millions of dollars for the larger ones. This is in addition to on-going operations, maintenance, and decommissioning costs. The latter is likely to extend for tens of years after the actual closure of the reactor, which is normally between 30 to 60 years after the commissioning, depending on the type, function, and the fuels used. The cost of the infrastructure associated with the research reactor may well exceed the cost of the research reactor itself. Research reactors are unlikely to sustain their financial obligations as mentioned earlier and will not generate sufficient funds to be used in the long-term storage facility of spent fuel or even the decommissioning of the plant. This is in total contrast to nuclear power plants, where such costs are paid for from the revenues. Therefore, funding mechanisms must be clearly detailed and identified at the onset of the project to ensure financial stability during the operation lifetime of the reactor and the decommissioning and spent fuel storage management period. This is not only important to safeguard the government against disruptions of operations and heavy losses, but also to give investors a clear understanding of the investment situation of the project to attract the best bids preferably through the PPP mechanism due to the benefits discussed earlier in this study (Bignan, 2014; Fourie & Burger, 2000; IAEA, 2012; Oyedele, 2012;).

Research into the field of research reactors nowadays is centred on reducing cost while maximizing the utilisation of such facilities. The reason for this is that the majority of research reactors in operation today are either near retirement or underutilised. Furthermore, the demand on research reactors is ever increasing, forcing the decision makers to look for innovative ideas to reduce the cost while supplying the market with the required services (IAEA, 2006; Peld & Ridikas, 2014).

State-of-the-art research reactors are being developed or are in the design phase that are expected to revolutionize the industry due to the fact that they are safer, their technology is more controllable, and they produce a lower volume of nuclear waste. In addition to this, they reduce radio-toxicity, optimize utilisation of uranium reserves, allow for a wider range of application, and focus more on socio-economic impacts (IAEA, 2003; BNRC, 2014). The new breed of research reactors are expected to cater to both public and private interests. Such interests include the joint development of research reactor projects between the public and private sectors (IAEA, 2006). There are leading state-of-the-art research reactors that are currently under development and are of a direct interest to this research. These projects are integrating, with varying levels of participation, PPP models into their developments. They include the MYRRHA research reactor in Belgium, the PALLAS Project in the Netherlands, and the Jules Horowitz reactor in France.

## 1.2 Research aim and objectives

### 1.2.1 Aim of the study

This study seeks to develop a framework for establishing a research reactor (RR) project in the UAE through the utilisation of public private partnerships (PPP).

### 1.2.2 OBJECTIVES

In order to achieve the aim of this research, the following objectives were identified:

1. Study the best practices of PPPs to develop the UAE's generic framework.
2. Establish the favourable outcomes factors, the value for money factors, and the critical success factors of PPPs for the UAE.
3. Identify the success factors and commercial viability of a research reactor, with particular focus on the UAE.
4. Establish a framework for implementing PPPs for RR in the UAE.
5. Validate the framework for implementing PPPs for RR in the UAE.

### 1.2.3 Questions

In order to achieve the above objectives, the following research questions underpin the entire study:

- What is the best way to develop a generic PPP framework for the UAE?
- What are the PPP critical success factors for projects in the UAE and how can they be integrated/implemented to establish a UAE specific PPP framework?
- What are the critical success factors to build/establish Research Reactors?

## 1.3 Overview of upcoming sections

The research consists of four segments: the literature research, the quantitative survey, the qualitative investigation, and the quantitative framework validation. These segments were divided into sub-segments, or chapters. Figure 1 illustrates the phases of this research and the sequence of their implementation.

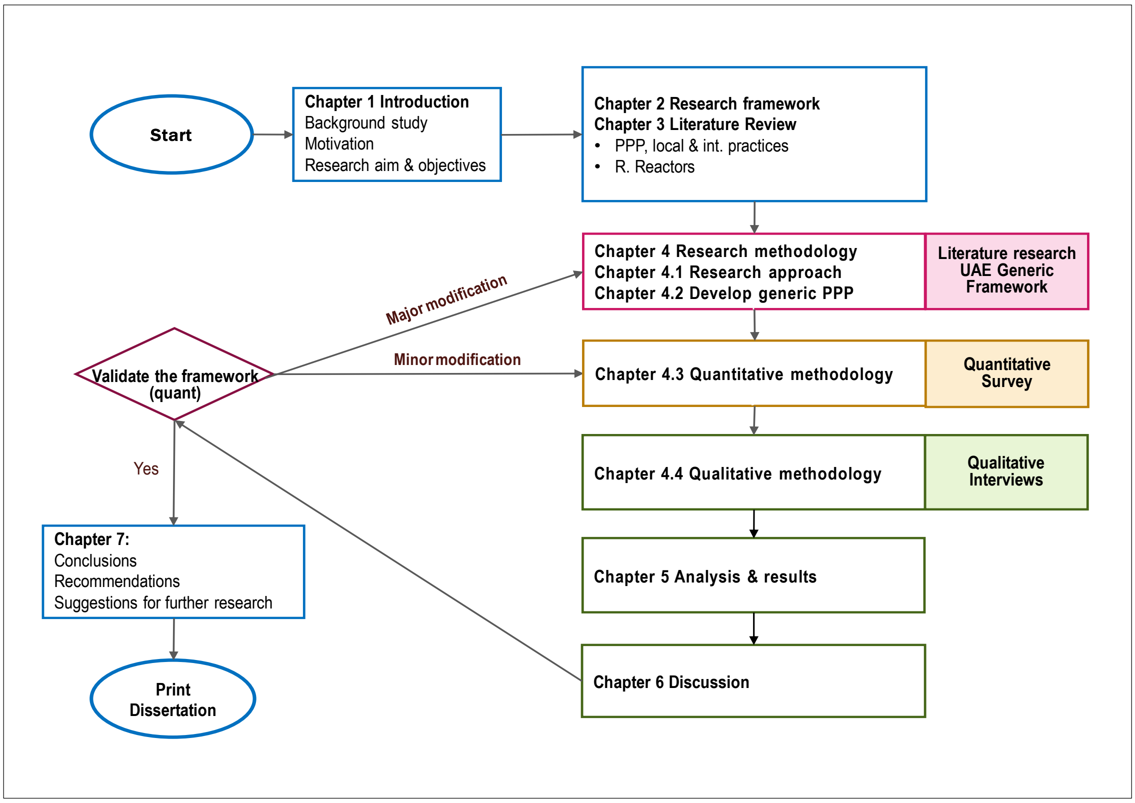


**Figure 1: Structure of research study**

Chapter 2 introduces the research framework, where the theoretical structure will be introduced and substantiated. Chapter 3 will present the literature research of the study which comprises two integral parts: a PPP literature review, and a research reactor literature review. Both reviews will be detailed separately in Chapter 3.

Chapter 3 includes important aspects about PPPs, such as the development of the concept, the underlying theories, viability, procurement alternatives, financial frameworks, legal frameworks, risks, participation cost, skills, credibility, stakeholder's communications, negotiation process, best practices, and other factors. Chapter 3 also will focus on the literature available on the topic of research reactors, including their types, uses, viability, benefits, risks, funding, life cycle obligations, waste management, site and material safety, international conventions, radiation, environment, and industrial involvement.

Chapter 4 presents the research methodology. There is a detailed investigation concerning the identification of the best practices in PPP implementation globally to establish a generic PPP framework. It also includes the quantitative survey design, collection, and analysis. The quantitative survey was used to establish the viability of using PPP as a procurement method for all types of projects in the UAE and to identify the variation of the impact of key success factors between the UAE and the UK, which were identified through the best practice investigation section. This eventually led to the establishment of the initial PPP framework that is unique to the UAE context by merging the findings of this survey with the generic framework established in the literature research section of this study. Chapter 4 also includes designing the semi-structured interview questions based on the success factors of PPPs and RRs identified in the comparative analysis of the best practices selected for this research.

Chapter 5 presents and analyses the results of the study. Chapter 6 is a discussion of the analysis and results, and how they add up to achieve the aim of this study, and the validation process of this study. Finally, chapter 7 will outline the conclusion, where findings, limitations, and future work are detailed.

## 1.4 Conclusions

In this chapter, the concept of utilising PPPs in developing a research reactor project for the UAE was introduced. The rationale for this idea was presented and supported by literature from both disciplines. The aim of the study, objectives, and questions were identified as well. The chapter concluded with an overview of the next chapters with an illustration highlighting the flow of actions of this study until completion.

# 2. CONCEPTUAL AND THEORETICAL FRAMEWORK

This research focuses on the development of a framework for establishing a research reactor project in the UAE through the utilisation of public private partnerships. Once developed, this PPP framework will be one of the first systematic models for developing projects through the PPP mechanism in the UAE. It will also be the first general framework that can be used for developing RR projects through the PPP mechanism.

Many theories are associated with the formation of partnerships, such as public private partnerships and the identification of their success factors. Lamprecht (2007) proposes two theories for the theoretical framework for partnerships and the success factors for PPPs. He introduced the Enforced Cooperation theory and Game theory. He outlined how Enforced Cooperation theory highlights the pressures affecting the cooperation between the actors who come with different motives and objectives, and he argued if such cooperation would be effective if there was no central control to override the self-interests. Game theory, on the other hand, offers a unique concept; that is, if a game (the scope) is repeated, the players will recall the previous results to maximize the pay-offs and minimize the exposed risks and losses leading to a cooperation that maximises mutual benefits (Lamprecht, 2007). Therefore, the cooperation conditions and surrounding contexts must be considered and studied to optimise the success rate of PPP projects. This research is divided into two constructs: improvement and application. The improvement is in the form of identifying the best practice framework that will help standardise PPP practice in the UAE. The application construct is in the identification of the critical success factors that will improve the success rate of PPP practice in the UAE and applying them to the best practice framework.

The applications of PPPs vary globally based on the following factors: country, sector, and project (Carbonara, Costantino & Pellegrino, 2013). The framework proposed by Carbonara et al. (2013) for integrating the three contexts is vital for this study to enable the finalization of the UAE's PPP framework for the research reactor project. For the country-layer, there are four main dimensions: “institutional, legal, economic, and financial;” for the sector-layer, they are “industry organisation, market structure, and performance” and for the project-layer, the dimensions are grouped into two sets: “the structure of PPP arrangements and financing of PPP arrangements” (Carbonara et al., 2013, p. 801). These variations must be considered when designing the PPP framework for the UAE.

Cheung (2009) developed the first PPP framework for Hong Kong that was unique to the local context. Her methodology was to identify the critical success factors for Hong Kong as compared with leading PPP countries such as the UK and Australia, and then to merge the findings with the existing framework. Similarly, the first step in the formation of the intended framework for the UAE will be through the identification of the best practices for benchmarking. This is because there is no starting point in the UAE such as the generic PPP process in Hong Kong, and a framework must be developed so that the critical success factors could be added to it.

A best practice is a method that top performing organizations are using in their policies, procedures and programmes to sustain superior performance (Jeffcoate, Chappell & Feindt, 2002). Jeffcoate et al. (2002) stressed that in order to implement competitive strategies by adopting a best practice, identification of strategic objectives is required, where each objective is supported by a set of critical success factors. Three studies are considered for guiding the data collection for developing the generic framework, and establishing the CSFs for the UAE. These studies are the Mediterranean comparative study (EIB, 2011), the British and Turkish comparative study (Kahyaoğullari, 2013), and the Chinese and Hong Kong comparative study (Cheung, AP Chan, Lam, DW Chan & Ke, 2012). A selection process of the best practices in PPPs will commence so that a generic new practice for the UAE can be developed. In the formation of this generic framework, the qualitative approach will be used.

The second and third steps of this research will be the process of identifying the critical success factors for PPPs and for research reactors, and merging them with the generic PPP framework. Critical success factors are essential for the success of any process, and their identification and ranking according to their importance helps not only adhere to the contexts under which the projects are being developed, but also directs the efforts and resources of the organisation to more important areas, which leads to the successful delivery of the objectives (A Gupta, MC Gupta & Agrawal, 2013). “The ‘Critical Success Factors’ (CSF) concept was developed by Rockart and the Sloan School of Management with the phrase first used in the context of information systems and project management” (Jefferies, Gameson & Rowlinson, 2002, p. 354). The concept focuses on areas in which positive outcomes are critical for the organisation to achieve its objective in an efficient and effective way.

Rockart’s classification of the critical success factors is widely used in literature and particularly in the public private partnerships research (Gudienė, Banaitis, Podvezko & Banaitienė, 2014; Liu et al., 2014b; Liu et al., 2014c; Medeiros Jr, Perez & Lex, 2014). Rockart classified CSFs as industrial (industry characteristics), environmental (economy, competition, infrastructure), strategic (stakeholder’s objectives), and temporal (internal forces, barriers) (Jefferies et al., 2002).

Various governments and organisations, in addition to researchers in the field of PPPs, have extensively identified such success factors and further grouped them into discreet groups that can be studied collectively or individually to establish, for example, the causal, contextual, and intervening effects, and how they contribute to the success of PPP projects. Such identified factors and groups of factors, such as the ones proposed by Li, Akintoye, Edwards and Hardcastle (2005), Chan et al. (2004), Zhang (2005), Cheung (2009), A Chan, Lam, D Chan, Cheung and Ke (2010), IAEA (2012), Oyedele (2012), will be used in this study.

Therefore, as mentioned earlier, the first step is the comparative analysis of the best practices internationally and the generation of the generic PPP framework for the UAE. The second is the country and sector contexts, which will be determined through the identification of the PPP critical success factors and the adapting of their relevance to the local practice through the comparative analysis of two samples from the UAE and the UK. Finally, the project-layer is added to complete the framework, which, for this study, consists of the critical success factors for the project context of a research reactor.

## 2.1 Conclusions

This chapter focussed on the theoretical framework for conducting this study in order to achieve the objectives identified in chapter one. The development of the partnership concept was highlighted to provide the theoretical background of the concept. Enforced Cooperation and Game theories were identified for the theoretical framework for partnerships and the success factors for PPPs.

Later, examples of developing PPP frameworks were highlighted, and hence the concept was designed for conducting this study. The concept consists of developing a generic PPP framework, establishing the critical success factors so that it could be adapted to the UAE's context, and later to merge it with the critical success factors associated with the development of a research reactor project.

The applications of PPPs were found to be dependent on the following factors: country, sector, and project factors, and therefore will form the basis for developing the PPP framework in the coming sections. The project layer is the research reactor project. Following the previous work done on establishing PPP frameworks, Cheung’s (2009) work on developing the first PPP framework for Hong Kong, which was based on the identification of the CSFs, was adopted. However, as Cheung (2009) used the existing process to develop her framework, this study will start from scratch as there is no such practices in the UAE. This prompted the process of developing a generic PPP framework for the UAE. A best practice content analysis was adopted to develop the generic framework, so that it could be adapted to the UAE through the identification of the CSFs. Rockart’s classification of the critical success factors was adopted as it is widely used in literature in the public private partnerships research. These factors are industrial (industry characteristics), environmental (economy, competition, infrastructure), strategic (stakeholder’s objectives), and temporal (internal forces, barriers). The historical development of the CSFs was presented and their value was emphasised. This chapter has provided the platform for the detailed methodology that will be presented in chapter 4.

# 3. LITERATURE REVIEW

## 3.1 Introduction

Chapter 3 will be a review of the literature available on the topics of PPPs and research reactors, to assess the value of adopting PPP models as compared to conventional procurement methods, and the value of adopting a research reactor project.

### 3.1.1 Public Private Partnerships

PPP is a method of measuring procurement that is being practiced widely around the globe. There are different types of PPPs, and they are not necessarily the best option for all public works. In the following sections, a detailed overview of the literature review conducted in this study will be presented, where, among others, a full account of how the concept was developed, types, success factors, and obstacles that limit the benefits of PPPs will be detailed. A literature review is provided as well of research reactors, their uses, their success and failure factors. Lastly, current research on the topics of PPPs and research reactors will be reviewed.

Governments are increasingly entering partnerships with the private sector through the PPP model for the joint development of public projects. There are scores of best practice projects developed under the PPP mechanism. These best practices will be analysed and compared in this research to formulate the best framework for implementation in the UAE.

PPPs have become a widely used governmental procurement method for developing infrastructure and providing services. In certain developed countries, such as the United Kingdom, procured governmental projects through the PPP model have reached about 20% of the total public procurements (Alfen, 2010). According to the

Treasury of New South Wales, PPPs “are one of the options the Government uses to procure infrastructure and offer opportunities to improve services and better value for money, primarily through appropriate risk transfer, encouraging innovation, greater asset utilisation and integrated whole-of-life asset management” (NSW, 2012, p. 1).

However, the terminology of PPP is not as much developed as its practice and remains unspecific as it consists of complex structures related to the collaboration between the two parties in the contract; the public and private sectors. The confusion in terminology arises from the stakeholders understanding of the characteristics of PPP that they apply to their unique location and environment (Alfen et al., 2009).

The successful development of the method and its application in the UK encouraged other countries to follow suit. The key characteristic that led to the proliferation of the method was the transfer of the scope related to the development cycle of projects, which consists of planning, funding, constructing, maintaining, and managing the projects, to private investors who are thought to better run them and only for a specified period of time (Broadbent & Laughlin, 2003; EU, 2003; Alfen, 2010; PPPC, 2011).

PPPs primarily consist of private finance initiatives or concessions. Payments for the PFIs are based on satisfying the criteria for the investment set by the government, which typically are the availability of the infrastructure and achieving the pre-set performance targets. The payback for concessions is normally collected directly from the users. Moreover, there are two types of PPP opportunities depending on which party initiates it: solicited and unsolicited projects. For the solicited projects, the government identifies key investments and calls for tenders from the private sector. For the unsolicited projects, the investor identifies the investment and seeks a mandate from the government for its development (Alfen et al., 2009; Hoppe & Schmitz, 2013; Merk, Saussier, Staropoli, Slack & Kim, 2012; UNESCAP, 2011).

The main features of PPP include the risk equilibrium, the life-cycle approach, the incentivised structure, the use of private funds, and the utilisation of the private sector's experience and innovation, all of which are expected to add an efficiency edge when compared with other procurement methods. In this efficiency state of PPP engagement, both the public and private sectors share equitably the risks in the contracted projects (Alfen et al., 2009; Broadbent & Laughlin, 2003, 2004; EU, 2003; PPPC, 2011).

Developing countries are very interested in PPP methods for procuring their infrastructure projects because of their lack of experience in developing large projects in non-conventional manners and the risk transfer associated with such projects to the investors. It is therefore important to understand the conventional procurement methods and contrast them against the PPP method (Cheung, Chan & Kajewski, 2010).

### 3.1.1 TRADITIONAL AND PPP PROCUREMENT OF PUBLIC PROJECTS

Governmental projects are awarded in four different categories. The first one is the design or build only; the second is design and build; the third is finance, design, and build; and the fourth one is finance, design, building and operation. The private sector has a different level of involvement according to the category, with most involvement in the fourth one, and this is equivalent to a PPP contract, as it will require a consortium for completing the project. The first through third categories are considered traditional procurement models for public works (EU, 2003; Hoppe & Schmitz, 2013; P3, 2011).

Whether the government decides to award the project the traditional way or through the PPP's, the government in both alternatives holds the lead. In the traditional way, the government will call on the private parties for the design or construction of a project, whereas for PPPs, the government would issue a set of specifications to solicit proposals for the finance, design, construction, maintenance, and operation of a certain project for a specified duration (EU, 2003; P3, 2011).

The PPP model is shaped by three major factors: ownership, internal control, and funding. Ownership refers to the financial gearing of the project, where the equities are clearly defined. Internal control refers to the management of the project to achieve its goals, while funding refers to financial support that either party is willing to contribute. Based on these three factors, the type of PPP is defined. There are different types of PPPs to choose from, and they include, among others, public agency management, service contract outsourcing, management contract, leasing, concession, build operate and transfer (BOT), and divesture privatization (UOM, 2011).

### 3.1.2 Obstacles hindering the full potential of PPPS

Obstacles that may prevent PPPs from being fully used include behavioural, policy, capital, technological, and coordination failures. Behavioural failures may be situations where participants are not given complete information about the opportunity's benefits and the costs involved, and as result, behaviours or skills must be modified significantly to improve productivity. Policy failures include the lack of structures for supporting implementation, productivity measures that have been defined without considering political interests, and the lack of credit-worthy authority. Capital failures occur when the private financing cannot compete with public financing, the supply can be expanded only if the budget for capital costs is increased, when there is a lack of or no access to mature markets that can assist in capital funding, and when the financing bodies are not interested in PPPs. Technological failures include approaches that rely on technologies that have yet to be tested or have never been used at an industrial or commercial level, as well as the lack of data to allow for design and preparations. Coordination failures occur when there are no incentives that can result in active participation from the market and when the infrastructure is unable to deliver the solutions in an effective manner (EU, 2003; 3GF, 2012).

### 3.1.3 Research conducted in PPPS

PPPs are increasingly deployed around the world, and therefore researchers have been more interested in studying their applications, which led to a wealth of literature in the form of published studies in the field of PPP. Most of this research is the product of researchers in the following countries: the United Kingdom, the United States, Singapore, and Hong Kong. In addition, the most active universities in this field are Glasgow Caledonian University, NTU and NU of Singapore, and the University of Hong Kong, as cited by Cheung (2009). As highlighted by various studies, the best case studies in PPP implementation come from the United Kingdom (EIB, 2011; Kahyaoğullari, 2013).

#### *3.1.3.1 PPP research by Esther Cheung*

Esther Cheung (2009) of Queensland University of Technology, in her thesis 'Developing a Best Practice Framework for Implementing Public Private Partnerships (PPP) in Hong Kong,' highlighted the role PPPs play in bringing quality and efficiency to the projects they are used for. She cited various attempts to implement the mechanism in her home country of Hong Kong which ended without reaping the true benefits due to various factors. Such factors included the comfortable financial status of the country, leading to less focus on regulating the practice for a widespread implementation. In her view, if it was done systematically, PPPs would contribute significantly to economic growth and would nourish various sectors and industries in Hong Kong. Therefore, Cheung endeavoured to develop a best practice framework for implementing PPPs in Hong Kong.

To develop such a framework, a thorough investigation into the characteristics and challenges of PPP was warranted, and a comparative analysis with other procurement methods was conducted. She achieved the objectives of her study by using a mix of qualitative and quantitative approaches through a comprehensive literature review, in-depth case study analysis, interviews with local and international experts, and a large-scale questionnaire with professionals in the fields of PPP and construction. The author used the grounded theory for data acquisition and analysis. The findings were used as the basis for the intended framework and were further validated by PPP experts.

Although Cheung's work preserved the local practice criteria as a starting point, which is a limitation in her work, this researcher is intending to use local practices for contrasting only and not use them as the basis for the framework. The basis for the framework will be drawn from comparative analysis of international best practices and will only be refined to match local nature and complexity.

#### *3.1.3.2 PPP research by Johan Lamprecht*

Johan Christiaan Lamprecht (2007) of North-West University of South Africa, through his thesis entitled 'Public-Private Partnerships: A qualitative approach to prospects for pharmacy in the South African health care environment,' aimed to examine the prospects for PPP implementation in the pharmaceutical sector of South Africa (SA), where he utilized a purely qualitative research approach. The study consisted of literature review and a qualitative research process and used the grounded theory approach for data collection and analysis. Various sampling methods and techniques were employed as well. The data collected from the literature study and from the interviews were integrated and analysed through computer aided data analysis.

The study revealed a range of prospects for employing PPP in the pharmaceutical sector in SA. The management elements for such joint ventures were identified, prompting the design of such a PPP framework. Several barriers were identified as well, such as competition and market entry, that impeded the progress of the PPP, all of which were related to the sensitivity of the industry. PPP models transfer the management of the intended projects to a private party or to a special purpose vehicle that includes representatives of the government but still is led mostly by the investing party. Such transfer of leadership is constricted by the fear that the private party would infringe quality for better financial returns, which will expose the public to higher risks, leading to costly interventions by the government or even the termination of the contract.

### 3.1.4 Critical success and failure factors in PPP

The review of the body of knowledge in the area of PPP revealed that there are many factors that contributed to the success of PPP projects, and therefore they must be recognized in this study. According to Dulaimi et al. (2010, p. 394), who conducted a study on PPPs in the UAE, such factors, included risk allocation, savings, and need for finance, favourable legal framework, political support, strong private consortium, available financial market, stable economy, transparent and competitive procurement process, effective technology transfer, thorough feasibility and assessment study, and opportunities for innovation.

They also identified factors that contribute to the failure of PPPs, which included the "lack of appropriate skills, high participation cost, high project value, high risk, lack of credibility and contacts, demands on management time, poor communication between private partners, and long procurement and negotiations processes" (Dulaimi et al., 2010, p. 394).

### 3.1.5 Current research in Project Management

Given the wide variety of contexts project management is practiced in, the project management paradigm is very well established through bodies of knowledge such as 'the Project Management Institute's PMBOK® Guide' and 'the Association for Project Management's APMBoK' (Besner & Hobbs, 2013). Such variety of contexts are widely acknowledged, however researchers, such as Müller and Turner (2007), in their study 'Matching the project manager's leadership style to project type,' call for further studies for determining the appropriate management style for any given type of project. There have been sufficient empirical studies to validate the contextual variability, and there must be more empirical work into project management within unique contexts such as PPPs, which come in diverse contexts and have varied complexity according to the project being developed.

## 3.2 Research reactors

Research reactors (RRs) have been the main contributors to innovation in nuclear science and technology for over 60 years. The research that RRs facilitate has been the centrepiece for the advancements seen in radioisotopes production and nuclear medicine, neutron beam application, computer code validation, material characterization, and nuclear power generation (IAEA, 2010).

"Research reactors are nuclear reactors that serve primarily as a neutron source" (Yin, 2010). Research reactors, which are generally not used for power generation purposes comprise a wide range of designs. Their primary use is to produce a neutron source that is used in research and industrial applications. They are relatively much smaller in size when compared with power generating reactors. They are also simpler and require far less fuel, as they operate at lower temperatures where less fission builds up as fuel is consumed. However, they require lower enriched uranium fuel with a higher enrichment, (typically up to 20% in U-235), than the fuel used in nuclear power plants (NPP), which is enriched up to 3-5% in U-235. Research reactors also require special design features, as the core has a very high power density, it usually requires a moderator to slow down neutrons enhancement of fission, and, to minimize the neutron loss, reflectors are used which also help sustain the chain reaction (IAEA, 2010, 2012).

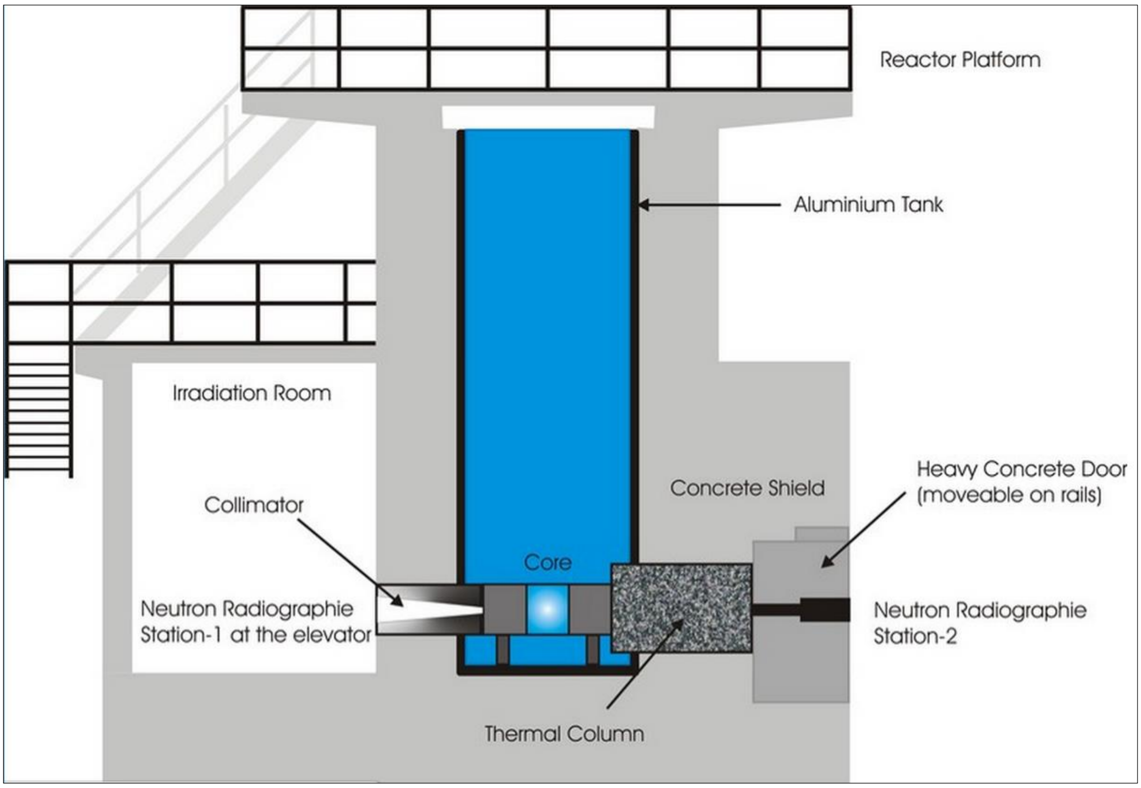



**Figure 2: Cross Section of TRIGA Mk-II research reactor (TU, 2015).**

### 3.2.1 Types of research reactors

There are more types of designs for research reactors than for power generating reactors, and they come in either a pulsed or steady operating mode. The reason for the variety of types of research reactor designs is due to the fact that the selection depends on the purpose and the type of fuel the government can secure for the operation of the reactor. Another reason is the purpose behind developing a research reactor project, as some countries are more focussed on educational and training purposes, whereas others focus, for instance, on commercial or medical causes. Research reactors normally come in three different categories: miniature, medium, and large reactors. The miniature reactors require less than one MW of power, medium reactors use 1-10 MW, and the large reactors require between 10-100 MW of power. The most common research reactor type is the pool reactor, where the core, which consists of a cluster of fuel elements, is placed in a pool of water. There are control rods and channels between the fuel elements to allow for conducting experiments. The TRIGA reactor is a very common and widely used one; it is a versatile reactor which can operate in a steady mode or be pulsed to a very high power (Figure 2). Other types require heavy water to cool and moderate the core. Less popular reactors are fast reactors, which use a combined fuel of uranium and plutonium and require no moderator (Bode, 2014; IAEA, 2010, 2012).

### 3.2.2 Uses of research reactors

Research reactors offer a wide variety of applications that significantly affect our daily routines. Such applications include neutron beam research, which is used in non-destructive examination of materials and material research and measures minute element quantities, radioisotopes for industrial and medical use, materials testing for fission and fusion reactors, transmutation doping of silicon, and coloration of gemstones. Another important contribution of research reactors is to the area of nuclear technology, where operators and staff of nuclear facilities, regulatory personnel, researchers, and students are trained and provided a platform for experimentation (Bode, 2014; IAEA, 2010).

Radioactive isotope production is one example of the most important uses of research reactors, and is produced at 40% of the operational research reactors. It ranks third to Education & Training (71%), and Neutron Activation Analysis (52%) (Adelfang, 2014). The atom is made up of protons and neutrons, and their unique identifier is always the number of protons as it does not change under any circumstances, however, the number of neutrons defines the properties of the element. These are called isotopes, and some of them are unstable, radioactive, and normally do not exist in nature and require irradiation for their production. Therefore, in pursuit of particular properties of an element, radioisotopes are artificially produced through irradiation in a research reactor. The commercial production of radioisotopes requires specifically modified research reactors with a high neutron flux that is annexed to a hot cell processing plant, which consists of containment boxes to protect the individuals processing and analysing the isotopes (IAEA, 2012).

The most important radioisotope is Molybdenum-99; its application is most evident in the evaluation of medical conditions associated with the heart, lungs, kidneys, spleen, liver, bones, and blood flow studies. Another popular isotope is Cobalt-60, which is used in radiotherapy, in healthcare, and in many other industrial applications. It is also used in the sterilization of disposable medical items and in the preservation of certain foods. There are over 200 different isotopes currently in use. It is estimated that 10,000 hospitals are dependent on the use of radioisotopes; 90% of the procedures are diagnostic, and Molybdenum-99 alone is used in over 77,000 procedures per day as estimated by IAEA (2012).

### 3.2.3 Critical success and failure factors in research reactors

There are many factors that affect the success of nuclear research projects. Such factors include the infrastructure, quality assurance, and the lack of participation of local researchers and businesses. The infrastructure that is annexed to the research reactor plays a significant role in the maximization of the utilisation of the reactor. The successful processing of the products and services of research reactors requires a rigorous and innovative R&D process to convince the customers of the value of such services and products. Qualified personnel and ample R&D expenditure are preconditions for the success of research reactors (Borio di Tigliole, Bradley, Zhukova, Adelfang & Shokr, 2014; IAEA, 2012).

Research reactors are linked to almost all industries and the scientific community. Efforts must be exerted in reaching out to all industries, universities, and scientists in order to inform them of the services and the potential of such services for all sectors. Failing to get the industries and scientific bodies interested in the project will lead to underutilisation of the reactor and, subsequently, the failure of the project. Particular success and challenge factors include: stakeholders, life-cycle funding and financing, waste management, site and material security, industrial involvement, human resources, environment, and radiation protection (Borio di Tigliole et al., 2014; IAEA, 2012).

There is a significant threat to research reactors in the form of the plan to minimise the use of HEU in research reactors for security reasons. There are already other alternatives to certain applications of research reactors such as the isotope production through accelerators. However, the commercial viability of using accelerators is still not achieved. Pillai, Dash and Knapp (2013) stressed the advantages of using research reactors over the accelerator options by stating that research reactor applications are inexpensive and realistic among other advantages. However, in light of the requirement for the security measures, the commercial viability might not be a hindrance to resorting to other alternatives.

According to IAEA (2012) the threat of these technologies is still minimal since their associated capital and operating costs are high compared to RRs. Furthermore, the new technologies have not been used for continuous production of radioisotopes, and cannot cater for certain applications of research reactors. Any plans for future RRs must consider the threat of these technological alternatives.

## 3.3 PPP, RR, and project management

According to PMI (2015, p. n1), "a project is temporary in that it has a defined beginning and end in time, and therefore defined scope and resources." To oversee the development of the project and handling of all its operational issues, a team must be appointed. The management team must be highly skilled to manage PPP projects and must be well versed in the technical, financial, and legal aspects of this type of project procurement (MOFS, 2012). PPP procurements are more complex than conventional projects and require more effort than any other procurement method. This is mainly due to the long-term engagement required. Both parties in the contract must address many issues prior to the initiation of the contract. Such issues include the specifications, leadership, scope, payment mechanisms, exit strategy, renegotiations, etc. The responsibilities of this team, as defined by the Ministry of Finance of Singapore (MOFS) (2012, p. 21), are:

a) Evaluating whether it is feasible to structure a PPP model for the project;

b) Structuring the PPP tender that delivers the best value for money to Government while providing sufficient business opportunities for the private sector. This could include carrying out a detailed study to recommend a feasible PPP scheme, including the financial arrangements, pre-qualifying criteria of the PPP provider, and preparation of the PPP tender documents;

c) Evaluating the tender proposals to select the best provider for the PPP contract;

d) Preparing the final PPP contract document after the preferred bidder has been selected; and

e) Monitoring the progress and performance of the private provider's work.

In research reactor development, there are three project phases that require meticulous management of their interrelated and integrated tasks. These three phases are pre-project, project formulation, and project implementation. Each one of the three stages comes with its unique responsible organising party and a set of contractors to develop that particular phase. A single and integrated system is required to ensure that all requirements are satisfied to enable the achievement of the objectives of research reactors.

## 3.4 Conclusions

This chapter provided an overview of the comprehensive literature review conducted for this study. The conventional procurement methods were discussed and contrasted against PPP models, where the definitions and concepts were clearly introduced. The issues that must be considered to maximise the potential of PPPs were identified and they include, among others, risk allocation, legal framework, political support, financial market, stable economy, transparent and competitive procurement process, technology transfer, and feasibility studies.

Research conducted in the area of PPPs was examined, highlighting the findings and the limitations encountered in the production of these studies. The information introduced in this chapter will help in the selection and analysis of the best practices in PPPs to achieve the first objective of this study, which is to develop a generic framework for the UAE.

Then, the literature review moved to the next part of this study, concerning research reactors. Full details were provided on the purpose of research reactors, and the value of their uses, so that such value could be linked later in this study to the existing nuclear power project in the UAE, in order to substantiate the adoption of a research reactor project.

The success and failure factors for research reactors were identified from various sources, which included the infrastructure, quality assurance, and the lack of participation of local researchers and businesses. Significant risks to the sustainability of research reactors were also identified, such as technology and financial risks, in addition to the plans to minimise the use of HEU fuel for security reasons. All of these elements have guided the third objective of this research in the identification of the critical success factors for research reactors in the UAE. Finally, commercial viability was identified as the main factor determining the future of research reactors, which forms the basis for the application of the PPP methods.

# 4. RESEARCH METHODOLOGY

## 4.1 Research approach

The approach for this research can be chosen from two research paradigms: the qualitative and quantitative paradigms. The qualitative paradigm is exploratory in nature, where hypotheses are generated to find how things work. On the other hand, the quantitative paradigm is confirmatory in nature, the findings of which are obtained through testing the hypotheses. Lamprecht (2007, p. 164) explains that "[T]he qualitative paradigm is termed the constructivist, the naturalistic, the interpretive, the post-positivist or post-modern perspective, while the quantitative paradigm is termed the traditional, the positivist, the experimental or the empiricist paradigm".

As such, this research employed a mixed methods research approach. The objectives of this research are focused on the formation of a generic PPP framework, the success factors of collaborations between the public and private sectors in developing projects in the UAE, and the success factors for a research reactor project. Such objectives warrant the utilisation of balanced approaches of in-depth literature appraisal for the establishment of benchmark practices, quantitative research process for the identification of the critical success factors associated with the local context in the UAE as compared with a comparator country, and exploratory qualitative inquiry to establish the critical success factors for research reactors, as the exploratory techniques facilitate the scrutiny of scarce data enabling the researcher to identify the critical factors affecting the performance of research reactors.

Venkatesh, Brown and Bala (2013) highlighted the call by scores of researchers for the use of this methodological combination to develop a deeper understanding of the phenomenon. "Mixed methods research is an approach that combines quantitative and qualitative research methods in the same research inquiry" (Venkatesh et al., 2013, p. 21). Venkatesh et al. (2013) encouraged researchers to use the mixed methods research to "provide rich insights into various phenomena and develop novel theoretical perspectives."

Data collection, analysis, and presentation in mixed methods research are done concurrently or sequentially. In concurrent mixed methods research, quantitative and qualitative elements are collected and analysed around the same time and then merged together to offer a better understanding of the phenomenon whereas, for the sequential type, there is a definite sequence between the two research methods where data collection and analysis are implemented and then integrated at different phases (Clark, Huddleston-Casas, Churchill, Green & Garrett, 2008).

There are four main types of mixed methods research: triangulation, explanatory, exploratory, and embedded method. Triangulation is one of the oldest and most recognizable forms of mixed methods research. It is used to merge different but complimentary data to offer a better understanding of the problem. Explanatory design is used when qualitative data is needed to support quantitative findings. Exploratory type is used when researchers explore a phenomenon qualitatively and need to test it and explain its relationships quantitatively. Embedded design of the mixed methods research uses one research method in support of the other to achieve an objective within a largely quantitative or qualitative research (Clark et al., 2008; Creswell & Clark, 2007; Venkatesh et al., 2013).

The mixed method approach for this study falls under the embedded type, as the three segments of this research are done concurrently to achieve the aim of this study. Clark et al. (2008, p. 1555) state, "The supplemental data set is collected to enhance the overall study, and it can be collected before, during, or after the collection and analysis of the emphasized data" where "the researcher uses one type of data in a supportive role to the other method type."

## 4.2 The generic PPP framework

For the first objective, "Study the best practices of PPPs to develop the UAE's generic framework", the comparative study draws from the best practices in the field of PPP. In this segment of the study, investigative work was carried out to satisfy this objective. The data for this phase will be drawn from secondary data of existing best practices.

The selection criteria of the best practices conformed to a rigid performance indicators measurement to ensure that the framework is among the best frameworks in delivering value and achieving the objectives of PPP projects. Performance measurement is instrumental in the long-term success of organisations (Demartini, 2014). "Performance measurement is being applied in different areas, such as manufacturing, business service, logistics, and supply chains" (Liu et al., 2014a, p. 502). Liu et al. (2014a, p. 502) cited Kagioglou et al. (2001) and Yong (2010) to emphasise the critical role of performance measurement for organisations to realise project success. They contend that "[A]t project level, performance measurement is always vital and relates to the realisation of project success, particularly in PPP projects." Thus, performance measurement relates to the alignment of strategic objectives of the organisation.

Liu et al. (2014) cited the work of Akintoye et al. (2003) and Henjewele et al. (2011), stating that value for money is the benchmark strategic objective of PPP projects. Liu et al. (2014) also quoted Yuan, Zeng, Skibniewski and Li (2009) in stating that the strategic objective of value for money encompasses “public client’s overall strategic plan and mission objectives, private sector’s long-term development and payoff strategy, and the general public’s requirements of quality public facilities and services.” Furthermore, Liu et al. (2014a, p. 502) cited Henjewele et al. (2011), saying, “meeting client’s requirements should be considered as a core dimension in performance measurement of PPPs.”

Qualitative content analysis will be used for developing the generic framework from the selected best practices. Qualitative content analysis is "a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns" (Hsieh & Shannon, 2005). Zhang and Wildemuth (2009, p. 1277) elaborated on this approach by stating

…qualitative content analysis involves a process designed to condense raw data into categories or themes based on valid inference and interpretation. This process uses inductive reasoning, by which themes and categories emerge from the data through the researcher’s careful examination and constant comparison.

According to Hsieh and Shannon (2005), there are three main approaches to qualitative content analysis, conventional, directed, and summative content analysis. In the conventional content analysis approach, themes and codes are derived from the raw data. This approach is used later in this research for the identification of the critical success factors for research reactors, where grounded theory is employed. Directed content analysis is an approach where the initial coding starts from a theory or previous findings, then during the data analysis researchers establish themes in support of previous findings or frameworks. In the summative approach, the process starts with a quantitative approach in counting words or phrases, and then it moves into a more inductive manner in the exploration of the usage of such words or phrases (Hsieh & Shannon, 2005; Zhang & Wildemuth, 2009). The directed approach is of interest to this research and will be employed for the development of the generic PPP framework. The well-cited work of Yan Zhang and Barbara Wildemuth (2009) 'Qualitative Analysis of Content' helped guide the qualitative content analysis process of the best practices for achieving the first objective of this research, which is the generic PPP framework.

### 4.2.1 Identifying PPP best practices

This generic framework will form the foundation of this research. The generic PPP model, once finalized, will be modified in the second phase of this research to adapt to the nature and complexity of the UAE's financial and development context through a quantitative research process.

Many PPP frameworks and guides were developed around the globe to help improve the outcomes of PPP projects. These guides and PPP reference books share common core processes related to the development, implementation, and management of PPP projects. The ones used in this research include the frameworks designed by the world's leading financial organisations, such as The World Bank Institute (WBI), The European PPP Expertise Centre (EPEC), the Asian Development Bank (ADB), The Economic and Social Commission for Asia and the Pacific (UNESCAP); and country-specific frameworks, such as the Australian and the Canadian models. The World Bank's study, for instance, was a comprehensive joint work that was in collaboration with the Asian Development Bank and the Inter-American Development Bank (WBI, 2012).

The gathering and analysis of information from the above mentioned best practices allowed for the initial analysis between all elements of PPP practice in the best practices countries. This allowed for the visualisation of the generic framework for the UAE. The initial analysis of the manuals and publications of the identified best practices revealed that in order for the PPP process to be a successful one, it must cover the full lifecycle of the developed project. Although the phases of development of PPP projects vary from a country to country, and depend on the type, size, industry, and local considerations, the development process was almost identical in all these countries (EPEC, 2012; Ho, 2006; Mustafa, 1999; WBI, 2012).

To identify their suitability for inclusion in this research, comparative analysis of the selected best practices was conducted. The following brief sums up the main highlights of PPP practice in these countries. The majority of governments involve the private sector for filling the funding gap for developing public projects. They use several models for involving private finance in governmental projects. One of these models is in the form of public-private partnerships, whereby many conditions must be satisfied before acquiring this kind of funding. The most important condition is the availability of the market for the type of the project offered for investment. There are two major approaches of PPP which are concessions and PFIs. For concessions, the payback is through direct payments from users, whereas payments for private finance initiatives are based on the availability of the infrastructure and meeting the performance targets set by the government. Depending on who initiates the opportunity, there are two PPP opportunities: solicited or unsolicited projects. For solicited projects, the government identifies attractive opportunities and solicits proposals from investors. On the other hand, for unsolicited projects the investor identifies the opportunity for PPP and seeks a mandate to develop the project (Alfen, 2010; Alfen et al., 2009; Ho, 2006; EPEC, 2012; UNESCAP, 2011; Merk et al., 2012; WBI, 2012).

The main objective of seeking a PPP model is it is the holistic solution as it allows any government in obtaining the finances, design, construction, maintenance, and operations of public works projects. The main characteristics of PPP, which are expected to lead to efficiency compared to conventional procurement, include the lifecycle approach, the balanced risk transfer, the incentive structure and innovation potential, the use of private funds and experience, and the long-term contract governed partnership (Alfen, 2010; Alfen et al., 2009; EU, 2003). In this definition of efficiency, both parties, the public and private sectors, share the risk in PPP projects. However, each party tries to maximize its gains and minimize its risks. It is more noticeable that developing countries are keener on this approach because of the risk transfer it involves and their lack of experience in developing projects through non-conventional financing models. It is therefore important to understand the conventional methods of procuring public projects and the progression from this conventional form to PPP (Cheung et al., 2010; EPEC, 2012; Van & Koppenjan, 2001; WBI, 2012; Yuan et al., 2009).

PPPs can facilitate sustainable public services, which will be characterized by high quality and will be cost effective as well. This can be done if the public sector allows the investors to utilize their skills in terms of capital mobilization, technology, and management (EPEC, 2012; EU, 2003; 3GF, 2012). PPPs can increase awareness at a public level, which will lead in an expansion of stakeholder diversity. An environment can be created in which the private sector would prefer to participate by strengthening the cash flows from loans and grants. Consequently, a base for economic growth can be laid in the country. PPPs mitigate associated business risks because they promote joint development activities, which cater to both the public and private sectors. As such, large projects can be implemented which neither the public nor the private sector can achieve on their own because of their limited financing or technological options. The after effect is a more even distribution of risk between all participants and an expanded contribution towards economic growth (Bovaird, 2004; Grimsey & Lewis, 2002; WBI, 2012).

There are many obstacles that prevent the PPP from being fully utilized. These would include behavioural, policy, capital, technological, and coordination failures. The behavioural failures can range from when participants are not given complete information about the opportunity benefits and the costs involved, or when the behaviours or skills must be modified significantly in order to improve productivity. Policy failures include the lack of structures for supporting implementation, situations where the productivity measures have been defined without considering political interests, and the lack of a credit worthy authority. Capital fails when private financing cannot compete with public financing, the supply can only be expanded if the budget for capital costs is increased, when there is a lack of or no access to mature markets which can assist in capital funding, and when the financing bodies are not interested in PPP. Technology fails when the approach lies on technologies which have yet to be tested or which have never been used at an industrial or commercial level prior to this, or when there is a lack of data to allow for design and preparations. Coordination fails when there are no incentives which can result in active participation from the market and when the infrastructure is not suitable for delivering the solutions in an effective manner (Abdel Aziz, 2007; Chan et al., 2009; EU, 2003; 3GF, 2012; WBI, 2012).

### 4.2.2 Preparation of the data

In this phase, the content analysis of the identified best practices was conducted qualitatively with the assistance of a computer program. "The programs vary in their complexity and sophistication, but their common purpose is to assist researchers in organizing, managing, and coding qualitative data in a more efficient manner" (Zhang

& Wildemuth, 2009, p. 6). NVIVO is a research software that is widely used in qualitative studies. It is a data management system where data can be stored according to various criteria such as context, theme, time, and can be retrieved, searched, grouped, modelled, and classified, among other valuable functions that facilitate data collection and analysis. All of the identified best practices were imported into the software.

### 4.2.3 Defining the unit of analysis

The basic unit of text must be identified to enable the coding process of the content analysis. It is one of the fundamental decisions that affect the outcome of the study and its comparability with other studies. "Qualitative content analysis usually uses individual themes as the unit for analysis, rather than the physical linguistic units (e.g., word, sentence, or paragraph) most often used in quantitative content analysis" (Zhang & Wildemuth, 2009, p. 3).

The unit definition process consists of breaking down the text into discrete elements by identifying meaningful units, grouping these meaningful units into categories, and then establishing relationships among these categories for the establishment of a new concept (Bradley, 1993). Bradley (1993) further argues that "[G]uidance for identifying meaningful units may come from prespecified frameworks that are more or less explicit." Bradley (1993, p. 445) quoted Tesch (1990) in defining meaningful units as "a segment of text that is comprehensible by itself and contains one idea, episode or piece of information."

### 4.2.4 Developing categories and a coding scheme

The grouping of the meaningful units varies based on the prespecification of categories. Bradley (2003, p. 445) point out that "[P]reunderstandings, such as formal theory or constructs, can guide the formation of categories, or ideas for categories can emerge from observation" while Zhang and Wildemuth (2009, p. 3) suggest that "[C]ategories and a coding scheme can be derived from three sources: the data, previous related studies, and theories.". Zhang & Wildemuth (2009) suggest that when there is no theory available, categories must be generated inductively from the data.

## 4.3 Quantitative methodology

This section is related to satisfying the second objective, which is "Establish the favourable outcomes factors, the value for money factors, and the critical success factors of PPPs for the UAE."

In establishing the favourable outcomes factors, the value for money factors, and the critical success factors of PPPs for the UAE, quantitative techniques will be utilized to establish the key success factors for PPPs in the UAE when compared with the model best practice country, the UK, which will be conducted through a quantitative survey in both countries. The quantitative approach will also be used at the end of this research, where a validation process will be conducted on the final model. This is to benefit from the confirmatory characteristics of the quantitative research and is done by allowing the practitioners to test the new framework, where full analysis of their responses will be conducted quantitatively.

“The qualitative paradigm is termed the constructivist, the naturalistic, the interpretive, the post-positivist or post-modern perspective, while the quantitative paradigm is termed the traditional, the positivist, the experimental or the empiricist paradigm” (Lamprecht, 2007, p. 164). The main distinction between the two paradigms is the logic of explanation between data deduction and induction (Gibbs, 2002; Lamprecht, 2007). Qualitative research aims to explain the outcomes of individual cases. Its purpose is to identify “the causes of these specific outcomes for each and every case that falls within the scope of the theory under investigation. By starting with cases and their outcomes and then moving backward toward the causes, qualitative analysts adopt a "causes-of-effects" approach to explanation" (Mahoney & Goertz, 2006, p. 230). In contrast, quantitative research uses the approach of controlled experiments, where the outcomes are only known after the application of the treatment. Therefore, the quantitative paradigm follows the "effect-of-causes" approach (Mahoney & Goertz, 2006). Mahoney and Goertz (2006, p. 230) summarise the difference between qualitative and quantitative approaches by saying "the difference between the causes-of-effects approach, in which the research goal is to explain particular outcomes, and the effects-of-causes approach, in which the research goal is to estimate average effects."

This section covers the quantitative process used for data collection and analysis for this study. This section consists of various segments related to the quantitative methodology. These segments are the sampling process, the development of the questionnaire for data collection, the pilot study, the respondent's information, and the statistical analysis definitions of the techniques that will be used in this study. The site for this research is the United Arab Emirates.

Quantitative survey was used to establish the viability of using PPPs as a procurement method for all types of projects in the UAE, and to identify the variation of the impact of key success factors between the UAE and the comparator country, the United Kingdom. This led to the establishment of the initial PPP framework that is unique to the UAE context, which will be through merging the findings of this survey with the generic framework established in the previous section.

The following three studies helped identify the initial list of PPP critical success factors to support the final selection of the instrument that will be used for the qualitative data collection.

The European Investment Bank commissioned a comparative study in 2011 entitled ‘Study on PPP Legal & Financial Frameworks in the Mediterranean Partner Countries.’ The intention of the study was to promote the prospects for successful PPP implementation in the studied countries. The report included a detailed cross-country assessment of the legal and financial frameworks of the member countries in the Euro-Mediterranean Investment and Partnership Region countries, including Algeria, Egypt, Jordan, Lebanon, Morocco, Syria, Tunisia, and the West Bank, and a comparative assessment of the legal and financial frameworks in the member countries against five good practice comparators: England, France, Mexico, Poland, and South Africa (EIB, 2011). In this report, the comparator countries were selected “on the basis of their successful PPP environment, their unique experience of PPP and/or the lessons learned from their experiences that could inform good practice in less developed markets.” (EIB, 2011). The purpose of the study was to identify the key characteristics of PPP in the comparator countries and to establish the reasons for their success, along with any shortcomings encountered during the implementation. The study revealed seven mean headings for the key factors in these five countries: “funding capacity and availability, institutional issues, the legal and regulatory framework, bidding process, contract design and risk allocation, financial risks and payment terms, and PPP/project finance investment readiness for lenders and investors” (EIB, 2011, p. 6). The authors also conducted a detailed cross-country assessment of the partnership countries according to each of the identified comparator countries’ headings. Finally, the comparator countries and the Mediterranean partnership countries were compared, which led to the identification of the features of a successful PPP framework in relation to the identified key issues. This allowed for the establishment of improvement criteria for the legal and financial frameworks in partner countries based on successful practices and lessons learned in the comparator country.

Another comparative study which will help in the identification of the critical success factors for the generic PPP framework for the UAE, according to local characteristics and context, is the comparative study conducted by Kahyaoğullari (2013) entitled 'Public-Private Partnerships in Developing and Developed Countries: The UK and Turkish Cases.' The rationale for selecting this study was that it focussed on the development level of the country and the PPP policy for implementation. The findings showed there is a difference in the adoption and implementation of PPP concepts between the developed and developing countries, using the UK (a developed country) as the best practice comparator to Kahyaoğullari's native country of Turkey (a developing country). Through an extensive literature appraisal and empirical work comparing the practice between the two countries, the author listed his key findings of the major differences in the adoption and implementation of PPPs between developed and developing countries. These differences were related to "how PPP policy penetrates into the political agenda, with what aims PPP policy is adopted, the sectoral distribution, the form it takes, and the regulatory framework." Therefore, this researcher will ensure that these major differences will be accounted for during the modification of the generic framework to adapt it to the UAE's local context.

For more emphasis on the critical success factors for the establishment of the questionnaire, the study of Cheung et al. (2012) is considered to supplement the previous selections. Cheung et al. (2012) conducted a study to explore the critical success factors for the successful implementation of PPP in China and Hong Kong. The study entitled “A comparative study of critical success factors for public private partnerships (PPP) between Mainland China and the Hong Kong Special Administrative Region” has identified 15 key CSFs that affected the success level of PPP implementation. These 15 factors were grouped under seven categories: “equitable allocation of risks, strong private consortium, judicious government control, transparent and efficient procurement process, project economic viability, adequate legal framework, and available financial market.” These seven categories, in addition to the CSFs that will be used for the designing the questionnaire, will be considered during the factor analysis grouping of the critical success factors, when utilising the Varimax rotation to determine whether the factors are multidimensional and have interrelationships among them.

Esther Cheung (2009) of Queensland University of Technology, in her thesis ‘Developing a Best Practice Framework for Implementing Public Private Partnerships (PPP) in Hong Kong,’ used a large-scale questionnaire with professionals in the fields of PPP and construction. She utilised Li et al.’s (2005) questionnaire for the identification of the critical success factors in Hong Kong and compared them to the findings of Li et al.’s study (2005) in the UK, to establish the unique factors for Hong Kong. Li et al.’s (2005) template is extensively cited and recognised in the PPP industry (Cheung et al. 2009; Chou & Pramudawardhani, 2015; Hwang et al., 2013; Ismail, 2013; Osei-Kyei et al., 2015; Robert et al., 2014), and therefore the decision was made to choose the quantitative method for the identification of the CSFs for PPPs in this research, by employing Li's questionnaire. The original work of Li et al. (2005), who used quantitative techniques for his thesis entitled ‘Risk management of construction public private partnership projects’ helped in guiding this researcher in conducting the quantitative methodology part of this study to satisfy the second objective.

### 4.3.1 Questionnaire design

The format of the interview questions was adapted from relevant sections of the template questionnaire designed by Li et al. (2005). The template consisted of separate segments for testing the attractive factors, value for money factors, and the critical success factors for PPP/PFI projects in the UK. The decision to adapt Li et al.'s (2005) template was based on many considerations. Firstly, this template and its contents are well recognized and cited in the PPP industry (Cheung et al. 2009; Chou & Pramudawardhani, 2015; Hwang et al., 2013; Ismail, 2013; Osei-Kyei et al., 2015; Robert et al., 2014). Secondly, it will save time to use a valuable existing resource rather than trying to invent a new one, which will allow more time to be focussed on the analysis of the findings. Lastly, Li et al.'s (2005) template was derived within the construction industry in the UK, which matches the UAE's construction code.

Li et al.'s (2005) template was designed based on extensive literature review to establish the critical success factors for PPP/PFI in the UK. Each factor was supported by scores of studies. For example, eight critical success factors were imported from the work of Qiao et al. (2001) in BOT projects in China. These eight factors were 'appropriate project identification', 'stable political and economic situation'; 'attractive financial package'; 'acceptable toll/tariff levels'; reasonable risk allocation'; 'selection of suitable subcontractors'; 'management control'; and 'technology transfer.' Then, these factors were cross checked with other studies. For example, reasonable risk allocation, was supported by the work of Grant (1996) and Arthur Andersen and Enterprise LSE (2000). Another example is available financial market, which is supported by the work of Jefferies et al. (2002), McCarthy and Tiong (1991), and Akintoye et al. (2001b). And so on for the other factors. The final list of the eighteen factors were included in a questionnaire survey for a pilot study to identify their significance within the PPP/PFI projects in the UK.

As discussed earlier, the quantitative survey was used to establish the viability of using PPP as a procurement method for all types of projects in the UAE. It was also used to identify the variation of the impact of the key success factors between the UAE and the comparator country, all of which leads to the establishment of the initial PPP framework that is unique to the UAE context by merging the findings of this survey with the generic framework established in the previous section. The selection criteria of participants for the questionnaire considered practitioners from the public and private sectors and researchers in the field of PPP. Experience in the field of PPPs in the UAE, and PFI/PPP in the UK was mandatory. All responses ticking “no” on the experience requirement were eliminated. The managerial role was also required for establishing the sensitivity and strength of responses for analysis reasons.

The questionnaire was conducted in the UAE and the UK to establish the unique considerations for PPP critical success factors for the UAE through a comparative analysis of the responses between the two countries. No less than 150 respondents per group is the general rule of thumb for statistical validity. Ojiako et al. (2012, p. 58) present an example of this requirement by arguing that "if the intention was to analyze the differences in how these individual relationships between cultural variables work based on project roles, with nine project roles emerging in the eventual survey, at a minimum, 1350 (9x150) responses would be required."

The chosen sampling criteria for this segment of the study was convenient sampling criteria. The reason for this selection was that the pool of respondents in the UK was difficult to penetrate and referrals were the only means of reaching qualified respondents. In addition, the pool of respondents to draw from was relatively scarce in the UAE, and the population that the sample was supposed to draw from was unknown, which constricted the minimum requirement for using the random sampling criteria (Ellsberg, Heise, Watts & Garcia-Moreno,, 2005). Therefore, the minimum requirement for the sample size as set by Ojiako et al. (2012) was also unlikely to be achieved under such conditions.The qualified responses from the UAE were 30, and from the UK. 62 qualified responses were obtained.

### 4.3.2 Questionnaire structure

The questionnaire consisted of two parts: general information and research questions (Appendix A, Table A.1). The first part consisted of five questions aimed at identifying the respondents sector, organisational level, years of experience, and experience possessed in the field of PPP/PFI. The second part included the research questions and consisted of three questions adopting the scales from Li et al. (2005). These questions aimed at getting the respondents to rate the three major areas of: the reasons for adopting PPP models (13 item scale), the value for money enhancing factors (16 item scale), and the critical success factors (18 item scale). The questionnaire followed a 1-5 Likert scale to establish the significance of the items of each scale (1 = strongly disagree, and 5 = strongly agree).

The first question identified the background of the respondent for perspective classification purposes. The second through fifth questions identified the respondent's level within the decision making process of the organisation, the years of experience within the field, and the relevance of his/her responses to this research, which will enhance the credibility of the responses.

The sixth question, “The main reasons for adopting PPP models are,” was intended to highlight the projects, from the respondents’ perspective, that can benefit from PPP application. It highlighted the attributes of PPP that the respondents associated with the practice in their respective countries to justify the implementation of PPP. There were thirteen choices (items) of benefits for the respondents to assign the level of importance to, and they were: capacity building, cap service cost, cost and time control, economic growth, lack of governmental resources and experience, large size of projects, long-term engagement, private sector’s funds, private sector’s skills and experience, risk transfer to private party, stimulation of financial market, technology transfer, and value for money.

The seventh question, ‘The achievement of value for money (VFM) is enhanced by’, was intended to get perspectives of the respondents on how they perceive the significance of value for money in the practice of PPPs and which attributes they consider as most significant in achieving the value for money criteria. The respondents assigned the level of importance to the following factors: clear output specification, competitive bid process, early service delivery, efficient dispute resolutions, reduced negative environmental impact, appropriate capital structure, improved facilities to the users, optimised risk allocation, improved services to the community, incentives for private party, long-term engagement, low life-cycle cost, low tariffs, optimisation of assets efficiency, private sector's project management skills, and technical innovation.

The eighth question, ‘The key success factors for PPPs implementation are,’ was to identify the critical factors for the successful implementation of PPPs. These critical factors, when contrasted between the UAE and the UK's respondents through comparative analysis, highlighted the key differences on how the respondents from the UAE and the UK perceive their impact on the success of PPP projects within their respective contexts. Such differences allowed this researcher to move closer to the PPP framework for the UAE. The respondents were asked to assign the level of agreement to the importance of 18 factors. The factors were transparent procurement process, competitive procurement process, good governance, well-organized and committed public agency, social support, shared authority between the public and private sector, detailed cost/ benefits assessment, project technical feasibility, appropriate risk allocation, commitment of public/private sectors, strong private consortium, favourable legal framework, government guarantees, multi-benefit objectives, political support, macro-economic conditions, sound economic policy, local financial market.

For comparison purposes, the two groups of respondents from the UAE and the UK will be contrasted. The Kendall's coefficient of concordance, within the SPSS program, will be utilised to measure the agreement of the two groups on the agreement of significance on the critical success factors of PPPs in their respective territory. This will allow for the establishment of the degree of consensus on each factor within each group of respondents and therefore will help establish the UAE's unique success factors.

### 4.3.3 Pilot study

The questionnaire was tested on select respondents prior to sending it to the full selection of respondents in the UAE and the UK. This was necessary for checking the accuracy of items included in the scales, evaluating their relationship to the objectives of the study, taking into consideration any unaccounted for information, and making sure that the meaning was clear and no unambiguous terms could affect the responses of participants. Regarding the sample in the UAE, a pilot study was conducted with local

PPP practitioners; the sample consisted of 6 participants who were all from the private sector.

The criterion for the respondents' experience was to have more than five years of experience, as this is equivalent to the minimum qualifications for becoming a professional project manager at the Project Management Institute, based on a high school diploma or higher degrees (PMI, 2015). The requirements at the Association for Project Management is a minimum of 3 years for a practitioner qualification (APM, 2015). So to have more than five years of experience is considered sufficient for this study.

For each question, a comment box was offered so that participants could add or request any information or modifications. All of the comments were incorporated, most of which were related to using simpler terminology, as the local practitioners are relatively new to PPP practice. The UK pilot study consisted of 21 participants who were from all disciplines required in the survey: public and private practitioners and researchers. There were no significant modifications requested by the participants in the provided comment boxes, and therefore the full data collection processes was completed. Both pilot samples were later merged with the larger sample collection.

### 4.3.4 Statistical analysis definitions

#### *4.3.4.1 Mean score ranking*

Cheung (2009) adopted the mean score technique to measure the mean score of each critical success factor for PPP implementation. This method enabled Cheung (2009) to establish the ranking of the importance of each factor, which made it possible to triangulate such rankings from samples of respondents from Hong Kong, Australia, and the UK. This researcher is intending to use the same technique to establish the relative importance of the CSFs to the UAE as compared to the UK, where parts of Li et al.'s (2005) template was used for designing the survey. Li et al. (2005) used the following formula for calculating the mean:

$$Mean=\frac{\sum_{i=1}^{5} iN_i}{\sum_{i=1}^{5} N_i}$$

Where *N* represents the number of respondents who replied to each Likert scale; "Strongly Disagree =1 to "Strongly Agree =5. Regarding the rating score, this researcher is interested in what defines a factor as being a critical one, as the final work will only focus on the critical success factors for developing the PPP framework for the UAE. Therefore, any mean score above 3, "Neither agree nor disagree" will be considered for further analysis.

#### *4.3.4.2 Kendall's coefficient of concordance*

For the purpose of comparison, the two groups of respondents from the UAE and the UK will be contrasted. The Kendall's coefficient of concordance (KCC) within the SPSS program was utilised to measure the agreement of the two groups on the assignment of significance to the factors of PPPs in their respective territory. Kendall's coefficient of concordance (represented by W) is calculated by the formulas offered by Kendall and Smith (1939) as cited by Verner and Tvrdon (2012) as follows:

$$R_i = \sum_{j=1}^{m} r_{i,j}$$

*Ri* is the row sum of ranks, *r* is rank, *i* is country, and *j* is rank number.

$$R=\frac{1}{2}m(n+1)$$

$R$ is the sum of mean values of all ranks, $m$ is the number of countries, and $n$ is the number of variables.

$$S = \sum_{i=1}^{n} (R_i - R)^2$$

$S$ is the sum of squared deviations.

$$W = \frac{12S}{m^2 \, (n^3 - 1)}$$

$W$ is the Kendall's coefficient of concordance.

As per the Kendall's utilisation requirements, the survey complies with the minimum number of variables. This allows for the establishment of the degree of consensus on each factor within each group of respondents and consensus between both groups, which indicates the validity of the questionnaires and the rankings of the critical success factors therein. The value of the calculated Chi square will be checked against the critical Chi square value according to the degree of freedom (Appendix A, Table A-2).

#### *4.3.4.3 Reliability test*

In order to examine the reliability of the factors, a reliability test will be utilised. Cronbach's alpha is a measure of internal consistency, that is, “how closely related a set of items [is] as a group” (IDRE, 2012). The minimum acceptable cut-off point is 0.70. This will determine the need to delete any item to improve the value of alpha to insure the inter-consistency (homogeneity) among each scale and its remaining factors (Brace, Kemp & Snelgar, 2012).

Alpha can be calculated as per the following formula offered by Devellis (2011):

$$\propto = \frac{k}{k-1} \, (1 - \frac{\sum \sigma_i^2}{\sigma_{y_i}^2})$$

This is where $k$ is the number of items, $\sigma_i^2$ is the sum of the variances of the individual variables, and $\sigma_{y_i}^2$ is the variance of component *i* of the current scale persons.

#### *4.3.4.4 Factor analysis*

A factor analysis, the Varimax rotation, will be utilised to determine whether the factors are multidimensional and to check the interrelationship among all factors. Factor analysis is a data reduction tool used to identify a smaller set of factors to represent the correlated sets of variables. The criteria that will be followed to arrive at a meaningful factor analysis are: the cut-off point of loading of any item on a factor must be 0.50 or greater, and, any item loading above 0.5 on any factor must have a low cross loading on the remaining factors (Brace et al., 2012).

Taylor (2001) offered the following linear equation for factor analysis:

$$X_n = a_{n1}F_1 + a_{n2}F_2 + a_{n3}F_3 + \dots + a_{nm}F_m + a_nU_n$$

This is where *X* is the variable, *F* is the factor, *U* is the unique factors, and *a* is the coefficient of variables in the regression equation.

For the estimation of the factor scores, Taylor (2001) offered the following equation:

$$F_m = b_{m1}X_1 + b_{m2}X_2 + \dots + b_{mn}X_n$$

In this equation, b is the factor score coefficient.

#### *4.3.4.5 Kaiser-Meyer-Olkin (KMO)*

Prior to conducting the factor analysis, the respondents' data must be checked for suitability. This can be done through several tests, such as the Kaiser-Meyer-Olkin

(KMO) test and Bartlett's test of spherisity. KMO measures the amount of variance that can be explained by the factors within data.

The KMO is measured by comparing the sum of the squared correlations of two variables by the sum of the squared partial correlations of the same variables as illustrated in the following equation:

$$\text{KMO} = \frac{\sum\sum r_{jk}^2}{\sum\sum r_{jk}^2 + \sum\sum p_{jk}^2},\ j \neq k$$

This is where r is the correlation coefficient between variables j and k, and p is the partial correlation coefficient of the same variables. The value of KMO indicates if one should proceed with factor analysis. The KMO index ranges from 0 to 1. A KMO of below 0.5 is considered not factorable, whereas if the figure is above 0.5 it will be considered suitable for factor analysis (Brace et al., 2012; Kaiser, 1981; Williams et al., 2012).

#### *4.3.4.6 Bartlett's test of spherisity*

Bartlett's test is used to indicate if the data is factorable. It checks for the significance of diversion of the observed correlation matrix from the identity matrix. The calculations are based on the calculated determinant of the correlation matrix $|R|$. Bartlett (1950) offered the following equation for calculating the deviation from the reference point:

$$x^2 = -\left(n - \frac{1}{6}\,(2p+5)\right) log_e |R|$$

This is where n = instances and p = variables. If Bartlett's test of sphericity is large and the significance is small ( $< .05$), it will be unlikely that the correlation is an identity matrix.

## 4.4 Qualitative methodology

This section is related to satisfying the third objective of this research, which is to" Identify the success factors and commercial viability of a research reactor, with particular focus on the UAE."

The decision to use the qualitative method for the third objective ‘Identify the success factors and commercial viability of a research reactor, with particular focus on the UAE’ was due to the scarcity of data available on any research reactor projects that have been developed through the PPP mechanism. The choice of qualitative method was supported by the exploratory study conducted on PPP projects in the UAE by Dulaimi et al. (2010, p. 395), where the authors of that study stressed that “a qualitative approach is more appropriate where there is limited or restricted research on the topic as is the case with PPP in the UAE.”

Various techniques can be employed by the qualitative method for data collection and analysis. Phenomenology, ethnography, and Grounded theory are the main methods used in qualitative research (Lamprecht, 2007). This researcher used the Grounded theory, as it is the most suitable approach for achieving the CSFs objective for research reactors as detailed earlier.

Grounded theory originates from the symbolic interactionism of sociology, which advocates that meanings are extracted and understood through the interaction with others within social processes. Such processes have codes of conduct and procedures that define how interactions shape the meaning that is extracted from these processes. Grounded theory develops explanatory theories of social process within a specified context. “Grounded theory examines the ‘six Cs’ of social processes: causes, contexts, contingencies, consequences, covariances, and conditions, to understand the patterns and relationships among these elements.” (Starks & Trinidad, 2007; Strauss & Corbin, 1998).

Grounded theory methodology has become one of the leading approaches in recent qualitative studies. Not only is it valuable when there is little data or practices to draw from, as is the case in the UAE, but also it “offers a powerful methodological framework if the aim of the study is to learn about individuals’ perceptions” (Gorra, 2007). Such features were needed in the third phase of this research, which employed the Grounded theory for the identification of success factors for research reactors. Such factors were drawn from the purposive sample of subjects through interviews.

The work of Boadu (2013), who used the Grounded theory techniques to guide his investigation into the ethical dimensions of corporate governance practice in Ghanaian public sector and private enterprises, assisted in the systematic utilisation of the Grounded theory in this study.

The following provides an overview of the qualitative methodology used for data collection and analysis for the establishment of the critical success factors for research reactors, which is the final step in the development of the PPP framework. The instrument used was grounded theory for data collection and analysis of the in-depth semi-structured interviews. The following sections will detail the instruments used, interview structure, and the grounded theory process. First, a questionnaire that guided the design of the interview questions will be presented. Next, the in-depth semi-structured interviews will be discussed. Last, the grounded theory and all its steps - open, axial, selective coding, and substantive theory - will be presented.

### 4.4.1 Q*UESTIONNAIRES*

A questionnaire was used to guide the formation of the semi-structured interview questions since the questions for grounded theory cannot be based on previous theoretical scales. Therefore, there was a need for a starting point for developing the interview questions, which could be refined at a later stage according to the findings and the need for further theoretical sampling. The initial set of questions that was developed for the semi-structured interviews was put in the format of a survey to get responses from a purposive sample of participants (Appendix D, Table D-1). The sampling criteria for the survey was based on locating participants from the research reactor industry with varying experience in all disciplines of that industry. This researcher participated in a workshop organized by IAEA entitled "Training Workshop on Specific Considerations and Milestones for Research Reactors Project." The attendees of the workshop were representatives of all countries wishing to establish or improve their research reactor projects. With the consent of IAEA's representative, this researcher administered a survey where 15 participants returned completed questionnaires.

All ethical considerations were implemented. The participants were provided with a cover letter that explained the objectives of the questionnaire and the uses of the findings (Appendix D, Table D-2). Anonymity was guaranteed and options for further participation in other parts of the study were offered. Acknowledgement for participation was also offered for those wishing to contribute further to the study. The questionnaire consisted of two parts (Appendix D, Table D-1). The first part consisted of nine questions with multiple choices in the form of five Likert scale ranging from strongly agree to strongly disagree and focused on issues related to research reactors as identified from the literature review. The second part consisted of two segments; the first segment consisted of nine questions with multiple choices in the form of five Likert scale type ranging from essential to of little importance and focused on the critical success factors for research reactors. The second segment consisted of two open-ended questions to allow the participants to elaborate further.

The analysis of the collected questionnaires proved their value in the finalization of the interview questions. It confirmed the content of most questions therein and prompted the refinement of others. It also highlighted the importance of other issues not covered in the questionnaire and were added later to the semi-structured questions for the qualitative interview.

### 4.4.2 Semi-structured interviews

#### *4.4.2.1 Interview design*

Semi-structured questions were selected for data extraction because of the established value of such instruments in allowing the researcher to comprehensively study the phenomena and to reflect and identify new areas for expanded study based on the responses gathered from the subjects.

#### *4.4.2.2 Interview content analysis*

The grounded theory approach is a complex one whose objectives are achieved through practice. Such practice involves continual data collection and analysis through three coding stages: open coding, axial coding, and selective coding; through these the linkage between all elements is identified and subsequently leads to the construction of the theory. The emphasis in this section is on the tools used for conducting these steps.

The most widely used software in qualitative data analysis is NVIVO. This software is of particular importance to grounded theory, as the key functions of NVIVO allow for the open coding, axial coding, and hyperlinks to other forms of data such as audio, video, photographs. The software program was developed to encourage researchers to collect data and analyse it simultaneously, not to wait until all data is collected. It also allows the researcher to text search all data and any ideas and memos linked to it. Moreover, it enables the access to original data and the build-up of concepts. Another advantage of using NVIVO is that it transforms the way data is viewed, as it allows, through a dynamic view rather than typical static view, the visibility of the relationships between the categories leading to the build-up of the theory. One thing to clarify is that NVIVO does not offer any analysis; it is simply a piece of software that organizes data and to maximize the efficiency of data collection and analysis (Bringer, Johnston & Brackenridge, 2006; Hijaz, Al-Hujran, Debei & Abu-Khajil, 2015; Hutchison, Johnston & Breckon, 2010; Odena, 2013; Walther, Kellam, Sochacka & Radcliffe, 2011)

In grounded theory, data collection and analysis are inter-related. The theory develops through the constant comparison of the constructed elements of theory and the new sets of data collected in response to identified gaps in existing data. Such comparison is continued until the new data confirms the previous findings or until no further themes or relationships emerge from the new data, leading the research to reach a state of theoretical saturation; a point at which a formal theory can be proposed (Gasson, 2004; Urquhart & Fernández, 2013).

The qualitative investigation was used for the identification of the key success factors for research reactor investments. The findings of this investigation are then merged with the initial PPP framework for the UAE that was completed in the quantitative survey analysis section.

The instrument for data collection for this qualitative investigation was semi-structured interviews with identifiable experts in the field of research reactors. The selection criteria focussed on individuals who are in senior positions in research reactor projects within the leading countries in this industry. Therefore, the technique used for the initial identification of the subjects was purposive sampling. Snowball sampling also was used for the interviews due to the limited number of subjects identified since PPP practice in RR is relatively new. Therefore, this researcher sought referrals to other subjects that the initial subjects identified during the interviews.

All ethical considerations were observed. Total anonymity of the subjects was guaranteed at all times except for those who wished for their names to be acknowledged in the dissertation. Detailed letters of approval were sent to the identified subjects. The letter included information about the objectives of the research, what is exactly needed from the subjects, conduct for interviews, confidentiality, etc. (see Appendix D, Table D-3). Then, once the invited persons replied with their acceptance to participate, further emails were exchanged to assign a date and a favourable time for the interview. The interviews were conducted in three different styles: person to person interviews, Skype, or telephone conversations. All interviews were transcribed within five days and returned to the interviewee for final approval. The interviewees were clearly asked if they wished for anonymity or to be acknowledged in the thesis.

The total number of conducted interviews was ten interviews. This figure is assumed to be sufficient to render the research viable. It was clear that trying to interview nuclear scientists was not going to be an easy task for various reasons. First, there was reluctance to be involved in the research due the sensitivity of the industry and the security issues related to exchanging information. Second, some participants requested the researcher to obtain a clearance from the employer to participate in the study, which was not feasible at all. Lastly, there were issues related to interviewing tools, where interviewees had concerns about being recorded or showed concerns about voice spams if called by phone, which in their view could pose threats to their nuclear facilities. Some participants withdrew from the study after furnishing the full requirements, while others modified their transcripts; still others wished for their contributions to be anonymous.

Most studies conducted through the grounded theory approach, as highlighted by Mason (2010), start with a minimum number of interviews and then follow them by a second round of interviews based on gaps found in data. To establish the sample size for research reactors' specialists, for the semi-structured interviews, the work by Lincoln and Guba (1985), and Holsti (1969) is considered, which established the minimum number of interviews to be “a dozen or so interviews, if properly selected, will exhaust most available information” (Lincoln & Guba, 1985, p. 235). Additionally, if the sample size for interviews is “to include as many as twenty will surely reach well beyond the point of redundancy” (Lincoln & Guba, 1985, p. 235). Unless a saturation of research is experienced as prescribed by the grounded theory approach, further interviews will be conducted as necessary until reaching such saturation for the identification of the CSFs for RRs. Only then can a theory can be presented to complement the established generic framework from the previous quantitative section for the UAE, which concludes this research. Fortunately, given the hardship faced in the pursuit of finding participants, saturation was present from the beginning and around the sixth interview the data analysis began to indicate repetitive patterns and no new themes were found. Therefore, ten interviews were deemed sufficient for this study.

The interview questions are emergent as the interviews progress. Unlike other qualitative approaches, the grounded theory instrument does not follow a pre-defined structure for the questions, as that would contaminate the emerging theory (Hernandez, 2008). The researcher starts with open-ended questions related to a certain phenomenon, and modifies them according to the outcome of the interviews. "Grounded theory questions are emergent during the interviews as participants tell their stories, or during the subsequent analysis of this participant data" (Hernandez, 2008, p. 14). Therefore, the bottom line is to come up with the best open-ended question that would guide the formation of the semi-structured question, to generate the data required for the analysis and further refinement of the questions.

The semi-structured questions were aimed at collecting data from experts on the factors affecting the success of a research reactor project. The results of the questionnaire informed the foundation of interview questions. The intention was the collection of the maximum amount information possible related to the success of research reactor projects and investing in them as well so that a connection can be established for developing a PPP framework for RR in the UAE (Appendix D, Table D-4).

The first question “Tell me about the future prospects of research reactors?” is intended to establish the significance, in the view of the interviewee, of the contribution of research reactors to the future, which will highlight the importance of adopting RR projects. The future of research reactors is being changed by a new set of requirements, in addition to technological developments, that may pose threat to their existence. Such factors include the transition from HEU to non-HEU options, especially for the production of medical isotopes. However, "specific scientific and technical obstacles, substantial economic, political, and security issues are inhibiting the transition to non-HEU–based options" (Pillai et al., 2013, p. 321). It was therefore warranted to start the semi-structured interviews by first checking on the opinion of the interviewee and if he is interested in new research reactors, or he prefers focussing on developing the new alternatives and overcoming the associated obstacles. The outcome of this question is expected to guide the data collection of the next questions.

The second question ‘What are the strengths and weaknesses of research reactors?’ will allow for understanding the key issues related to developing research reactors, such as decommissioning costs, high security risks, radiation, and other relate issues. Lamprecht (2007), in developing his PPP model in the pharmaceutical sector in South Africa, utilised the grounded theory approach, where the key question centred on themes including ‘Strengths and weaknesses of the different sectors under research’. Therefore, this question was used, which will allow for the identification of the intervening risks that could influence the successful operation of a research reactor project.

The third question ‘Would you like to elaborate on the justification for building a research reactor?’ is intended to highlight key issues for consideration when studying the feasibility of research reactors. IAEA (2012) clarifies that "[A] research reactor project can take many forms. The type, size, power and cost of the research reactor designs and its ancillary facilities should be matched to the needs of the potential stakeholders and to the financial resources that are available". This could identify the actions that will be required to make the research reactor projects more successful.

The fourth question, ‘What are the success factors for RRs in your opinion?’ is the most important question as it will provide information for satisfying the first part of the third objective, ‘Identify the success factors and commercial viability of a research reactor, with particular focus on the UAE. Cheung (2009), in identifying the benefits, difficulties and critical success factors of PPPs in Hong Kong, asked ‘what do you think are the critical success factors leading to successful PPP projects?' to draw data from the interviews for her grounded theory analysis. Furthermore, Akhavan, Jafari and Fathian (2006) asked the question 'What are the critical success factors of KM program for a company?' to guide their identification of the critical success factors of knowledge management systems. The interviewees will be asked about the success factors they deem critical from their experience, and they will later be presented with the key success factors that were identified in the literature review section to get their opinion. These CSF's are: stakeholders, life-cycle funding and financing, waste management, site and material security, industrial involvement, human resources, environment, radiation protection, and utilisation.

The fifth question 'What makes a research reactor commercially viable for investors?' is another important question that is expected to provide information for analysis to satisfy the second segment of the third objective 'Identify the success factors and commercial viability of a research reactor, with particular focus on the UAE'. This is expected to provide information on what will attract investors through the PPP mechanism to develop a research reactor project or to make them financially involved from the initial stages of the project. IAEA (2001) offers the following questions to guide the establishment of the commercial viability of the RR project: 'Are there areas of potential commercialization that you should develop?' and 'Do you have a feeling for the commercial viability of new products or services?' IAEA (2001) further stated 'The evaluation of these abilities should enable a determination as to whether or not the facility should attempt to enter into a competitive market with respect to certain commercial products or services.'

The sixth question 'Any particular issues for consideration when developing RR in the UAE?' is intended to collect general information related to the issues that are expected to be encountered by the RR project in the UAE so that such unique issues will be considered in the analysis to check their significance to the UAE. The analysis of this question will play a significant role in identifying the contextual factors for the identification of the grounded theory as they are the ones that arise from unforeseen circumstances (Strauss & Corbin, 1998).

The last question 'Any other comments you want to add regarding investing into research reactors?' is a generic question that is always asked at the end of any interview to conclude the interview session, where the interviewee will be allowed to further comment or suggest any ideas and to add any point he/she deems necessary that was not covered in the previous questions.

### 4.4.3 Grounded theory

There are various techniques that qualitative research can employ, such as pattern searching, coding, and data linking. However, there is no consensus on the best techniques to employ, as there is variation, for example, on how much coding or data linking process may be used. The main methods in qualitative research are phenomenology, ethnography, and grounded theory (Lamprecht, 2007; Urquhart & Fernández, 2013).

This research will employ the grounded theory, and therefore this literature review will focus on the philosophy of the grounded theory. Over the past four decades, Glaser and Strauss have developed the grounded theory to a stage where it has become one of the most used theories in social science research (Lamprecht, 2007). They have consistently advocated the inductive discovery nature of theory grounded in data.

Grounded theory focuses on an area of study and gathers data from various sources mostly from, but not limited to, interviews and field observations, which are analysed by using coding and theoretical sampling techniques. Once this is done, theories are generated, reported, and presented using interpretive procedures. Gasson (2004, p. 80) describes the grounded theory approach (Glaser & Strauss, 1967; Glaser, 1978, 1992; Strauss, 1987; Strauss & Corbin, 1998) as one that "is designed to develop and integrate a set of ideas and hypotheses in an integrated theory that accounts for behaviour in any substantive area". Gasson (2004, p. 80)) further attributed the uniqueness of the grounded theory approach to two elements:

1. Theory is based upon patterns found in empirical data, not from inferences, prejudices, or the association of ideas.

2. There is constant comparison between emergent theory (codes and constructs) and new data. Constant comparison confirms that theoretical constructs are found across and between data samples, driving the collection of additional data until the researcher feels that the point of diminishing returns from any new analysis has been reached. (Strauss & Corbin, 1998; Gasson, 2004; Urquhart & Fernández, 2013).

The grounded theory is a complex approach that is ultimately learned through practice. There are three coding stages - open, axial, and selective coding - that shape the linkage between elements that emerge from data to eventually construct the theories (Gasson, 2004).

#### *4.4.3.1 Open coding*

Data coding is the process of classifying the data elements into categories or themes and looking for any patterns that link them, such as association, commonalities, or causality. The process of the initial, vague understanding of linking categories is called open coding. Open coding is the process of breaking down the data into discrete parts to allow for comparison and analysis of the data to search for themes or attributes that can be linked to each set of data. Open coding follows the first step of data organisation, which is the creation of nodes for the categorization of data.

Glaser (1978) offers three questions for generating open codes: “What is the data a study of? What category does the incident indicate? What is happening in the data?” Open coding is the first step in theoretical analysis, where categories and attributes of data are captured to enable the next stage of theoretical analysis, which is axial coding.

#### *4.4.3.2 Axial coding*

Axial coding is the process of finding the emerging relationship or relationships between the elements of data that are coded already through the open coding process. A substantive theory emerges through searching for any similar or different patterns in the relationships between the categories and their sub categories and between the categories and their properties. Axial coding should focus on elements such as subject interactions, tactics, consequences, and antecedent conditions. Strauss and Corbin (1998, p. 127) argue that “by answering the questions of who, when, where, why, how, and with what consequences, analysts are able to relate structure with process." Furthermore, Gasson (2004, p. 83) cited Glaser’s (1978) suggestions to apply the six C’s for the coding process: “causes, contexts, contingencies, consequences, covariances and conditions.”

#### *4.4.3.3 Theoretical memos*

Theoretical memos are the theorizing process about identified codes and their established relationships as they progress while analysing the codes. They “reflect emerging ideas concerning the relationship between data categories, new categories and properties of these categories, cross-category insights into the process, mention of relevant examples from the literature and many other reflections. They provide a way to capture those insights that we want to explore further and should be treated as a resource, triggering further constant comparison" (Gasson, 2004, p. 83). Glaser (1978) suggests, as cited by Gasson (2004), that the researcher should always suspend coding to memo and record any idea that becomes apparent to him.

#### *4.4.3.4 Selective coding*

The process of refining and integrating categories to relate them to core categories in order to become the basis for the emerging grounded theory is called selective coding. The analysis process of grounded theory involves a single core category at a time. A core category is a category which lies in the core of the theory under development and explains significantly the variation in the patterns of behaviour (Gasson, 2004). There is a significant overlap with axial coding, however, in the selective coding there is more emphasis on the relationship of the core category to the other categories. Once this relationship is identified, a theory will start to emerge in the data prompting further detailed interviewing for further analysis and comparison for confirmation (Hallberg, 2006; Strauss & Corbin, 1998; Urquhart, Lehmann & Myers, 2010).

#### *4.4.3.5 Constant analysis and comparison*

To the contrary of conventional pre-designed research, data acquisition and analysis are interrelated. The researcher collects the corresponding data, codes it, analyses it, and then decides on the next step of data collection and where to obtain it from to enable the emergence of the theory (Gasson, 2004; Strauss & Corbin, 1998).

The theory is developed through the constant comparison of the theoretical constructs and the new sets of data. Such comparison sits at the core of the grounded theory concept, and it establishes the rigor level of the grounded theory against guesswork of inductive approaches. The researcher must check continuously if the analysis of new data is providing similar categories or themes or if new patterns are emerging. The theory closure is informed by reaching the state of theoretical saturation, which is the situation when no new themes, categories, or relationships emerge, and also, when the new data confirms the previous findings. It is therefore, at this point, possible to arrive at a formal theory (Gasson, 2004; Strauss & Corbin, 1998).

#### *4.4.3.6 Substantive to formal theory*

Substantive theory is differentiated from formal theory by the state of being generated through empirical work. Formal theory, on the other hand, is generated through conceptual or theoretical research. A substantive theory is an emergent theory, where the researcher indulges in the analysis of the relevant data, rather than following a predetermined research design, which enables him the development of original theories related to human behaviour. However, the ultimate objective of the grounded theory is to generate a generalizable formal theory or theories. Only sufficient data can help a formal theory to emerge, as the researcher might be describing a case in a single situation (Gasson, 2004; Strauss & Corbin, 1998). Therefore, the process of analysis in grounded theory goes through the following sequence:

an open coding of data to axial coding through the identification of core categories of the data, through the use of theoretical memos to capture insights on how categories are related, to the analysis of "networks" of interactions between categories (and their properties), to the construction of substantive theory, through a rigorous analysis of how core categories (and network models) fit with new data (Gasson, 2004).

### 4.4.4 Criticisms of grounded theory

Researchers who are using grounded theory approach encounter difficulties with their peers in the field since the theory is outside the traditional research paradigms. Most of the criticism stems from the differences related to the application of the deductive and inductive enquiry. The grounded theory through the inductive enquiry generates new meanings and theories and requires researchers to approach the problem from the participant's perspective, whereas traditional research utilizes the deductive inquiry to prove or disapprove existing theory, requiring the researcher to approach the problem from the extant literature (Elliott & Higgins, 2012). However, the criticism of inductive techniques is not justified, as inductive tools form the foundation of the majority of techniques that employ coding in qualitative research, such as qualitative case studies analysis (Gasson, 2004). The reason for the bias against inductive analysis is because of the subjectivity it brings to research and therefore the findings are prone to be challenged. Gasson, (2004) cited Strauss and Corbin, (1998) as saying:

We are deducing what is going on based on data but also based on our reading of that data along with our assumptions about the nature of life, the literature that we carry in our heads, and the discussion that we have with colleagues. (This is how science is born). In fact, there is interplay between induction and deduction (as in all science). … This is why we feel that it is important that the analyst validate his or her interpretations through constantly comparing one piece of data to another.

## 4.5 Conclusions

Chapter 4 presented and justified the research approach and methodology used in this research. The types of research paradigms, the development of the mixed method approach that was chosen for this study, and the types of mixed method approach were presented. The reason for this selection was substantiated from literature. The best practices that were identified to add value to this study and to be considered for the content analysis for the formation of the generic PPP framework included The World Bank Institute (WBI), The European PPP Expertise Centre (EPEC), the Asian Development Bank (ADB), and The Economic and Social Commission for Asia and the Pacific (UNESCAP).

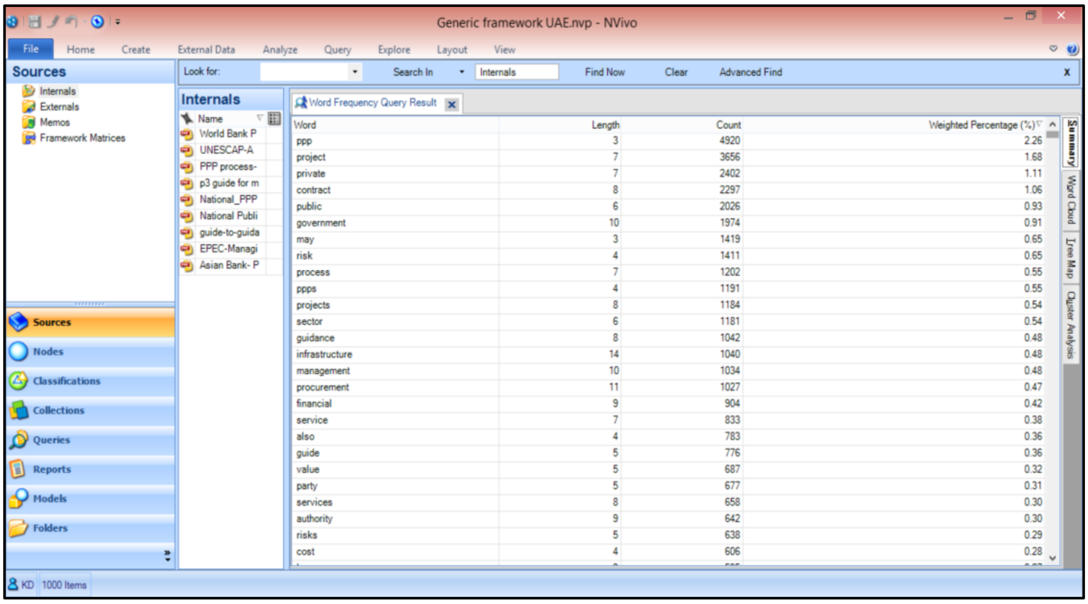
Quantitative survey was identified and chosen as the best method to study the second objective, establishing the favourable outcomes factors, the value for money factors, and the critical success factors of PPPs for the UAE, and Li et al.'s template (2005) was utilised for its significant value as reported in the literature. The full methodology was presented in this section including questionnaire design, questionnaire structure, and the statistical analysis definitions. The last segment of the methodology chapter was related to the third objective, identify the success factors and commercial viability of a research reactor, with particular focus on the UAE, and the grounded theory was selected for the data collection and analysis to achieve this objective. The full qualitative methodology was reported including the pilot questionnaire, the design of the semi-structured interview questions, and the detailed steps for conducting the coding steps.

# 5. RESEARCH ANALYSIS AND RESULTS

## 5.1 The qualitative content analysis process

This research, accordingly, employed common codes and coding categories from the imported best practices to guide the preliminary categories and the coding scheme to enable the content analysis between the best practices. This approach, as offered by Zhang and Wildemuth (2009), is also supported by Miles & Huberman (1985, 1994). Zhang and Wildemuth (2009, p. 4) stipulate that "[T]he adoption of coding schemes developed in previous studies has the advantage of supporting the accumulation and comparison of research findings across multiple studies."

A sample of data was coded and tested early in the process as suggested by Zhang and Wildemuth (2009) to validate the coding scheme. The level of consistency was satisfactory, and therefore the full text of the best practices was coded accordingly. Then, the next step was to check for the most widely used vocabulary in all of these documents to guide the identification process of the key terminology in the PPP oractice. Through the word frequency function in NVIVO, a list of frequently occurring words was established (Figure 3) (Johnston, 2006; Hutchison et al., 2010; Odena, 2013; Walther et al., 2011).




| Word | Length | Count | Weighted Percentage (%) |
|---|---|---|---|
| ppp | 3 | 4920 | 2.26 |
| project | 7 | 3656 | 1.68 |
| private | 7 | 2402 | 1.11 |
| contract | 8 | 2297 | 1.06 |
| public | 6 | 2026 | 0.93 |
| government | 10 | 1974 | 0.91 |
| may | 3 | 1419 | 0.65 |
| risk | 4 | 1411 | 0.65 |
| process | 7 | 1202 | 0.55 |
| ppps | 4 | 1191 | 0.55 |
| projects | 8 | 1184 | 0.54 |
| sector | 6 | 1181 | 0.54 |
| guidance | 8 | 1042 | 0.48 |
| infrastructure | 14 | 1040 | 0.48 |
| management | 10 | 1034 | 0.48 |
| procurement | 11 | 1027 | 0.47 |
| financial | 9 | 904 | 0.42 |
| service | 7 | 833 | 0.38 |
| also | 4 | 783 | 0.36 |
| guide | 5 | 776 | 0.36 |
| value | 5 | 687 | 0.32 |
| party | 5 | 677 | 0.31 |
| services | 8 | 658 | 0.30 |
| authority | 9 | 642 | 0.30 |
| risks | 5 | 638 | 0.29 |
| cost | 4 | 606 | 0.28 |

**Figure 3: Frequently occurring words in the best practices chosen**

The next step was to focus on a single terminology and search for associations between the identified terminology and the best practice PPPs (Figure 4). For example, project scoping was established through the literature review to be the first action in the PPP process. Therefore, a text search function through the NVIVO software was initiated where all activities and concepts related to "scope" were generated through the word tree model. This enabled the establishment of the underlying criteria for PPP project scoping process. The same process was followed for all major terminologies according to their significance as identified by the word count table (Andrew, Salamonson & Halcomb, 2008; Johnston, 2006)

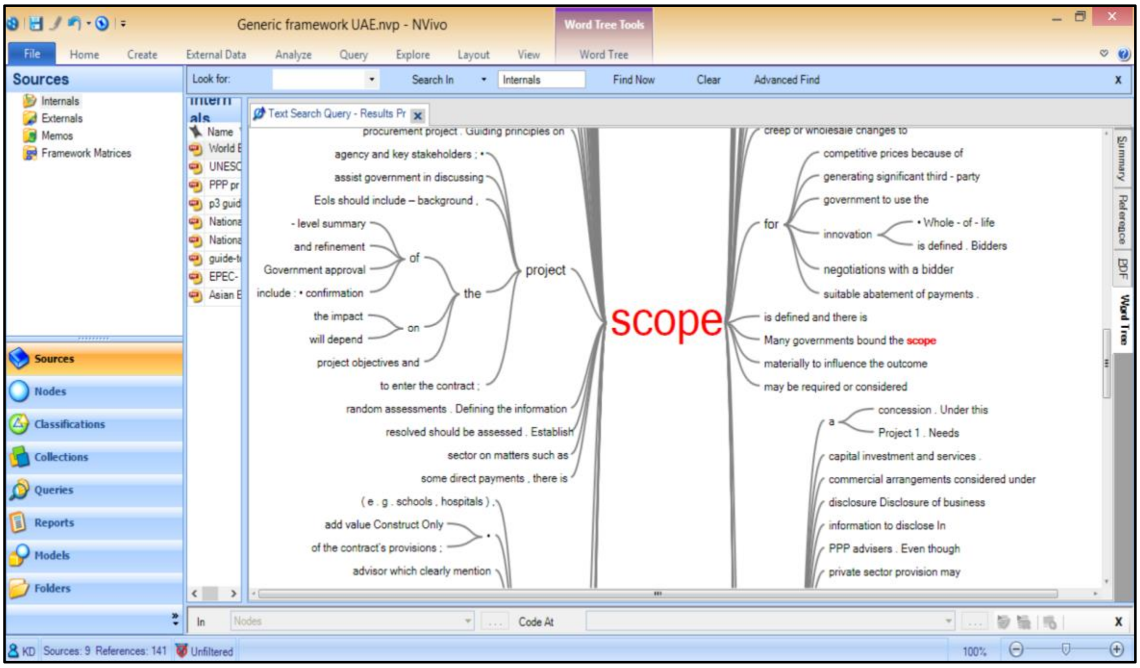


**Figure 4: Example of NVIVO text search function**

The initial identification of the main items in PPP practice from the best practices yielded 80 items (Table 1). These items were found to be present in most of the best practices compared. Some of them were merged into one item in this study. These items were taken without any consideration to linkage or sequence solely for the purpose of segregation. They will be merged within a higher group, and their relationships to other activities will be established later in this chapter (Charmaz, 2011; Eaves, 2001).

**Table 1: Item identification of basic concepts in PPP practice**

- Approval procedures
- Bid template
- Capabilities based allocation
- Capacity Building
- Commercial viability study
- Commercial, legal, & political risks
- Competitive negotiations
- Conditions precedent
- Contract management
- Contract type role
- Deadline default consequences
- Delivery of output specifications criteria
- Development procedures
- Dispute resolution measure
- Disputes
- Early termination terms
- Economic & commercial viabilities
- Economic viability studies
- Environmental and social impact studies
- Equity - debt financing
- Evaluation categories
- Evaluation criteria
- Final negotiations roles
- Financial & technical mixed approach
- Financial considerations
- Financing
- Guarantees for delivery
- Handover terms
- Initial project screening
- Inputs monitoring
- Institutional Responsibility
- Institutions role
- Investors remunerations
- Laws & regulations for PPP control
- Legal feasibility
- Maximize project outcome
- Multi-stage bid process
- Output performance indicators
- Party bearing risk consequences
- Pass - fail method
- Pay-back based completion
- Performance indicators
- Performance specs in contract
- Post-bid negotiations
- PPP company duties
- PPP Process
- PPP related risks
- PPP Unit
- Pre-qualification documentations
- Prioritization
- Private party responsibilities
- Project & financing contracts close
- Project-corporate financing
- Project feasibility
- Project management
- Project monitoring
- Project origination
- Project size
- Public party responsibilities
- Rankings method
- Refunds
- Regulatory oversight requirements
- Renegotiations
- Response to government need
- RFP content
- RFP to award process
- Rights of other bidders
- Risks monitoring
- Risks severity & occurrences ranking
- Roles for renegotiations
- Sector needs
- Shared costs
- Stakeholders engagement
- Stakeholders identification
- Technical feasibility
- Termination circumstances
- Time-based completion
- Unsolicited Proposals
- User charges, government, bonuses
- Value for money

These items were further analysed to establish a theme that can group a set of them under a single group. This exercise led to the establishment of 25 categories as presented in Figure 5 (Andrew et al., 2008; Charmaz, 2011; Eaves, 2001).

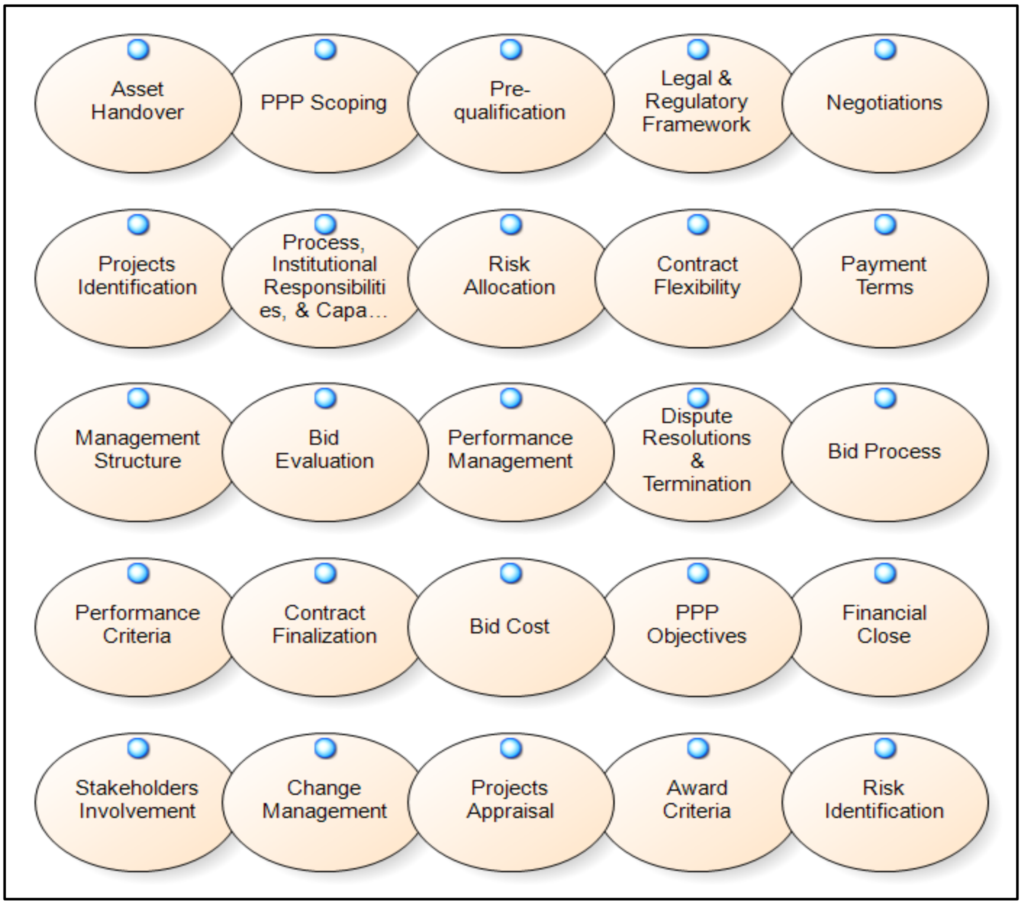



**Figure 5: Categories of PPP practice (Nvivo view)**

The last step was to establish stages to merge the categories in a sequential manner. These stages were identified as PPP implementation, PPP contract management, establishing PPP framework, contract design, and bid management.

The following sections will detail the stages, the categories, and the items that each category consists of.

### 5.1.1 Establishing the PPP framework

#### *5.1.1.1 PPP Objectives*

The objectives for pursuing PPPs vary from one country to another depending on their priorities and policies. For some countries, PPPs provide an ideal solution for governments to respond to infrastructure service demands without straining their fiscal capabilities. For others, PPPs are a viable option for improving public services in terms of accountability and efficiency, innovation, value for money, and economic growth (Goodliffe, 2002; WBI, 2012).

PPPs are not a solution for infrastructure service shortages; they can only help in improving the outcomes of the projects procured under their mechanism due to the fact that their process is based significantly on joint risk sharing between all parties involved in the contract. Therefore the objectives must directly correspond to the needs of the government, should be explored if the project considered is among the best to respond to that particular need, and determined if PPPs are expected to maximise the outcomes of that project as compared to other mechanisms (Pongsiri, 2002; UNESCAP, 2011).

#### *5.1.1.2 PPP Scoping*

The scope of PPP programs depends on the purpose for which governments are using this mechanism. The scope is therefore corresponding to the projects that governments are considering for achieving their objectives. It is also corresponding to the types of contracts used to achieve that success. Contract type plays a significant role in shaping the scope for delivering projects through the PPP mechanism. Some contract types, such as ‘design build operate’, are more prevalent in the projects procured under the PPP framework in certain countries, where lighter versions of PPPs, such as managerial contracts, are widely practiced in others.

It all depends on the policy and the objectives of each government. Another issue that defines the scope of PPPs is the sector. Governments may limit the utilisation of PPPs to certain sectors that are in need of service improvement or to ones that are expected to be implemented successfully without straining the resources and capabilities of the government. Another factor that might define the parameters for the scope definition is the size of the project. Some governments are defining the size of the project in order to consider its selection for PPP procurement. This is because the fiscal implications and resource allocation should be justified and correspond to actual benefits generated from each project (P3, 2011; WBI, 2012).

#### *5.1.1.3 Legal & Regulatory Framework*

PPP legal and regulatory framework is all laws and regulations that control the implementation of PPPs. Such laws and regulations include specific legislation, administrative laws, procurement laws, public financial management laws, concession rights, dispute settlement mechanisms, labour laws, environmental laws, licensing, public service laws, sector-specific laws, and other related laws. Regulatory framework as well should include oversight requirements to enable the government to control pricing, services, and operations (ADB, 2008; Hoppe & Schmitz, 2013; WBI, 2012)

#### *5.1.1.4 Process, Institutional Responsibilities, and Capacity Building*

##### *5.1.1.4.1 PPP Process*

In PPP projects, the private party will undertake the scopes of financing, designing, building, managing, and maintaining the project. The public party is responsible for ensuring that the project achieves its goals as outlined in the policy objectives. A standardized process helps ensure that all PPPs are in compliance with the objectives. The PPP process refers to the procedures that must be followed for developing PPP projects. Therefore, governments must define a clear PPP process with segmental approval requirements to ensure these procedures are implemented properly. The process consists of many stages where PPPs are developed iteratively. This is important to ensure that considered projects are viable ones and are not going to waste efforts and resources. It also gives authorities sufficient time for involvement and oversight (Abdel Aziz, 2007; UNESCAP, 2011; WBI, 2012).

*5.1.1.4.2 Institutional Responsibility*

The role of institutions in implementing, approving, and controlling PPPs is vital in achieving the government's objectives. Agencies responsible for the implementation of PPPs must possess skills and experience to attend to the needs of the sectors involved in the PPP process. Such skills include feasibility studies, financial appraisals, private fund structuring, procurement methods, and contract management. The responsibility for implementing the PPP projects varies from one country to another, but mostly falls under the authority responsible for providing the service. This authority is termed the "contracting authority." The approval process for PPPs is different from the typical procurement methods, which require certain approvals for committing financially to any project. PPPs do not take any advances or payments from the government, and therefore the approval process must correspond to a different situation. Approvals are related to controlling the final cost of the PPP project, which is unknown until its completion. Approvals also are required when considering moving forward with the project considered for PPP at early stages before it becomes a future burden on the government. Most World Bank publications emphasise the central role finance ministries should play in the approval process of PPPs. In most countries, finance ministries hold the approval process for PPPs, or at least play a controlling role in the PPP process. This helps governments ensure that the PPPs are streamlined with the objectives of value for money and limit the fiscal exposure of governments (Iossa & Martimort, 2015; UNESCAP, 2011; WBI, 2012).

*5.1.1.4.3 Capacity Building*

There are various matters that contracting authorities should take care of when assessing the capacity of the government for handling PPPs. These matters include previous experience and capacity in implementing PPPs, the existence of a PPP unit or any assistance that can be obtained from other governmental entities, and the available fiscal resources for the development of the PPP project and any other backup funds (Brinkerhoff & Brinkerhoff, , 2011; UNESCAP, 2011).

*5.1.1.4.4 PPP Unit*

A PPP unit is a dedicated entity within the sector or within the central government responsible for implementing and facilitating PPP projects within the jurisdiction. The scope of PPP units in countries implementing the concept includes the regulation of the PPP process, the promotion of PPPs within the governmental entities, providing guidance and advisory services to help the agencies improve their skills specific to PPP projects, quality control, providing a "one stop shop" for investors to exchange information about the opportunities and the requirements, and ensuring accountability and consistency of the process (ADB, 2008; Tserng, Russell, Hsu & Lin, 2011; WBI, 2012).

#### *5.1.1.5 Stakeholders Involvement*

The identification and engagement of stakeholders from the early stages of the PPP project plays a significant role in the achievement of the objectives set by the government. Such involvement of stakeholders ensures the proper formation of the project structure, the early identification of planning and implementation issues, and providing the remedy for those issues. It is also important because failing to meet stakeholder's requirements will increase the chances of opposition to the project, leading to delays or cancelations. It also leads to increased risks facing the sustainability of the project if the public does not support it. Stakeholders may include relevant representatives from the contracting agency or other concerned agencies, representatives of interest groups, beneficiaries, public groups, and representatives of potential investors (ADB, 2008; Tang, She, Skitmore & Cheng, 2012; UNESCAP, 2011).

#### *5.1.1.6 Unsolicited Proposals*

Unsolicited proposals are proposals that are offered by private entities for undertaking a PPP project that they have identified, rather than being offered by the government to place a bid. Governments benefit significantly from the skills and resources available from the private sector in identifying and appraising new projects that can be beneficial to both parties. A clear mechanism must be in place to deal with unsolicited proposals that include incentives to private entities and the minimum requirements for considering such proposals without straining the resources of the government or failing to meet value for money criteria (UNESCAP, 2011; WBI, 2012; Yun, Jung, Han & Park, 2015).

### 5.1.2 PPP IMPLEMENTATION

#### *5.1.2.1 PPP Projects Identification*

##### *5.1.2.1.1 PPP Projects Origination*

The identification of candidate PPP projects is the process of establishing which projects are likely to be delivered successfully through using the PPP method. Most PPP projects originate from a governmental planning process, infrastructure gap analysis, or policy driven selection criteria. For the governments to identify potential projects for

PPPs, a capacity building per sector is required for such identification. The planning process can be at any level based on capacity strength, such as the national level or sector level. Some countries prefer to focus on infrastructure gaps rather than becoming involved in an overall national development plan. In this option, governments identify essential projects according to their development needs and establish the investment requirements accordingly to invite investors. Then they merge such investments into a national plan at a later stage, as the intention is first to satisfy the demand and then to look into making profits. The policy driven selection criteria is based on evaluating any project on its viability and contribution to the investment process, regardless of its fit within an overall selection process (Predonu & Gherman, 2014; WBI, 2012)

##### *5.1.2.1.2 Initial PPP Projects Screening*

The second step in the identification process is the screening of the potential projects for PPPs. This step overviews, without in-depth analysis, the legal and technical compatibility of the project to pass the initial approval stage and to enable the next step, which is the detailed legal and technical assessment. At this stage as well, economic viability will be checked without going into detail about cost/benefit analysis, which will only be conducted on screened projects for efficiency purposes (Carbonara & Pellegrino, 2014; P3, 2011; WBI, 2012).

##### *5.1.2.1.3 Prioritization for final Selection*

The third step in the project identification process is the prioritization of screened PPP projects for further studies. This step requires moderate allocation of funds and human resources. Factors that are likely to influence the prioritization step include the role the PPP project will play within the sector or within the national development plan, the likelihood of success in delivering the scopes intended from their development, and the interest of investors (Carbonara & Pellegrino, 2014; WBI, 2012).

#### *5.1.2.2 PPP Projects Appraisal*

The appraisal process of PPP projects is the process of checking if the project would contribute positively to the overall development plan and to check if the PPP mechanism would enhance that contribution. The project will have to satisfy pre-set criteria to establish if it makes sense to go forward with its implementation. Such criteria includes items that directly address the fit of the project, such as the justification of the cost/benefit outcomes, legal and technical feasibility, environmental and social sustainability, the attractiveness to investors, fiscal commitments and constraints, and the delivery of value for money as compared to conventional methods (Carbonara & Pellegrino, 2014 ; P3, 2011; WBI, 2012).

##### *5.1.2.2.1 Project Feasibility*

By completion of the appraisal phase, the concept of the project must be detailed with regards to the physical design, the technology required for its delivery, the output performance, and service users.  This concept is then tested to ensure compliance with several requirements to ensure its success. Testing of the concept normally includes technical feasibility, which is the study of the available tested technologies that are required for the delivery of the project and the technical risks that are expected to be faced by the project during its life cycle, and it includes also the legal feasibility of the concept, which is concerned with studying the legal constraints to the project, such as if the government is eligible to enter into a PPP contract. Lastly, environmental and social impact studies are conducted to ensure that the project concept meets the local planning and environmental regulations and would contribute to the sustainability and welfare of the community. External consultancy firms normally handle these studies (Ho, Levitt, Tsui & Hsu, 2015; P3, 2011; WBI, 2012).

*5.1.2.2.2 Economic & Commercial Viability*

The economic viability of a project is the study of the economic benefits expected from it when compared to its financial cost. Economic benefits are the value the project is expected to deliver to the public. When the economic benefits exceed the financial costs, the project is considered to be economically viable. Economic viability studies also show the cost effectiveness of a project, that is, whether the project is representing the lowest cost approach for delivering the required benefits. Commercial viability of the project is conducted after establishing its economic viability. This refers to the attractiveness of the PPP structure to private parties. Normally, investors will look for good returns on their investment and reasonable levels of risk. Financial models and business plans showing projected net cash flows are normally considered for establishing the commercial viability of projects (Royal & Windsor, 2014; UNESCAP, 2011; WBI, 2012).

*5.1.2.2.3 Financing*

PPPs are normally financed through project financing. This means that the project's cash flows are the basis for repayment of lenders, normally without recourse to public and private parties' equities to make up for any shortfalls. This is in total contrast to corporate financing, where collaterals are secured to ensure payback. Investors and financiers engage in extensive technical, legal, and financial due diligence to ensure that the project company is capable of delivering the PPP contract. The main sources of project financing are equity and debt. Equity is the capital invested by the sponsors, the government, and third party investors. Debt is the capital borrowed from banks, financial institutions, and capital market. Debt raising constitutes the larger share of investment in PPP projects. Debt has a fixed maturity tenor and a fixed interest rate that is paid on the principal and allows the lenders a senior claim on returns and assets. Debt comes in different forms, such as commercial loans, bridge loans, subordinated loans, and bonds. Commercial loans are the ones lent by financial institutions or banks. Bridge loans are short-term loans that enable the initiation of the project until other forms of long-term financing are secured. Bonds are purchased directly from the capital market or institutional investor; they are long-term debt instruments with a defined tenor and fixed interest rate used widely for financing governmental projects. Subordinated loans are similar to commercial loans; they only differ in being secondary to commercial loans in claiming returns or assets. Governments, to reduce default risk, use subordinate loans to improve PPP project financial viability. Another source of project finance is grants. Although grants come from various donors, grants from governments make up the majority. They are aimed at improving the project's viability, reducing financial risks, and achieving growth objectives (Demirag, Khadaroo, Stapleton & Stevenson, 2011; EPEC, 2012; UNESCAP, 2011).

*5.1.2.2.4 Value for Money*

Value for money means delivering the services required with the optimal cost and benefits. It is a key indicator for governments implementing PPP projects to assess whether the PPP project will offer better value over other conventional procurement options. It is a good practice to assess the value for money at the initial stages of projects, regardless of the procurement method. There are different approaches for conducting value for money assessment. One approach is to check qualitatively that all conditions are satisfied to achieve value for money, such as checking how well the PPP is structured. The other common approach is the quantitative assessment. This is the practice where a comparison is conducted between the PPP option and a public sector comparator (PSG) to show what the project would be like if delivered through another procurement method. Comparisons of PPP projects could be through comparing fiscal costs, risk adjusted costs, or economic cost-benefit basis to the conventional procurement options (EPEC, 2012; Siemiatycki & Farooqi, 2012; P3, 2011; WBI, 2012).

It is generally assumed that PPP projects offer efficiency in investment costs when compared to the PSG. So it is expected that the efficiency benefits of the PPP option will outweigh the cost factors that could be in favour of the conventional method. Therefore, the comparison should take into consideration the non-financial benefits of PPP projects, such as the enhanced delivery of projects. Based on previous experience, a PPP method offers value for money when there is a program requiring an effective management of risks associated with the implementation of the PPP project, the private sector to be capable of designing and developing the project, risk sharing between the parties is clearly identified, the public sector to be capable of producing clear service outputs, the possibility of estimating life cycle costs, and the technological requirements to be tested and applicable for the full duration of the project (EPEC, 2012; Siemiatycki & Farooqi, 2012; P3, 2011).

#### *5.1.2.3 Risk Identification*

The starting point for structuring a PPP is to establish a list of risks associated with the development of the project. Risks are the variations to the value of the project that are associated with risk factors, such as demand risk. Depending on the services involved and the nature of the PPP project, risks vary from one PPP project to another. Nonetheless, there are common risks in many types of PPPs, allowing for them to be grouped into risk groups. There are two main groups of PPP project risks: commercial risks, and legal and political risks. Commercial risks can be further categorized into two categories: supply risks and demand risks. Supply risks include construction and operations risks. Demand risks are concerned with user volumes as compared to initial assumptions. Legal and political risks refer to, among other things, the legal system, regulatory procedures, taxation system, government policy, and disputes settlement management. There are standard risk lists and preferred risk allocations available for certain types of PPP projects; they can offer guidance in identifying project risks. However, certain projects are more unique in nature and require extensive work by experts to identify the associated risks. It is equally important when identifying a project's risk to assess and establish the importance of each risk. Some risks are more likely to occur and some are more severe and bear more consequences on project outcomes. There are qualitative and quantitative assessment methods for the evaluation of risks. However, more agencies are focusing on the qualitative approaches for risk management due to the value they offer. Such approaches include categories of risks according to their impact on the outcomes of the project and their likelihood of occurrence, where each risk is assigned a category of low, medium, or high level of impact and likelihood of occurrence (EPEC, 2012; Li & Zou, 2012; P3, 2011; WBI, 2012).

#### *5.1.2.4 Risk Allocation*

Achieving value for money in PPP depends on the ability to identify and allocate risks to the parties that best manage them. Risk allocation is the principle of deciding which party to the contract will bear the financial consequences of variations in the outcome of the project in response to each risk factor. Successful risk allocation leads to improved value for money in PPP projects. The underlying principle of risk allocation is that each risk should be allocated to the party capable of managing it best. This includes allocating risk to the party who is able to control its occurrence, the party who can control its impact on the project, and the party who can absorb its consequences with the lowest financial impact (Chou, Tserng, Lin & Yeh, 2012; P3, 2011; WBI, 2012).

### 5.1.3 Contract design

The PPP contract holds the highest importance in the PPP project. It defines the nature of the relationship between the contracting parties, the rights and responsibilities, risk sharing, and details the mechanism for change management. As designing the detailed contract takes a significant amount of time and effort and since a contract is required to show the terms of engagement in order to offer a competitive bid, an initial contract is required to go with the request for the proposal to interested bidders. This draft can be later modified based on negotiations for a contract close. According to the Asian Development Bank (2008), PPP contracts must include the parties involved, important terms and definitions, the scope, the objectives, jurisdiction, the duration of the contract, circumstances of engagement, rights and obligations of all parties, performance bonds, insurance requirements, all party's warranties, service quality and performance targets, the consequences to law changes, a definition of the role of regulatory authority, the types and mechanisms for payments, risk allocation and management, access to site, monitoring procedures, environmental liabilities, dispute resolution, delay management procedures, force majeure, variations, intellectual property, the termination conditions, step-in circumstances, change in ownership, compliance with laws, the obtaining of necessary approvals and permits, and conflict of interests. PPPs are long-term projects, and contracts cannot predict issues in the future. Therefore there must be a buffer for flexibility to deal with changing circumstances and not resort to re-negotiations or terminations. It is the duty of the government to create certainty in the contract, where possible, and to define flexibility when needed in certain circumstances (Cruz & Marques, 2013; Cruz, Marques & Cardoso, 2014; WBI, 2012).

#### *5.1.3.1 Flexibility in PPP contracts*

In theory, PPPs are the best option for governments to procure projects and services through the private sector's funding, where the risks are assumed to be transferred to the concessionaire. Such transfer reduces the economic burden related to such risks if they were left to be handled by governments. However, although this long-term, detailed engagement is beneficial to both parties with specified respective equities of risk, the conditions of such an engagement can change with time, prompting the renegotiation of the contract to adapt to the new reality and to mitigate its associated risks. Partnerships between the public and private parties are supposed to be governed by mutual benefits rather than rigid contracts in order to achieve the outcomes expected from them. The public party will bear most of the blame and the economic consequences if the decision is to terminate the contract for any contingency or change of plans. Conversely, the private party is well protected by various clauses that warrant the termination of the contract for any undesired variations or uncertainties with ample protection from financial consequences. Therefore, shared understanding of each other's perspectives must be persistent throughout the duration of the full development cycle until the project is completed and in parallel to the durable contract clauses to safeguard the interests of the public party (Cruz & Marques, 2013; Cruz et al., 2014; Quiggin, 2005).

#### *5.1.3.2 Performance Criteria*

Clear specifications of output performance and the quality and quantity of the assets must be detailed in the PPP contract. Performance indicators and pre-set targets are typically annexed to most PPP contracts. Performance is specified in terms of outputs (such as quality) rather than inputs (such as design) to enable the private party to use innovation in responding to the required scope. It also enables the competition to be open and transparent. With regards to specifications in the contract, they must include clear performance targets and how such performance will be monitored. They also should include consequences for not meeting such targets through penalties, liquidated damages, etc. Lastly, they should include the terms under which the government should step-in to control the project if the output specifications could not be achieved by the private party (Oyedele, 2012; UNESCAP, 2011; WBI, 2012).

#### *5.1.3.3 Payment Terms*

Payment terms refer to the mechanism under which the private partner is paid. There are various ways for such payments; they can be through user charges, government payments, or performance based bonuses and penalties. When the payment to the private party is based on user charges, setting the tariff and applying any changes to it becomes a significant risk in the partnership. The reason is that governments regulate tariffs to protect the users, while there are circumstances that warrant changing the tariff to correspond to changes in expected conditions, such as inflation or other changes in costs. Setting initial tariff levels and defining a formula for regular tariff adjustments based on certain circumstances, such as inflation, can control this situation. Government payments are made under the availability mechanism, which means the government bears the demand risk, whereas both the government and the private party share risk demand under the user charge method. Payments also can be linked to output performance based on well-defined performance targets. Bonuses and penalties, under government payment or user charge mechanisms, are typically tied to certain outcomes and are implemented in the form of adjustments to the contracted payments (Oyedele, 2012; Sharma, 2012; WBI, 2012).

#### 5.1.3.4 *Dispute Resolution and Termination Mechanisms*

##### *5.1.3.4.1 Dispute Resolution*

The worth of PPP contracts have been acknowledged by governments engaged in this financial procurement method, and the work done on stressing the importance of the successful implementation of PPP is quite extensive. However, since the model is built on the collaboration between the public and private sectors, more is needed to focus on the challenges encountered by both parties during the execution of the contract to maximise the full potential of their engagement. Disputes lead to delayed cash inflows from the services and therefore failure to payback project loan as contracted. It is therefore warranted to have a well-defined dispute resolution mechanism to deal with any situation as quickly as possible to avoid disruption of delivery of services. Some governments define dispute resolution measures in PPP legislation to have a standard mechanism across the board. Dispute resolution mechanisms typically include recourse to a sector's regulator, judicial systems, chamber of commerce arbitrators, and international arbitrators (Chou & Lin 2012; WBI, 2012).

##### *5.1.3.4.2 Termination*

Detailed clauses should be included in the contract to deal with contract termination circumstances. Typically, the contract should include the following termination issues: early termination circumstances by either party, payments to be made to the private party in response to termination, arrangements for contract closure, and conditions for handing over the project to the authority. Grounds for termination typically fall under circumstances such as the expiry of PPP contract, default by either the government or the private parties, a change of policy by the authority, or prolonged force majeure. The contract should define, in detail, the areas of default to warrant termination. A list of breaches should be included in the contract to avoid lengthy conflicts. Remedy periods should be specified in the contract to allow salvaging of the situation. Issues such as insolvency and bankruptcy or major deficiencies related to output performance of services or health and safety defaults should be promptly remedied or resorting to termination will be inevitable (Chou & Lin 2012; EPEC, 2012; WBI, 2012).

### 5.1.4 Bid management

#### *5.1.4.1 Pre-qualification*

A prequalification process is conducted to ensure that potential bidders are capable of handling the development of the PPP project in an effective and efficient manner. An invitation for prequalification is typically sent to interested bidders, which contains information about the project and instructions for participation. Such information and instructions include project general context information, available project information for bidders, prequalification evaluation criteria, and a timetable for the prequalification process (De Langen, Van Den Berg & Willeumier, 2012; EPEC, 2012).

There are two common types of prequalifying bidders. The first one is based on pass/fail criteria, meaning that bidders will be invited, no matter how many, to the bidding process. The second one is a prequalification to select a few bidders and rank them according to their capabilities; typically, the number of bidders in this case does not exceed six. The second type is preferred by authorities since it controls the number of entrants to the competition and therefore preserves the time and money of the authority in checking the qualifications of the bidders. The private party also prefers the second type, as the presence of too many bidders in the list will reduce the interest of bidders in the project, given the high cost associated with preparing a competitive bid (De Langen et al., 2012; WBI, 2012).

#### *5.1.4.2 Bid process*

Bid process is the process ranging from issuing the request for proposal (RFP) to awarding the project to the successful bidder. The request for proposal documentation should include all relevant information that will enable the bidder to submit a competitive bid. Due attention must be given to the preparation of the RFP documentation by the authority to avoid unnecessary debates and clarifications before the award of the PPP contract (WBI, 2012). Such RFP documentation will typically include sufficient details about the PPP project, key commercial terms and risk allocations, output performance and technical features and requirements, a draft PPP contract, instructions for submittal requirements and procedures, bid evaluation criteria, and performance bonds requirements (EPEC, 2012; Love, Smith & Regan, 2010).

#### *5.1.4.3 Bid evaluation*

The RFP should clearly set the criteria for bid evaluation, including the categories for evaluation and the process that will be followed for their assessment. Bidders should be guided to submit the required information in schedules corresponding directly to the instruction in the RFP. This will help bidders comply directly to the requirements and save time. It will also assist the evaluation panel in ensuring the alignment to the evaluation criteria and allowing ease of comparison between all submittals by focussing on the respective criterion, which will bring efficiency to the evaluation process with regards to time and effort exerted. The evaluation criteria vary between the countries and vary between projects as well. The key categories for evaluation typically include design, operational, commercial, and financial project management, interface management, and risk-adjusted cost categories (Love et al., 2010; NPPPG, 2011).

Governments may elect to use a multi-stage bid process. Bidders under this option present their initial proposal with comments and suggestions for revisions on the draft contract, which might also lack certain details such as financial structure. Based on the received comments, the government might re-issue the RFP with the required modifications and request a second round of proposal submissions. The government may also reduce the number of bidders based on their submissions and repeat the process until the final list of bidders is sealed. At this stage, the government may request the final bid, including the financial offer. Although multi-stage bid process can consume a longer time and are more complex, they can ensure that the buffer for innovation is maximized, the services are aligned to the needs of the government, and the quality for final proposals is improved (Marques & Berg, 2010; WBI, 2012).

#### *5.1.4.4 Award criteria*

The award criteria are based on the evaluation of the bids received, their ranking according to merit, and selecting the winning bidder. The method for the award criteria is selected based on the technical merits and the financial considerations of the PPP project. This combination is considered for achieving the value for money objectives of the PPP project. There are two common options for evaluating proposals. The first one is selection criteria based solely on financial considerations. In this option, the final list of proposals is evaluated on the basis of pass/fail for technical considerations. Then the finalists who pass the technical evaluation proceed to the financial evaluation process. In this process, the best financial proposal is selected. The second option is selection based on both technical and financial considerations. In this option, a weighted combination of the merits of the technical and financial proposals is established to reflect the value for money criteria and therefore selection of the bid winner is based on both considerations (Farley & Pourbaix, 2014; P3, 2011; WBI, 2012)

#### *5.1.4.5 Bid cost*

The preparation process for participation in PPP projects can be an expensive process for the private party. It is also equally expensive for the government to manage the procurement of PPP projects. Each party will bear all costs related to its respective scopes. To ensure the outcome of their spending on the procurement process, some governments require the bidders to submit a performance bond to ensure their commitment to the project and prevent withdrawals after the award for any reasons. However, performance bonds may deter potential bidders from entering the bidding process to minimize their expenditure on any venture. In some governments, the bid cost is shared or reimbursed by the government during the development of the project. On some occasions, governments may ask the bidders to share the cost incurred by the government during the bid process (De Clerck & Demeulemeester, 2014; WBI, 2012;).

#### *5.1.4.6 Negotiations*

Negotiations with bidders can take the form of negotiating with multiple bidders at the same time, referred to as “competitive negotiations,” or negotiating with a single preferred bidder. In competitive negotiations, governments may elect to engage with a select number of bidders during the bidding stages. This can help improve the content of the RFP and the initial contract to yield a final RFP that is in line with the requirements of both the government and the investors. Competitive negotiations could be more suitable for large and complex projects. In post-bid negotiations, a single bidder is selected as the best one that represents the best option for value for money for further negotiations. Mostly this process is focused on fine tuning the offer and not negotiating on any core terms or processes. The post bid negotiation is needed when the RFP requirements and the initial contract are not clear enough or when such requirements or the contract are not acceptable to the private party. Therefore, they incorporate their comments and requirements in their proposals, which do not meet the initial requirements of the government, prompting a second round of proposal solicitation. It is always better to avoid the post-bid negotiations through improving the RFP and initial draft documentation by making it clearer and more comprehensive (Wang & Dai, 2009; WBI, 2012).

#### *5.1.4.7 Finalizing the PPP contract*

Once the bid winner is selected, governments engage in final negotiations to clarify any remaining elements that require final discussion. However, no extensive negotiations are recommended at this stage, as it might undermine the effectiveness of the bid process and might raise concerns about transparency. This is typically necessary in situations where the tender process did not have sufficient interaction with the bidders. However, at this critical stage, many governments prefer to limit negotiations. A European Union rule states that no changes that could have made another bid win should be incorporated at the post-bid stage (Liu et al., 2014a; P3, 2011; WBI, 2012).

#### *5.1.4.8 Financial close*

Financial close is achieved when all project and financing agreements have been completed, satisfying all conditions stated in them. Signing of such agreements enables the funding of the project and the commencement of the development. Typically, a deadline is set for completion of all requirements or the bond will be forfeited. Any pending elements in the signed financial agreement are referred to as 'conditions precedent,' and they must be fulfilled before the contract can be effective. The disbursement of funds and actual implementation of the project depends on satisfying these conditions. Such conditions include permits and planning approvals, land acquisition, outstanding technical issues, funding approvals, remaining project and funding documents, and registration of loan collaterals. The contracting authority will be required at this stage to check that all internal approval procedures are in place. Such procedures include checking for value for money criteria, getting approval for changes in the contract, and checking for affordability (EPEC, 2012; Liu et al., 2014a; P3, 2011; WBI, 2012).

### 5.1.5 *PPP contract management*

The manners through which PPPs are managed and monitored during the implementation stage are vital to their success and their ability to deliver value for money as planned. The contract management team will be responsible for managing the day-to-day contractual activities of the project. It is important before discharging the duties to the contract management team that the authority ensures the responsibilities and scope of work is clearly defined and allocated between the project and contract management teams to avoid overlapping of process ownerships. It is also important at this stage to outline the terms for change management and how to deal with delivery failures of the PPP company. The authority must ensure that there are sufficient human and financial resources available for the discharge of duties of the contract management team. The objective of establishing two parallel management teams is to introduce efficiency to the project management process. This will ensure that the services are delivered according to contract terms with the expected quality, responsibilities, and risk allocations are maintained and monitored, with efficient management of government's responsibilities and risks, and effective management of change in risk and opportunities (EPEC, 2012; Forrer, Kee, Newcomer & Boyer, 2010; P3, 2011; WBI, 2012).

#### *5.1.5.1 Management structure*

Managing PPP project contracts differs significantly from handling conventional projects. PPPs are long-term and complex projects, and their contracts are incomplete, as the scenarios cannot be predicted at the signing stage of the contract. Therefore, the government must ensure that there are two parallel management teams going hand in hand for the delivery of the contract: a project management team and a contract management team. The purpose is to ensure that the daily management of the project is conducted smoothly without interruptions from issues that are expected to occur after signing the contract. Contract management refers to the process of defining the roles for managing the contract within the government and the basis for interaction with the private party. It includes the establishment of the management body within the contracting authority and the roles of other entities associated with contract management within the government. The authority of this management body or manager must be clearly specified as to the level of autonomy in decision making is allowed. Contract management arrangements and communication protocols with the private party must be established as well (EPEC, 2012; Forrer et al., 2010; P3, 2011; WBI 2012).

#### *5.1.5.2 Performance management*

The PPP contract should include the obligations of the PPP company and define the service outputs and performance indicators. Effective management of the PPP contract depends on the proper design of the PPP contract. One of the key considerations for the successful completion of the PPP contract is getting the contract right in the first place. First, the foundations for the contract management process, setting performance indicators and managing relationships, must be completed before the award process. Second, less than comprehensive contracts could lead to disputes hindering cooperation with the PPP provider. Third, given the nature of long tenors of PPP contracts, it is likely that the personnel from the public and private parties will change over the life span of the project. It is therefore important to stipulate clearly the scope and obligations of either party at the early stages of contract design. Finally, accurate assessment by the public party of the needs is essential to create specifications of desired services required instead of facilities to be developed. The criteria for selecting PPP providers should be based on getting value for money and finding the most capable provider of delivering the required concessions over the full duration of the contract. The contract should cover pertinent aspects such as allocation of risk, the quality of service required, and procedures for variation of service scope and dispute resolution (EPEC, 2012; MOFS, 2004; Robinson & Scott, 2009;).

*5.1.5.2.1 Project Monitoring*

The PPP company will need to update regularly the contract management team with information related to the operations and financial status of the project. This is necessary to enable the contract management team to effectively monitor the implementation process. This does not mean that the PPP company must provide day-to-day detailed information, as this will lead to an unnecessary burden on the PPP company. Only information related to monitoring the progress and benchmarking it to the established performance indicators in the contract will be needed. The day-to-day progress of activities is the responsibility of the private party and should stay there. The contract management teams' responsibilities survive the full life cycle of the contract. Such responsibilities include the monitoring of the PPP company for contract compliance and performance, the compliance by the government in delivering its obligations to the PPP company, the managing of the relationship with the PPP company, the review of quality control and quality assurance procedures, and the monitoring of risk mitigation (EPEC, 2012; Robinson & Scott, 2009; WBI, 2012).

##### *5.1.5.2.2 Risk Monitoring*

The contract management team must have a clear understanding of the clauses and requirements in the PPP contract and the reason for the requirements. The reason is that the contract management team will have to establish whether or not the risks were identified in the contract and which mitigation mechanisms were offered for each. The risks to be monitored include project risks and their corresponding allocation between the parties, project risks not allocated between the parties, PPP contract change risks, and authority borne risks (EPEC, 2012).

Managing and controlling risks allocated to the government plays a crucial role in the success of the PPP project. Such risks are typically controlled by a risk management plan, which is a list of each risk and its corresponding responsibilities, whether borne by the government or shared with the PPP company, as well as any other ones that may affect the sustainability of the project. For each risk, information is identified to enable its monitoring and the mitigation options (Fischer, Riemann & Alfen, 2010; UNESCAP, 2011; WBI, 2012).

#### ***5.1.5.3 Change management***

##### *5.1.5.3.1 Disputes*

Partnerships between public and private parties are supposed to be governed by mutual benefits rather than rigid contracts in order for such contracts to deliver the outcomes expected from them. The public party will bear most of the blame and the economic consequences the contract is terminated due to any contingency or change of plans. Conversely, the private party is well protected by various clauses that warrant the termination of the contract for any undesired variations or uncertainties with ample protection from financial consequences. Therefore, shared understanding of each other's perspectives must be persistent throughout the duration of the full development cycle until the project is completed and in parallel to the durable contract clauses to safeguard the interest of the public party (Harisankar & Sreeparvathy, 2013; Quiggin, 2005).

*5.1.5.3.2 Renegotiations*

Renegotiations are of particular importance to the governments engaging in long-term contracts like PPP. If the government insists on keeping the contract as it was at the signing stage, it is possible that the government is forfeiting many benefits that have evolved over time within the long duration of the contract. Such benefits include new technologies, new methods, improved machinery, or even losing other competitors who can benefit the project more than the contracted one. If the government, at any point during the rigid contract clauses, elects to modify some conditions or add variations to the scope of work, it would trigger an opportunistic scheme from the developer, who can claim unrealistic compensations as the developer is well protected in the conventional type of PPP contracts by very well defined clauses for variations or even termination. This upper-hand situation, to the advantage of the private party, is the result of the developer's previous experiences in the field that were properly included in the contract to safeguard his interest. Therefore, there must be a controlled flexibility in PPP contracts to allow the public party to amend the contract and, when required, to adapt to public needs, such as new trends in consumerism or behaviour, increased capacity of the project, or inclusion of new technologies and plants, as long as everything falls within acceptable levels of remuneration and impact on the developer (Athias & Saussier, 2007; Nikolaidis & Roumboutsos, 2013; Zhang, 2005).

Therefore, it is recommended that flexibility be added to the contract by adding additional clauses to deal systematically with situations where either party is interested in revisiting the clauses to the mutual benefit of both parties. Such flexibility must be controlled and balanced; too flexible contracts will complicate the legal engagement and will prompt opportunistic behaviour from both parties, while less flexible ones will lead to claims and lost opportunities for improving the end product for the public (Athias & Saussier, 2007).

There are many forms of flexibility that can be considered for improving PPP contracts, one of which is through the addition of a renegotiation clause to the contract. For the public party, renegotiations are opted for when an improvement to the contracted service is needed or when there is a desire to balance the economic benefits and risks in the project. The risks can be any unexpected losses or gains that occur in favour of one party over the other, whereas for the private party renegotiations are opted for when there is a realization that there was an underestimation of risks, and therefore support from the public party is required. So, the underlying criterion for the renegotiation clause is to balance risks and rewards between the contracted parties to safeguard the efficient and effective completion of the project. Unexpected events are almost guaranteed to occur during the execution of PPP contracts, and mitigating such risks is compulsory to realign the goals of the project according to such events and to balance the risks equitably between the public and private parties. To reach this stage of equilibrium, both parties to the contract acknowledge that the only way forward is to renegotiate the contract or face the termination consequences. An example of an event that requires mutual effort to mitigate the consequences includes currency fluctuation. When a local currency depreciates, the public sector will lose revenue if the earnings are collected in another currency that did not depreciate below the agreed value at the signing stage. Conversely, when the local currency appreciates, the risks and expenses under the management of the private investor's become more expensive (Quiggin, 2005).

#### *5.1.5.4 Asset handover*

PPP contracts define the contract term and the measures for asset handover to the government. The most common approach is when the government defines the contract term in the draft contract as the approximate time required for the private party to achieve its financial objectives with reasonable tariffs and payments. The second alternative for the government is to set the tariffs and payment level and ask bidders to propose a contract length. A third option is to let the contract terminate when it reaches a terminal value calculated on the basis of the least present value of revenues. PPP contracts need to define the process for transferring the assets and the operations to the contracting authority at the end of the contract. This includes the quality of the assets, any payment mechanisms, and any payment expected for the handing over. Many governments appoint assessors to examine the quality of the assets and handle the handover requirements. Bonds and guarantees are also used to ensure the quality of the handed over assets (Shaoul, Stafford & Stapleton, 2012; Yang et al., 2011; WBI, 2012).

The conditions for early termination of the contract by either party must be clearly defined in the PPP contract. Such conditions will detail who may terminate under which conditions and at what price. There are three common reasons for termination: termination by the authority due to default or change of policy, default by the private party, and termination due to external factors such as force majeure. For any type of termination, the government pays the private party and seizes control of the PPP project assets. Sometimes termination is more valuable than trying to salvage the value of a done deal situation. In PPP contracts, which are long-term in nature, governments forgo any advantages arising from new technologies or even the entry of new developers who possess better skills and innovative tools that are in the best interest for delivering the outcomes of the contracted project. Governments, as well, lose their bargaining edge when the alterations to the contract exceed the allowable percentage, prompting them to concede to the will of the developer rather than the interest of the public. Unless the government can predict in detail what will happen during the 30 years or so of the contract, it should not always commit to long-term engagement. There must be a buffer for mutually terminating the contract when the objectives of either party are significantly affected. A ‘put and call’ option in the contract may be opted for in specified intervals of years. Through the utilisation of this option, either party will be able to terminate the contract at the specified intervals. In this case, in a put situation, the private party will have to purchase an equity calculated from the cash inflows of payments remaining in the contract to restore the financial equilibrium, while the government can call the contract by purchasing the equity of the developer (Shaoul et al., 2012; Quiggin, 2005; WBI, 2012).

## 5.2 Results and analysis of the surveys

### 5.2.1 Agreement of participants and ranking of factors

The agreement of the participants on both samples was assessed by employing the Kendall's coefficient of concordance method as detailed in the previous section. Since the number of items (N) in each scale is more than seven, it is recommended to use Chi square as the best approximation. The value of the calculated Chi square will be checked against the critical Chi square value according to the degree of freedom (N-1) in the table of Chi square distribution at a probability of 0.05 or lower (Appendix 6.2). If the Chi square is above the critical value with a low level of significance, a null hypothesis - that there is no association between the rankings given by the participants -

can be rejected and leads to the consistency of the rankings provided by the participants on each group (Siegel & Castellan, 1988).

### 5.2.2 Respondents' information

#### *5.2.2.1 UAE sample*

The survey conducted in the UAE, as expected, had a low number of responses due to the small number of PPPs implemented in the UAE. Emails were dispatched to an identified group of PPP practitioners in the UAE from experts who offered mailing lists to social media sites such as LinkedIn. The number of invitations sent was 126 invitations, and the returned responses were 46 (Figure 6).

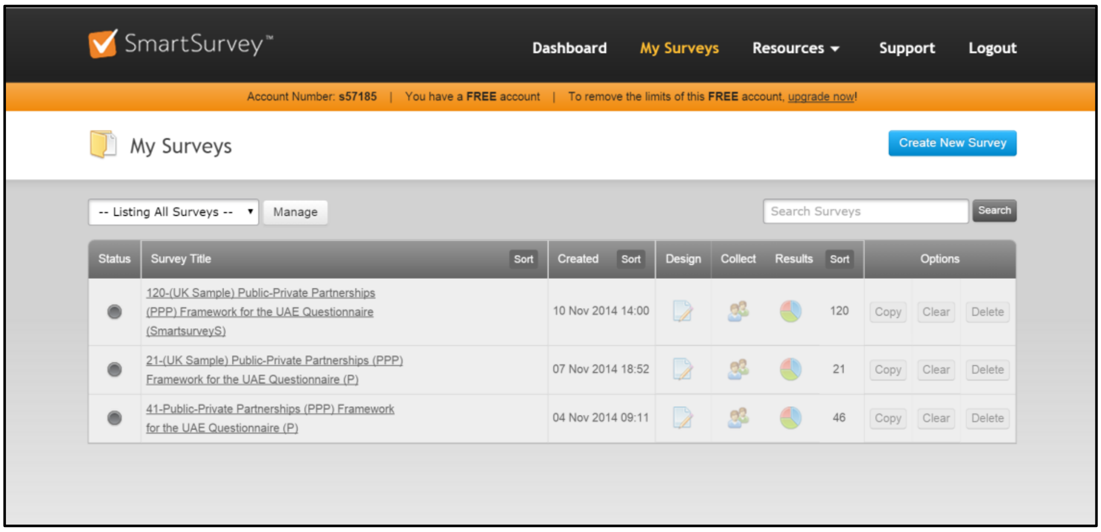



**Figure 6: Dashboard of the surveying website**

However, not all responses qualified for inclusion in the analysis. The figure dropped from 46 to 30 qualified responses. The reason was that some of the respondents actually ticked no to the question asking for their PPP experience in the UAE, as they might have had a PPP experience elsewhere, which warranted the exclusion of their responses. Another reason was incomplete surveys. Therefore, the response rate was 23.8%.

**Table 2: UAE sample (30 participants)- Personal and job-related variables frequencies.**

| | Frequencies | Percentage |
|---|---|---|
| **Profession sector** | | |
| **Researcher** | 3 | 10.0 |
| **Public sector practitioner** | 6 | 20.0 |
| **Private sector practitioner** | 21 | 70.0 |
| | | |
| **Organisational level** | | |
| **Top management** | 17 | 56.7 |
| **Middle management** | 10 | 33.3 |
| **General staff** | 3 | 10.0 |
| | | |
| **Years of experience** | | |
| **6-10 years** | 7 | 23.3 |
| **11-20 years** | 15 | 50.0 |
| **Above 21 years** | 8 | 26.7 |
| | | |
| **Have UK PFI experience** | | |
| **Yes** | 11 | 36.7 |
| **No** | 19 | 63.3 |

Table 2 presents background information of the respondents. On the question asked about the professional identification of respondents, out of the thirty qualified responses, 70% of the participants were from the private sector, 20% from the public sector, and 10% of participants identified themselves as researchers.

The second question intended to identify the organisational level of the respondent. This was important to give significance to their answers. 56.7% of the respondents identified themselves as top managers, 33.3% as middle managers, and 10% as general staff.

The third question asked for the years of experience, as more experience would give more significance to their answers on the survey. 50% of the respondents had between 11 and 20 years of experience, 26.7% had over 21 years of experience, and 23.3% had experience between 6 and 10 years.

The fourth question was a confirmatory one and was intended to make sure the participant was actually a PPP practitioner in the UAE and not elsewhere. Thirty participants confirmed this statement and therefore were considered for further analysis in the survey.

The fifth question asked if the respondents had a UK PFI experience, as this is important for the comparative analysis between the two countries to ensure there was no bias. 36.7% out of the thirty respondents ticked yes.

#### *5.2.2.2 UK sample*

Table 3 presents the information of the UK sample collected for the comparative analysis. The UK sample was identified through PFI groups identified over the internet along with mailing lists provided by leading practitioners in the UK. About 200 generic invitations were sent with a website link to the survey to potential respondents. 141 responses were received where the qualified responses for inclusion in the analysis dropped to 62 responses, thus, the response rate was 31%. The main reason was that the respondents ticked no on the question asking for direct PFI participation experience, only having knowledge about it.

The professional background of the respondents was 59.7% private sector practitioners, 27.4% public sector practitioners, and 12.9% researchers. 58.1% of the respondents were from middle management and 27.4% each for top management and general staff. The sample years of experience were as follows: 24.2% had more than 21 years of experience, 38.7% had 11 to 20 years of experience, 27.4% had 6 to 10 years, and 9.7% had less than 6 years of experience. Although the latter is below the criterion of experience set forth, and since they constitute less than 10% of the sample, it is left for the statistical analysis process to determine their elimination if needed based on the reliability and factor analyses tests.

**Table 3: UK sample (62 participants) - Personal and job-related variables frequencies.**

| | Frequencies | Percentage |
|---|---|---|
| **Profession sector** | | |
| **Researcher** | 8 | 12.9 |
| **Public sector practitioner** | 17 | 27.4 |
| **Private sector practitioner** | 37 | 59.7 |
| | | |
| **Organisational level** | | |
| **Top management** | 17 | 27.4 |
| **Middle management** | 36 | 58.1 |
| **General staff** | 17 | 27.4 |
| | | |
| **Years of experience** | | |
| **Less than 6 years** | 6 | 9.7 |
| **6-10 years** | 17 | 27.4 |
| **11-20 years** | 24 | 38.7 |
| **Above 21 years** | 15 | 24.2 |
| | | |
| **Currently involved in UK PFI** | | |
| **Yes** | 44 | 71.0 |
| **No** | 18 | 29.0 |

For the statement asking for UK PFI experience to confirm the suitability of the respondent, 62 subjects answered yes. The last statement was intended to check if the participant was involved in ongoing PFI projects, and 71% of them answered yes.

## 5.2.3 Favourable factors for adopting PPPS

### *5.2.3.1 Agreement of participants*

According the degree of freedom (13-1), as shown in (Table 4), the critical Chi square value for both samples was 21.03. The computed Chi square was 60.15 for the UAE and 137.33 for the UK, both of which are above the critical Chi square value with a significance of .000. Therefore, the null hypothesis - that there is a significant difference in the results - is rejected, and the rankings provided by the participants from both groups on the favourable factors for adopting PPPs are accepted as consistent.

**Table 4: Kendall's coefficient of concordance (KCC) for Favourable factors for PPP implementation**

| | | |
|---|---|---|
| Country | UAE | UK |
| Number of valid surveys | 30 | 62 |
| Kendall's CC (W) | .167 | .185 |
| Chi-Square | 60.15 | 137.33 |
| Degree of freedom | 12 | 12 |
| Asymptotic significance | .000 | .000 |
| Critical Chi-Square | 21.03 | 21.03 |

#### *5.2.3.2 Ranking of favourable factors for implementing PPPs*

The favourable factors sought after the implementation of PPP projects as summarized by Li et al. (2005) are thirteen factors as discussed previously in this study. Participants from the UAE and the UK associated significance to each factor (Table 5). The mean score for the four highest favourable factors for PPP implementation in the UAE ranged from 4.07 to 4.57 and the same for the UK from 4.18 to 4.40. Both countries ranked highest the same four factors, and they are:

1. Private sector's skills and experience
2. Private sector's funds
3. Value for money
4. Risk transfer to private party

A detailed explanation of all factors will be provided in the factor analysis section of this study.

**Table 5: Mean and ranking of Favourable factors for PPP implementation**

| Country | UAE | | UK | |
|---|---|---|---|---|
| **Items** | **Mean** | **Rank** | **Mean** | **Rank** |
| Private sector's skills and experience | 4.57 | 1 | 4.40 | 1 |
| Private sector's funds | 4.33 | 2 | 4.18 | 4 |
| Value for money | 4.10 | 3 | 4.18 | 3 |
| Risk transfer to private party | 4.07 | 4 | 4.37 | 2 |
| Technology transfer | 3.97 | 5 | 3.55 | 13 |
| Project cost and time control | 3.90 | 6 | 4.10 | 6 |
| Capacity Building | 3.80 | 7 | 3.63 | 12 |
| Lack of government resources & experience | 3.70 | 8 | 4.13 | 5 |
| Stimulate financial market | 3.67 | 9 | 3.74 | 9 |
| Long term engagement | 3.63 | 10 | 3.85 | 7 |
| Economic growth | 3.63 | 11 | 3.84 | 8 |
| Large size of projects | 3.50 | 12 | 3.74 | 10 |
| Cap service cost | 3.47 | 13 | 3.73 | 11 |

### 5.2.4 Value for money factors for adopting PPPS

#### *5.2.4.1 Agreement of participants*

As shown in Table 6, the Chi square value for the UAE and the UK' samples are 70.82 and 80.75 respectively. This is significantly higher than the critical Chi square value of 25.00 (degree of freedom = 15). Therefore, the null hypothesis - that there is a significant difference between the expected and the observed results - is rejected, and the rankings provided by each group on the value for money factors are established to be consistent.

**Table 6: Kendall's coefficient of concordance (KCC) for VFM factors for PPPs**

| Country | UAE | UK |
|---|---|---|
| Number of valid surveys | 30 | 62 |
| Kendall's CC (W) | .157 | .087 |
| Chi-Square | 70.82 | 80.75 |
| Degree of freedom | 15 | 15 |
| Asymptotic significance | .000 | .000 |
| Critical Chi-Square | 25.00 | 25.00 |

### *5.2.4.2 Ranking of value for money factors*

Sixteen main factors influence the achievement of value for money in PPP projects (Table 7). The respondents in both countries selected the same four factors as the most important ones in shaping the value for money outcomes. These factors are optimised risk allocation, competitive bid process, improved services to the community, clear output specification; the range of their significance was between 3.94 and 4.20.

**Table 7: Mean and ranking of Value for money factors for PPPs**

| Country | UAE | | UK | |
|---|---|---|---|---|
| **Items** | **Mean** | **Rank** | **Mean** | **Rank** |
| Optimised risk allocation | 4.20 | 1 | 4.13 | 2 |
| Competitive bid process | 4.20 | 2 | 4.15 | 1 |
| Improved services to the community | 4.17 | 3 | 3.94 | 4 |
| Clear output specification | 4.13 | 4 | 3.97 | 3 |
| Improved facilities to the users | 4.00 | 5 | 3.84 | 9 |
| Optimisation of assets efficiency | 3.93 | 6 | 3.87 | 7 |
| Technical innovation | 3.83 | 7 | 3.90 | 5 |
| Private sector's project management skills | 3.80 | 8 | 3.82 | 10 |
| Incentives for private party | 3.77 | 9 | 3.90 | 6 |
| Appropriate capital structure | 3.77 | 10 | 3.81 | 11 |
| Long-term engagement | 3.70 | 11 | 3.76 | 12 |
| Efficient dispute resolutions | 3.70 | 12 | 3.74 | 14 |
| Low life-cycle cost | 3.63 | 13 | 3.87 | 8 |
| Early service delivery | 3.37 | 14 | 3.53 | 15 |
| Reduced negative environmental impact | 3.30 | 15 | 3.40 | 16 |
| Low tariffs | 3.20 | 16 | 3.74 | 13 |

### 5.2.5 Critical success factors for implementing PPPS

#### *5.2.5.1 Agreement of participants*

As shown in Table 8, the Chi square value for the UAE and the UK' samples are 114.89 and 141.70 respectively. This is significantly higher than the critical Chi square value of 27.59 when the degree of freedom is 17. Therefore the null hypothesis - that there is a significant difference in the observations - is rejected, and the rankings provided by each group on the critical success factors for implementing PPPs are established to be consistent.

**Table 8: Kendall's coefficient of concordance (KCC) for Critical success factors for PPPs**

| Country | UAE | UK |
|---|---|---|
| Number of valid surveys | 30 | 62 |
| Kendall's CC (W) | .225 | .134 |
| Chi-Square | 114.89 | 141.70 |
| Degree of freedom | 17 | 17 |
| Asymptotic significance | .000 | .000 |
| Critical Chi-Square | 27.59 | 27.59 |

#### *5.2.5.2 Ranking of the critical success factors for PPPs*

Respondents from the UAE and the UK assigned almost identical significance to the factors of this scale, as they both ranked highest the same nine factors. This ranking was identical for positions one, two, three, seven, eight, and nine, with a minor variation in the order of factors four, five, and six (Table 9). The mean scores for the nine highest critical success factors for PPP implementation in the UAE and the UK were all above 4.00 and ranged from 4.13 to 4.70 for the UAE and from 4.05 to 4.42 for the UK. The nine factors are:

1. Commitment of public and private parties

2. Appropriate risk allocation

3. Committed and competent public agency
4. Transparent procurement process
5. Strong private consortium
6. Competitive procurement process
7. Political support
8. Detailed cost/ benefits assessment
9. Good governance

A detailed explanation of all factors will be provided in the factor analysis section of this study.

**Table 9: Mean and ranking of critical success factors for PPPs**

| Country | UAE | | UK | |
|---|---|---|---|---|
| **Items** | **Mean** | **Rank** | **Mean** | **Rank** |
| Commitment of public and private parties | 4.70 | 1 | 4.42 | 1 |
| Appropriate risk allocation | 4.70 | 2 | 4.40 | 2 |
| Committed and competent public agency | 4.43 | 3 | 4.27 | 3 |
| Transparent procurement process | 4.33 | 4 | 4.23 | 5 |
| Strong private consortium | 4.33 | 5 | 4.18 | 6 |
| Competitive procurement process | 4.27 | 6 | 4.24 | 4 |
| Political support | 4.23 | 7 | 4.13 | 7 |
| Detailed cost/ benefits assessment | 4.17 | 8 | 4.06 | 8 |
| Good governance | 4.13 | 9 | 4.05 | 9 |
| Favourable legal framework | 4.00 | 10 | 3.78 | 15 |
| Multi-benefit objectives of all stakeholders | 3.97 | 11 | 3.95 | 10 |
| Project technical feasibility | 3.97 | 12 | 3.82 | 13 |
| Shared authority between the public and private sector | 3.90 | 13 | 3.81 | 14 |
| Social support | 3.83 | 14 | 3.85 | 12 |
| Sound economic policy | 3.80 | 15 | 3.69 | 17 |
| Government guarantees | 3.63 | 16 | 3.65 | 18 |
| Macro-economic conditions | 3.53 | 17 | 3.87 | 11 |
| Local financial market | 3.50 | 18 | 3.77 | 16 |

### 5.2.6 Results and analysis: UAE sample

#### *5.2.6.1 Reliability test results*

The first step in the analysis of collected data is to ensure the reliability of the factors. Three scales (attributes) of PPPs that this study is focusing on were subjected to a reliability test. The results of the reliability test are illustrated in Table 10. The results are explained as follows: The favourable outcomes factors scale consisted of 13 items and scored 0.800 for Cronbach's Alpha, the value for money factors scale consisted of 16 items (Alpha was 0.853 for the inter-consistency of those items), and the critical success factors scale consisted of 18 items with an inter-consistency Alpha of 0.820.

Alpha results for the three scales were above the threshold of 0.70, as explained in Section 6.7.1. There was no need to delete any items from either scale to improve Alpha. Therefore, the three scales, without any modifications, are reliable, and the analysis can proceed to the next set of tests.

**Table 10: Results of Reliability Test UAE**

| Variables | Number of Items | Cronbach's Alpha |
|---|---|---|
| **Favourable outcomes for PPP implementation** | 13 | .800 |
| **Value for money factors** | 16 | .853 |
| **Critical success factors for PPP** | 18 | .820 |

#### *5.2.6.2 Factor analysis*

The strength of relationships among the items that each scale consists of must be established. As discussed earlier, factor analysis was used to check the interrelationship among all factors and to identify a smaller set of factors that could represent the correlated sets of variables.

*5.2.6.2.1 Favourable factors for PPP implementation*

In Table 11, the correlation matrix of the thirteen items of the favourable factors scale was produced through the utilisation of SPSS software. All factors satisfied the correlation requirements with other factors since they all had partial correlations above the required 0.3 (Brace et al., 2012).

**Table 11: UAE Favourable factors- Correlation Matrix**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capacity Building | 1 | | | | | | | | | | | | |
| Cap service cost | 0.303 | 1 | | | | | | | | | | | |
| Project cost and time control | 0.32 | 0.427 | 1 | | | | | | | | | | |
| Economic growth | 0.314 | 0.097 | 0.195 | 1 | | | | | | | | | |
| Lack of government resources & experience | 0.007 | -0.4 | 0.109 | 0.152 | 1 | | | | | | | | |
| Large size of projects | 0.143 | 0.047 | 0.358 | 0.433 | 0.283 | 1 | | | | | | | |
| Long term engagement | 0.157 | 0.209 | 0.353 | 0.394 | -0.04 | 0.389 | 1 | | | | | | |
| Private sector's funds | -0.14 | -0.39 | -0.25 | 0.102 | 0.297 | 0.316 | 0.092 | 1 | | | | | |
| Private sector's skills and experience | 0.301 | -0.13 | 0.328 | 0.311 | 0.484 | 0.52 | 0.439 | 0.394 | 1 | | | | |
| Risk transfer to private party | 0.017 | 0.293 | 0.489 | 0.1 | -0.1 | 0.415 | 0.583 | 0.131 | 0.427 | 1 | | | |
| Stimulate financial market | 0.484 | 0.317 | 0.069 | 0.14 | -0.07 | 0.173 | 0.503 | 0.021 | 0.228 | 0.295 | 1 | | |
| Technology transfer | 0.183 | -0.03 | 0.272 | 0.361 | 0.26 | 0.323 | 0.436 | 0.213 | 0.406 | 0.193 | 0.248 | 1 | |
| Value for money | 0.025 | 0.065 | 0.664 | 0.256 | 0.26 | 0.503 | 0.522 | 0.111 | 0.551 | 0.588 | 0.038 | 0.493 | 1 |

The value for the Kaiser-Meyer-Olkin measure of sampling adequacy was 0.677 (Table 12), which suggests, as explained earlier, that the sample is factorable (Brace et al., 2012; Kaiser, 1981).

**Table 12: UAE Favourable factors- KMO and Bartlett's Test**

| | | |
|---|---|---|
| *Kaiser-Meyer-Olkin Measure of Sampling Adequacy.* | | *.677* |
| *Bartlett's Test of Sphericity* | *Approx. Chi-Square* | *153.944* |
| | *df* | *78* |
| | *Sig.* | *.000* |

Bartlett's Test of Spherisity, as compared to the critical Chi-square value, was large (Chi-Square =153.9, significant= 0.000); it is therefore unlikely that the correlation is an identity matrix. The Anti-image correlation of all factors was satisfactory since the MSA was greater than 0.5 for all items. It is therefore confirmed that there is no need to eliminate any factors, and factor analysis should proceed to the next step of analysis (Brace et al., 2012).

**Table 13: UAE Favourable factors- Total Variance Explained**

| | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| Component | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 4.265 | 32.805 | 32.805 | 4.265 | 32.805 | 32.805 | 3.401 | 26.165 | 26.165 |
| 2 | 2.280 | 17.535 | 50.340 | 2.280 | 17.535 | 50.340 | 2.100 | 16.152 | 42.317 |
| 3 | 1.430 | 10.999 | 61.339 | 1.430 | 10.999 | 61.339 | 2.013 | 15.486 | 57.803 |
| 4 | 1.190 | 9.156 | 70.495 | 1.190 | 9.156 | 70.495 | 1.650 | 12.691 | 70.495 |
| 5 | .865 | 6.653 | 77.147 | | | | | | |
| 6 | .776 | 5.966 | 83.113 | | | | | | |
| 7 | .520 | 3.998 | 87.111 | | | | | | |
| 8 | .482 | 3.705 | 90.816 | | | | | | |
| 9 | .379 | 2.912 | 93.728 | | | | | | |
| 10 | .265 | 2.037 | 95.765 | | | | | | |
| 11 | .239 | 1.839 | 97.604 | | | | | | |
| 12 | .183 | 1.407 | 99.010 | | | | | | |
| 13 | .129 | .990 | 100.000 | | | | | | |

Table 13 shows the total variance explained by each factor. When the Eigenvalue was set to be greater than one, four factors could explain 70.5% of the total variance; the remaining nine factors collectively accounted for 29.5% of the variance. Therefore, a four-factor model is adequate to represent the favourable factors for considering PPP alternatives.

The data was analysed by means of principal component analysis (Table 14), where factor grouping through a Varimax rotation was conducted, six items loaded above 0.5 onto factor one; two of them with cross loading, but low on the other factors. The six items are value for money, risk transfer to private party, project cost and time control, long-term engagement, large size of projects, and private sector's skills and experience. This factor was labelled "Cost savings".

*Cost savings*

The cost savings factor accounted for about 26.2% of total variance in favourable PPP factors and consisted of 6 variables as mentioned above. This factor is themed by financial efficiency criteria, as the respondents associated the highest significance to this component as the main reason for considering PPP models.

Value in PPPs is the delivery of services or projects with the optimal cost and benefits. Value for money had a loading of 0.905 followed by Risk transfer to private parties (0.792) (Table 14). This indicates that for the private party, value for money and transfer risk are the most favourable factors in procuring projects through the PPP mechanism. Value for money is the tool for assessing whether the PPP will deliver a better value over any other conventional method (WBI, 2012). Achieving cost savings, as an attractive PPP factor, depends also on the capability of identifying and allocating risk. The guiding principal in this regard is that risks should be allocated to the parties capable of managing them best. It comes in the form of financial consequences in response to variations in project outcomes. Successful risk allocation leads to improved value for money (P3, 2011).

**Table 14: UAE Favourable factors- Rotated Component Matrix**

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| *Value for money* | *.905* | | | |
| *Risk transfer to private party* | *.792* | | | |
| *Project cost and time control* | *.703* | | *-.552* | |
| *Long term engagement* | *.618* | | | *.549* |
| *Large size of projects* | *.617* | | | |
| *Private sector's skills and experience* | *.591* | | | |
| *Capacity Building* | | *.787* | | |
| *Economic growth* | | *.626* | | |
| *Technology transfer* | | | | - |
| *Private sector's funds* | | | *.833* | |
| *Cap service cost* | | | *-.721* | |
| *Stimulate financial market* | | | | *.768* |
| *Lack of government resources & experience* | | | | *-.555* |

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 16 iterations.

A high loading (.703) is associated with project cost and the time control factor. This indicates that financial and time efficiency are expected to be gained from the involvement of private parties in the development of projects and also includes direct administration cost savings on the public party's side.

The last three variables that loaded fairly high on the cost savings factor for favourable outcomes for adopting PPPs are long-term engagement (0.618), large size of projects (0.617), and the private sector's skills and experience (0.591). These items indicate that cost savings are enhanced by the long-term partnership, where either party seeks sustainability and mutual benefits with the intention of reducing hindrances, reducing cost, and maximizing returns on the project. This also applies to the size of the project; respondents associated large size projects to cost efficiency if they are implemented under the PPP mechanism. As for the private sector's skills and experience, the respondents indicated the achievement of cost savings through the skills and experience of the private party in creating efficiency through utilising technologies that accelerate the handover of the project with less cost and the private party's capability for overcoming the challenges faced during the development of the project.

*Benefits to the public sector*

Factor two accounted for 16.15% of the total variance in favourable PPP adoption factors. Two items loaded onto factor two: capacity building (.787) and economic growth (.626), both loaded above 0.5 and had no cross loading on other factors. Factor two was labelled "Benefits to the public sector."  PPPs are attractive for adoption by the public sector when they are seen as opportunities for institutional development through capacity building. PPPs require legal frameworks, governmental bodies, integration between all related departments, and the required skills and resources to undertake a long-term engagement such as a PPP. Economic growth is another benefit to the public sector that is expected to be gained by adopting PPP models. Sustainable public services can be achieved if the private sector is allowed to utilize their skills in capital mobilization, technology, and management, leading to the creation of a base for economic growth.

*Benefits to the end users*

Two items loaded onto factor three which accounted for 15.4% of the variance: private sector's funds (0.833) and cap service cost (0.721); both loaded above 0.5 and had no cross loading on other factors. Factor three was labelled 'Benefits to the public.' The public sector's budget is relieved by the utilisation of the private sector's funds to respond to public pressure for improved services; overcoming such hindrances are perceived by the respondents as attractive reasons for selecting PPP procurements. The end users see in PPPs an opportunity for efficient project delivery where timely completion is more credible and reduced project cost is expected, all of which leads to reduced service charges for availing the services. This is seen as a favourable reason for adopting PPPs.

*Economic and technical benefits*

Factor four accounted for about 12.7% of the variance in the favourable PPP adoption factors and had two items loaded onto it: stimulate financial market (0.768) and lack of government resources and experience (0.555), where both loaded above 0.5 with no cross loading on other factors. Factor 4 was labelled "Economic and technical benefits." This factor indicates that economic impact through stimulating the financial market is seen as an attractive reason for preferring PPPs to the conventional procurement methods. PPPs facilitate the activity of local financial markets through the utilisation of local institutions for debt raising for the project. Debt comes in different forms, such as commercial loans, bridge loans, subordinated loans, and bonds, all of which stimulate financial transactions among the financial institutions and lead to improving the country's credit rating and economic growth.

Efficient procurement to correspond to the lack of government resources and experience is seen as an attractive reason for incorporating PPP procurements. PPPs help overcome the issues of inefficient and inexperienced government bodies for handling certain types of projects. Another advantage is the technology transfer expected to occur between the public and private parties, leading to the establishment of the required skills, resources, and exposure to the latest technologies for building local capacity for undertaking future projects.

*5.2.6.2.2 Value for money factors*

All factors of the sixteen items of the value for money factors scale, produced through the utilisation of SPSS, had correlations with other factors since they all had partial correlations above the required 0.3 (Brace et al., 2012) (see Appendix B, Table B-1)

The value for the Kaiser-Meyer-Olkin measure of sampling adequacy was 0.637 (Appendix B, Table B-2), suggesting that the sample is factorable (Brace et al., 2012; Kaiser, 1981).

Bartlett's Test of Spherisity was large (Chi-Square =*291.1*, significant= 0.000); it is therefore unlikely that the correlation is an identity matrix. The Anti-image correlation of all factors was satisfactory since the MSA was greater than 0.5 for all items. This confirmed that there is no need to eliminate any factors, and factor analysis should proceed to the next step of analysis (Brace et al., 2012).

When Eigenvalue is set to be greater than one, four factors could explain 72.5% of the total variance; the remaining twelve factors collectively accounted for 27.5% of the variance (Appendix B, Table B-3). Therefore, a structure of four factors is adequate to represent the value for money factors for adopting PPP models.

The data was analysed by means of principal component analysis (Appendix B, Table B-4), where factor grouping through a Varimax rotation was conducted. Six items loaded above 0.5 onto factor one without cross loading on the remaining factors.

*Financial efficiency*

Factor one accounted for 24.09% of the total variance in value for money factors and consists of optimisation of assets efficiency (.880), optimised risk allocation (.735), technical innovation (.699), clear output specification (.675), low life-cycle cost (.666), and competitive bid process (.601). This factor was labelled "Financial efficiency." The highest loading was from optimization of assets efficiency.

The items loaded onto the first factor comply with the above requirements for generating value for money. The highest loading was associated with the optimization of assets efficiency. Value for money in the form of financial efficiency is expected to be obtained from optimization of asset efficiency, as this will include using technology to best manage the assets, where the optimum exploitation of all assets to deliver the best value for the project will be an objective of the management team. The tasks will also include the integration of the asset with other assets and proactive and reactive maintenance measures to ensure the longevity of the assets.

The second variable loading onto the financial efficiency factor was optimised risk allocation. When public and private parties agree on a mechanism for sharing the risks, where they allocate the risks to the party that best manages them, this will lead to financial efficiency in the form of reduced financial implications related to mishandling of variations in the project development or the output performance of the project.

A fairly high loading is given to Technical innovation. The technologies and management systems that are employed by the private party are expected to minimise redundancy, optimise resource utilisation, integrate processes, and reduce tariffs on end users, all of which leads to cost savings and efficiency in the project.

Clear output specifications is another fairly high loading item onto financial efficiency factor. It is important for the safe completion of long-term projects, such as PPPs, to have clear output specifications rather than just inputs, as inputs are expected to change over the long duration of the project. Such actions will ensure financial efficiencies by avoiding potential variations to accommodate the services for the end users.

The last two items loading onto the first factor are Low life-cycle cost and Competitive bid process. Low life-cycle cost is possible in PPP projects since all cycles of the project such as design, construction, management, maintenance are under one contract, allowing the developer to better control cost and generate financial efficiency throughout the life stages of the project. Competitive bid process is very critical in order for the project to generate financial efficiency as well. It is very important that the public party gives ample time for this process and invites as many competent participants as possible. The pre-qualification of tenderers, bid evaluation, award criteria, negotiations, finalizing the PPP contract, and financial close are all important phases to be taken in order for the PPP project to be successful and result in cost savings to achieve the value for money criteria sought after by the implementation of PPP projects (WBI, 2012).

*Project sustainability*

Factor 2 accounted for 18.31% of the total variance and had three items loading onto it: reduced negative environmental impact (.908), efficient dispute resolutions (.855), and early service delivery (.680), all of which loaded above 0.5 and had no cross loading on other factors. Factor 2 was labelled "Project sustainability."

Reduced negative environmental impact is regarded as the most critical variable, as it loaded extremely high on the sustainability factor. This indicates that "going green" will lead to reduced environmental risks on the private party in addition to increasing the public support for the PPP project, which will minimise public risks as well as leading to attaining value for money by generating financial efficiency. The second item in the sustainability factor is Efficient dispute resolutions. Having a systematic approach for dealing with change will minimise the chances of disputes and will outlay a platform for renegotiations. Renegotiations are the best way to deal with input changes for long-term projects and ensure the sustainability of said projects. Such measures will lead to financial efficiency since renegotiations will result in mutual benefits. Early service delivery is expected to improve the sustainability of the project and lead to financial efficiency. Early delivery of the project will allow the cash inflows to be generated, providing a vital tool for the financing and repayment of debts of the PPP project, ensuring the sustainability of the project through less reliance on debt financing and the reduction of debt servicing and all other associated costs leading to financial efficiency in the project.

*Optimization of private party's contribution*

Three items loaded onto the third factor which accounted for 15.56% of the total variance; they are incentives for private party (.843), long-term engagement (.843), and the private sector's project management skills (.790), all of which scored above 0.5 and had no cross loading on other factors. Factor 2 was labelled "Optimization of private party's contribution."

Incentives for private parties and long-term engagement both loaded equally on the third factor. When private parties are offered incentives to participate in projects, they improve the financial efficiency expected from the PPP project. Incentives can be in the form of linking returns to performance, improved risk allocation, subsidies, off-take agreements, and guarantees. These measures are expected to maximise the performance of the private party, leading to efficiency in the project and achieving value for money. Long-term contracts are preferred by the private party because they employ its management skills to maximise the returns, as more considerations by the public party are given to completing the project, mutual benefits are ensured. This enables the private party to gain long-term benefits from the project rather than just short-term, as happens in conventional procurement methods. The private party will opt for creative solutions, through management skills obtained from previous experience, to attain as many benefits as possible, leading to better performance of the project.

*Benefits to the end users*

The fourth factor accounted for 14.56% of the total variance in the value for money scale and had four items loaded onto it. These items are improved services to the community (.763), improved facilities to the users (.693), low tariffs (.672), and appropriate capital structure (.571), all of which scored above 0.5 and had no cross loading on other factors, except the last one which loaded lower on the second factor. Factor 4 was labelled "Benefits to the end users."

Improved service to the community and improved facilities to the end users were the highest loading items on the first factor. It is expected that value for money can be achieved in PPP projects since they generate benefits to the community and end users where the private party employs state of the art technologies and skills to maximise the returns of the project and where innovative ideas are introduced to the community. Innovation also leads to lower costs for the project, leading to benefits in the form of low tariffs and service charges for availing the services. Appropriate capital structuring also generates an abundance of benefits to the public, as the most viable capital structure will lead to the optimum project cost, which will determine the service charges to the public. These are all benefits that the end users are deeming as value for money for adopting the PPP models.

*5.2.6.2.3 Critical success factors*

All factors of the eighteen items of the critical success factors scale, produced through the utilisation of SPSS software, had correlations with other factors since they all had partial correlations above the required 0.3 with at least a single factor (Brace et al., 2012) (Appendix B, Table B-5)

The value for the Kaiser-Meyer-Olkin measure of sampling adequacy was 0.541 (Appendix B, Table B-6), suggesting that the sample is factorable (Brace et al., 2012; Kaiser, 1981). Bartlett's Test of Spherisity is large (Chi-Square=296.06 and the associated significance is 0.000), therefore it is unlikely that the correlation is an identity matrix. Therefore, it is confirmed that there is no need to eliminate any factor, and factor analysis should proceed to the next step of analysis (Brace et al., 2012).

When Eigenvalue is set to be greater than one, seven factors could explain 83.2% of the total variance; the remaining eleven factors collectively accounted for 16.8% of the variance (Appendix B, Table B-7). Therefore, a structure of seven factors is adequate to represent the critical success factors considered for adopting PPP models.

*Project feasibility*

The data was analysed by means of principal component analysis (Appendix B, Table B-8), where factor grouping through a Varimax rotation was conducted. The primary factor accounted for 20.13% of the total variance in the critical success factors scale. Four items loaded above 0.5 onto this factor, one of them with low cross loading on factor four; they are local financial market (.905), macro-economic conditions (.875), multi-benefit objectives of all stakeholders (.761), and project technical feasibility (.653). Factor one was labelled ‘Project feasibility.’

Local financial market was the highest loading item onto the Project feasibility factor of the critical success factors for implementing PPP projects. This high loading indicates the importance of having an active and efficient local financial market to support the capital outlay requirements of the project. Such capital outlay consists of debt and equity; the equity includes direct contributions by shareholders, where debt, which comes as commercial loans, bridge loans, subordinated loans, and bonds, etc., requires a mature financial market to draw from. It is therefore seen as the most critical success factor for the feasibility of the project.

Macro-economic conditions had a very high loading as well, and ranked second after local financial market onto factor one. The economic conditions of the country, such as economic growth, GDP, inflation, interest rate, and unemployment, are seen as very critical factors for the financial conditions and must be considered favourable by the public and private parties in order to ensure that PPPs will be successful projects. These favourable economic conditions will provide the stable and integrated platform where the PPP project will improve the project feasibility.

Multi-benefit objectives of stakeholders loaded high on the project feasibility factor which indicates that achieving the objectives of the private parties along with the acknowledged objectives of the public party will improve the feasibility of the project .

Project technical feasibility loaded fairly high as well on the project feasibility factor of the critical success factors. Technical feasibility is the study of the available tested technologies that are required for the delivery of the project and the technical risks that are expected to be faced by the project during its life cycle (WBI, 2012). Therefore, it is critical that technical feasibility is conducted to support the other feasibility types of the PPP project.

*Effective bid management*

The second factor accounted for 14.53% of the variance and consisted of committed and competent public agency (.870) and competitive procurement process (specs, shortlist, etc.) (.796). Factor two was labelled ‘Effective bid management.’

Effective bid management is a very critical success factor for implementing PPP models. This factor consisted of two variables loading highly onto it: a Committed and competent public agency and a Competitive procurement process. Effective bid management requires a public agency committed to the cause of PPPs and a competent one in handling the process diligently and transparently. A competitive procurement process will ensure that the output specifications are clearly outlined, qualified tenderers are shortlisted, negotiations are effective, and the bid winner is actually the best one to deliver the objectives of the project.

*Favourable local conditions*

The third factor accounted for 11.78% of the total variance and had three items loaded onto it: favourable legal framework (.808), political support (.756), and social support (.655). the third factor was labelled ‘Favourable local conditions.’

The local legal framework loaded highly on the favourable local conditions, and that indicates that legal platform for agreements, policies, legislation, regulations, etc. are favourable in the view of private parties to initiate their investments in the country. Political support refers to the continuous support for the project regardless of what elections bring to the government. Social support is the public’s support for the facilities and the services the PPP project is expected to bring, where the lack of their support might delay the permits for the commencement, reduce revenues due to lack of use of services, or cause political debates that might delay the project. These three items are very critical in making the local conditions favourable for private investors.

*Commitment of public and private parties*

The fourth factor accounted for 10.32% of the total variance and consisted of two items: transparent procurement process (.854) and commitment of public and private parties (.589). The fourth factor was labelled ‘Commitment of public and private parties.’ Transparent procurement process loaded very highly onto this factor. It is very critical for the PPP project, in order to succeed, to have a transparent bid process until the final close. It is very common for a PPP project to undergo a multi-stage bid process where the rights of some bidders become infringed which undermines the efforts to award project to the best bidder. The government must show more commitment by ensuring transparency for the full duration of the bid process and not only in the initial submittals. The public and private parties must show equal commitment to the objectives of the PPP project in order for the project to be a successful one.

*Government involvement*

The fifth factor accounted for 9.52% of the variance and consisted of two items: appropriate risk allocation (.814) and government guarantees (.562). The fifth factor was labelled "Government involvement." The involvement of the government by providing guarantees that safeguard the investment from certain eventualities is regarded as a critical success factor for the respondents in the UAE. This is probably attributable to the fact that the government has scarce experience in this area which might lead to failure to respond to risks in due time or to act positively in ensuring the streamline of revenues from end users. Providing a clear plan for protecting the investment will improve the chances for success and will invite more tenderers to the project. Appropriate risk allocation is another area where the government can be involved to make the PPP project more successful. Realistic risk allocation to the private party is a very critical success factor for the PPP project, which the high loading of this item indicates (.814).

*Project delivery*

The sixth factor accounted for 8.93% of the variance in the critical success factors scale and consisted of two items: detailed cost/ benefits assessment (.826) and strong private consortium (.761). The sixth factor was labelled 'Project delivery.' In order for the project delivery to be a smooth and successful one, a thorough and detailed cost and benefit study must be done to identify all means and alternatives that are in the best interest of all stakeholders of the PPP project. This cost/benefit study is normally part of the project appraisal stage where project feasibility, economic and commercial viability, and financing options are studied for establishing the value of using the PPP option.

Another item that loaded fairly high on the project delivery factor was Strong private consortium. If the consortium of designers, contractors, and financiers under the special purpose vehicle for running the project are well established, the delivery of the project will be more successful. That will be through designing the most efficient project, being familiar with the construction and risks associated with the type of the project, and having the best financial experts in structuring the capital outlay and the management of cash flows.

*Effective leadership*

The seventh factor, which accounted for about 8% of the total variance, had two items loading onto it above 0.5: shared authority between the public and private sector (.771) and sound economic policy (.629), the latter of which loaded lower on factor one. This item was labelled "Effective leadership." Shared authority between the public and private parties is a critical factor related to effective leadership. The decision making process for the PPP project is a shared responsibility with established procedures for scope and the roles of each party. The public party should not take any measures that affect the operation of the project without prior consultation with the private party, nor should the private party make decisions affecting the pre-determined objectives of the project without the consent of the public party. Sound economic policy is another important variable affecting the effective leadership of the project. This indicates that the decision makers in the government should exhibit leadership in establishing a clear and sound plan for economic growth where all sectors are integrated and viable projects are identified for the private sector to contribute its funds and experiences in their development.

## 5.2.7 Results and analysis: UK sample

### *5.2.7.1 Reliability test results*

A similar approach to the one used for the UAE sample was used for the UK sample. The first step in the analysis of collected data was to ensure the reliability of the factors. The results of reliability test as, shown in Table 15, are as follows: The favourable outcomes factors scale consisted of 13 items and scored 0.894 for Cronbach's Alpha, the value for money factors scale consisted of 16 items and the Alpha was 0.925 for the inter-consistency of those items, and the critical success factors scale consisted of 18 items with an inter-consistency Alpha of 0.893.

Alpha results for the three scales were above 0.70 as explained earlier. There was no need to delete any items of any scale to improve Alpha. Therefore, the three scales, without any modifications, are reliable, and the analysis can proceed to the next set of tests.

**Table 15: UK Favourable Factors- Results of Reliability Test**

| Variables | Number of Items | Cronbach's Alpha |
|---|---|---|
| Favourable outcomes for PPP nentation | 13 | .894 |
| for money factors | 16 | .925 |
| Critical success factors for PPP | 18 | .893 |

### *5.2.7.2 Factor analysis*

*5.2.7.2.1 Favourable factors for PPP implementation*

Table 16 is the correlation matrix of the thirteen items of the favourable factors for PPP adoption. All factors had correlations with other factors since they all had partial correlations above the required 0.3.

**Table 16: UK Favourable Factors- Correlation Matrix**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capacity Building | 1 | | | | | | | | | | | | |
| Cap service cost | 0.704 | 1 | | | | | | | | | | | |
| Project cost and time control | 0.531 | 0.55 | 1 | | | | | | | | | | |
| Economic growth | 0.594 | 0.437 | 0.609 | 1 | | | | | | | | | |
| Lack of government resources & experience | 0.438 | 0.257 | 0.509 | 0.414 | 1 | | | | | | | | |
| Large size of projects | 0.385 | 0.309 | 0.496 | 0.577 | 0.431 | 1 | | | | | | | |
| Long term engagement | 0.454 | 0.308 | 0.546 | 0.579 | 0.514 | 0.587 | 1 | | | | | | |
| Private sector's funds | -0.02 | 0 | 0.383 | 0.212 | 0.137 | 0.225 | 0.329 | 1 | | | | | |
| Private sector's skills and experience | 0.273 | 0.222 | 0.419 | 0.34 | 0.53 | 0.222 | 0.44 | 0.414 | 1 | | | | |
| Risk transfer to private party | 0.181 | 0.3 | 0.419 | 0.331 | 0.387 | 0.188 | 0.343 | 0.311 | 0.554 | 1 | | | |
| Stimulate financial market | 0.351 | 0.27 | 0.59 | 0.591 | 0.295 | 0.437 | 0.548 | 0.172 | 0.258 | 0.314 | 1 | | |
| Technology transfer | 0.455 | 0.354 | 0.486 | 0.506 | 0.459 | 0.462 | 0.617 | 0.155 | 0.236 | 0.165 | 0.686 | 1 | |
| Value for money | 0.364 | 0.279 | 0.528 | 0.445 | 0.591 | 0.402 | 0.551 | 0.164 | 0.381 | 0.49 | 0.458 | 0.342 | 1 |

The value for the Kaiser-Meyer-Olkin measure of sampling adequacy (Table 17) was 0.798, which suggests that the sample was factorable (Brace et al., 2012; Kaiser, 1981).

**Table 17: UK Favourable Factors- KMO and Bartlett's Test**

| | | |
|---|---|---|
| *Kaiser-Meyer-Olkin Measure of Sampling Adequacy.* | | *.798* |
| *Bartlett's Test of Sphericity* | *Approx. Chi-Square* | *409.089* |
| | *df* | *78* |
| | *Sig.* | *.000* |

Bartlett's Test of Spherisity was large (Chi-Square = 409.08, significant = 0.000); it is therefore unlikely that the correlation is an identity matrix. The Anti-image correlation of all factors was satisfactory since the MSA was greater than 0.5 for all items. Therefore, there is no need to eliminate any factors, and factor analysis should proceed to the next step of analysis (Brace et al., 2012).

**Table 18: UK Favourable Factors- Total Variance Explained**

| Component | Initial Eigenvalues Total | % of Variance | Cumulative % | Extraction Sums of Squared Loadings Total | % of Variance | Cumulative % | Rotation Sums of Squared Loadings Total | % of Variance | Cumulative % |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 5.894 | 45.341 | 45.341 | 5.894 | 45.341 | 45.341 | 3.740 | 28.766 | 28.766 |
| 2 | 1.530 | 11.768 | 57.109 | 1.530 | 11.768 | 57.109 | 2.811 | 21.621 | 50.387 |
| 3 | 1.141 | 8.778 | 65.887 | 1.141 | 8.778 | 65.887 | 2.015 | 15.500 | 65.887 |
| 4 | .893 | 6.872 | 72.759 | | | | | | |
| 5 | .728 | 5.598 | 78.357 | | | | | | |
| 6 | .627 | 4.821 | 83.177 | | | | | | |
| 7 | .488 | 3.751 | 86.929 | | | | | | |
| 8 | .423 | 3.256 | 90.184 | | | | | | |
| 9 | .400 | 3.077 | 93.261 | | | | | | |
| 10 | .307 | 2.365 | 95.627 | | | | | | |
| 11 | .242 | 1.861 | 97.488 | | | | | | |
| 12 | .197 | 1.515 | 99.003 | | | | | | |
| 13 | .130 | .997 | 100.000 | | | | | | |

The total variance explained by each item is shown in Table 18. When Eigenvalue was set to be greater than one, three factors could explain 65.88% of the total variance; the remaining ten factors collectively accounted for 34.12% of the variance. Therefore, a three-factor model was adequate to represent the favourable factors for considering PPP alternatives.

The data was analysed by means of principal component analysis (Table 19), where factor grouping through a Varimax rotation was used.

*Cost savings*

Six items loaded above 0.5 onto factor one without cross loading on other factors. This factor accounted for 28.7% of total variance and had the following items loaded onto it: technology transfer (.813), stimulate financial market (.801), long-term engagement (.737), large size of projects (.722), economic growth (.676), and project cost and time control (.570) (Table 19). This primary factor was labelled "Cost savings."

**Table 19: UK Favourable Factors- Rotated Component Matrix**

| | Component | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| *Technology transfer* | .813 | | |
| *Stimulate financial market* | .801 | | |
| *Long term engagement* | .737 | | |
| *Large size of projects* | .722 | | |
| *Economic growth* | .676 | | |
| *Project cost and time control* | .570 | | |
| *Private sector's skills and experience* | | .825 | |
| *Risk transfer to private party* | | .806 | |
| *Private sector's funds* | | .573 | |
| *Lack of government resources & experience* | | .557 | |
| *Value for money* | | .552 | |
| *Cap service cost* | | | .830 |
| *Capacity Building* | | | .801 |

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 5 iterations.

Technology transfer had the highest loading on the cost savings factor. This indicates that cost savings, by adopting PPPs, are more achievable when there is transfer of know-how and knowledge from the private party to the public party, which will improve the capacity for handling certain scopes and similar projects and will improve risk allocation. Stimulation of financial market had a high loading on the cost savings factor, and this indicates that it is an attractive factor for adopting PPPs, where cost savings are expected to be achieved through the utilisation of the local financial institutions associated with debt raising for the project. Such utilisation will stimulate the market to be a competitive one for providing the optimum financial solutions for the project, leading to efficiency in savings from debt structuring and servicing. Long-term engagement and large size of projects loaded high on the cost savings factor, making them attractive factors for adopting PPP models. This indicates that long duration and large size of projects makes both parties realise the importance of the mutual and durable benefits of the project. This can be visible in the cost reductions that both parties deem necessary in order to maximise their long-term benefits from the project. Economic growth loaded high on cost savings factor, indicating that sustainable growth can be expected if the private sector is allowed to utilize its experience and capital capabilities in governmental projects, leading to a widespread local practice that creates a base for economic competitiveness which will provide cost effective services. The last variable that loaded onto the cost savings factor was Project cost and time control. It is expected that time and cost savings are gained from involving the private sector in developing public projects due to previous experience, the knowledge and technology used, and the access to financial resources. Time and cost savings are also expected to be achieved by the public party through the efficiency expected in the administration scopes.

*Benefits to private party*

Factor two accounted for 21.6% of total variance in favourable factors for PPP adoption. Five items loaded above 0.5 onto factor two and had no cross loading on other factors. These items are private sector’s skills and experience (.825), risk transfer to private party (.806), private sector’s funds (.573), lack of government resources and experience (.557), and value for money (.552). This factor was labelled ‘Benefits to private party.’

The private sector's skills and experience are seen as very critical variables in generating financial benefits to the public party, as it had the highest loading onto this factor. Cost savings are expected to be achieved when the private party utilises its state of the art methods, technologies, and previous experiences to safely complete the project and hand it over in time to enable cash inflows to be generated. This will relieve pressure on the capital outlay structure and will enable the government to realise some profits.

Risk transfer to private party had a high loading as well onto the financial benefits to the public party factor, indicating that risk transfer to private parties is a favourable reason for adopting PPP models. Since risk transfer to the private party will ensure that such risk is managed with the least responsibility to the public party, this will shield the private party from unaccounted for costs related to remedying the outcomes of such risks or the costs associated with obtaining insurances against them. Administration costs are also expected to be reduced since some scopes will be the liability of the private party.

The remaining three items loaded onto financial benefits to the public party loaded almost with equal significance. The private sector's funds are considered to generate financial benefits to the public party. Such funds allow the government to develop projects in response to public pressure for improved services, which relieves the constraints on its budget and allows for using local funds more wisely for generating more revenue.

The Lack of government resources and experience variable is seen is a favourable issue that PPP models can overcome and, among others, will create financial benefits to the public party. The lack of resources and skills in the government to handle large projects may deter the government from pursuing large investments that, when completed, yield strategic incomes and respond to local demands. The role of the private party, both in providing the funds and the know-how, is very significant in this matter and leads to overcoming this weakness.

The Value for money variable is the last variable loaded on Financial benefits to the public party. Value for money is assessed by comparing the PPP project to other conventional methods and establishing that the PPP method is delivering more value than its rival methods. Value for money enables the project to achieve financial efficiency, as it requires rigorous study, such as a feasibility study, and commercial and economic viability, to establish the true worthiness of the project (WBI, 2012).

*End users benefits*

The third and last factor of the favourable factors for the PPPs scale accounted for 15.5% of total variance and had two items loading above 0.5 onto it. These items are cap service cost (.830) and capacity building (.801). This factor was labelled "End users benefits." End users benefit from capping the service cost due to the efficiency PPPs deliver in public projects. The time and cost control achieved by the private party's skills and resources, and the incentive to achieve faster returns by early completion, leads to early availing of services and to financial efficiency in completing the project, which in turn results in reduced service charges on the end users of the facility. High significance of the Capacity building variable loaded onto the end users benefits factor. This indicates that capacity building is regarded as a favourable outcome for end users for adopting PPP models. PPPs require a solid platform for operation to maximise success, and such a platform consists of legal frameworks, regulations, legislation, and integration of governmental bodies. This requirement is seen by end users as an opportunity to improve the functioning of the government which will improve the services offered to the public.

*5.2.7.2.2 Value for money factors*

The correlation matrix of the sixteen items of the value for money factors scale (Appendix C, Table C-1) was produced through the utilisation of SPSS. All factors satisfied the correlation requirements since they all had partial correlations above 0.3 (Brace et al., 2012).

The value for the Kaiser-Meyer-Olkin measure of sampling adequacy was 0.637 (Appendix C, Table C-2), suggesting that the sample is factorable (Brace et al., 2012; Kaiser, 1981).

Bartlett's Test of Spherisity was large (Chi-Square =631.23, significant= 0.000), therefore it is unlikely that the correlation is an identity matrix. The Anti-image correlation of all factors was satisfactory with an MSA greater than 0.5 for all items. Therefore there was no need to eliminate any factor, and factor analysis should proceed to the next step of analysis (Brace et al., 2012).

**Table 20: UK VFM- Total Variance Explained**

| *Component* | *Initial Eigenvalues* | | | *Rotation Sums of Squared Loadings* | | |
|---|---|---|---|---|---|---|
| | *Total* | *% of Variance* | *Cumulative %* | *Total* | *% of Variance* | *Cumulative %* |
| *1* | *7.715* | *48.216* | *48.216* | *3.938* | *24.610* | *24.610* |
| *2* | *1.545* | *9.656* | *57.873* | *3.073* | *19.203* | *43.814* |
| *3* | *1.124* | *7.026* | *64.898* | *2.251* | *14.070* | *57.883* |
| *4* | *1.025* | *6.404* | *71.302* | *2.147* | *13.419* | *71.302* |
| *5* | *.904* | *5.651* | *76.953* | | | |
| *6* | *.780* | *4.877* | *81.830* | | | |
| *7* | *.548* | *3.423* | *85.254* | | | |
| *8* | *.454* | *2.841* | *88.094* | | | |
| *9* | *.414* | *2.586* | *90.680* | | | |
| *10* | *.367* | *2.292* | *92.972* | | | |
| *11* | *.291* | *1.822* | *94.794* | | | |
| *12* | *.246* | *1.539* | *96.333* | | | |
| *13* | *.216* | *1.348* | *97.681* | | | |
| *14* | *.159* | *.991* | *98.673* | | | |
| *15* | *.118* | *.736* | *99.409* | | | |
| *16* | *.095* | *.591* | *100.000* | | | |

When Eigenvalue was set to be greater than one, four factors could explain 71.3% of the total variance; the remaining twelve factors together accounted for 28.7% of the variance (Table 20). Therefore, a four-factor model was adequate to represent the value for money factors for PPP models.

The data was analysed by means of principal component analysis, where factor grouping through a Varimax rotation was used.

*Optimization of private party's contribution*

Seven items loaded above 0.5 onto the first factor without cross loading on other factors. This primary factor accounted for 24.6% of total variance and included incentives for private party (.714), improved services to the community (.707), appropriate capital structure (.687), efficient dispute resolutions (.651), optimised risk allocation (.645), private sector's project management skills (.611), and long-term engagement (.557) (Appendices 7-12). This primary factor was labelled ‘Optimization of private party's contribution.’

When the private party is offered incentives for participation in a project, it will maximise its efforts to reap the full potential of such benefits. Such incentives can be in the form of rewards for early completion, optimised services, appropriate risk sharing, guarantees for securing the funds provided by the private party, etc. These incentives are expected to optimise performance, reduce development cost, and minimise the public party's exposure to risk, all of which will increase the chances for the achievement of value for money of the developed project.

Improved services to the community had a high loading on the optimisation of the private party's contribution. By allowing the private party a buffer to introduce new technologies and innovative development ideas, improved services can be attained where efficiency in development cost are expected as well. Therefore, the community will receive better services and reduced tariffs and service charges for using such facilities and services.

Appropriate capital structuring loaded fairly high on the optimization of private party's contribution. By allowing the private party flexibility in introducing the most viable alternatives for structuring the funding of the project and providing them access to financial institutions, the most cost effective project can be achieved leading to success for value for money objectives.

The fourth variable loading on this factor was Effective dispute resolutions. The outcome of private parties is optimised when there are clear, detailed criteria for managing such change. Prompt and realistic settlement of disputes will minimise time and cost wastage and will enforce the mutual benefit objective for the safe completion of the project, all of which will lead to efficiency in cost and time and help maximise the contribution of the private party, leading to improved chances for value for money.

Optimised risk allocation also plays a significant role in the contribution of the private party. Risk should be allocated to the party capable of managing it best. The public party should not transfer any risks that the private party that it is not interested in handling. If all risks are allocated to the right party, fewer eventualities will be expected and the private party will contribute more to the project since they will feel protected from risks that do not belong to them.

The last two items loading on the first factor are private sector's project management skills and long-term engagement. If the private party is allowed to use their management skills in delivering the project where previous experiences and exposure to the latest technologies will be employed for completing the project, value for money will be achieved in the form of time and financial efficiency. The long-term engagement gives more security to the private party, as the public party will be more inclined toward the sustainability of the project and will prefer the mutual benefits from the project. This will improve the contribution to the project and efficiency is expected to be achieved.

*Project sustainability*

Factor two accounted for 19.2% of total variance in value for money factors for PPP alternatives. Four items loaded above 0.5 onto factor two and had no cross loading on other factors. These items are low tariffs (.794), low life-cycle cost (.789), optimisation of assets efficiency (.781), and technical innovation (.591). The second factor was labelled ‘Project sustainability.’

Low tariffs had a high loading onto the project sustainability factor, as it indicates that low tariffs are expected from the sustainability PPP projects offer. The private party involves their skills and resources to maximise the returns on the project where cost savings are supposed to be achieved and therefore lower tariffs can be expected.

The value for money through the sustainability of the project is also more achievable from the low life-cycle cost benefit achieved by PPP models. The integration of all development phases from design ,construction, management, maintenance, finance, etc. helps avoid redundancy and utilise the resources more properly which leads to better value for money.

Optimization of assets efficiency loaded high on the project sustainability factor for value for money objectives of PPP projects. Proper optimisation of the assets through the use of technology to exploit the potential of these assets will generate additional value through efficiency and improve facilities and services for the community.

Technical innovation through the utilisation of state of the art concepts and products is expected to contribute significantly to the sustainability of the project. Such concepts and products will be integrated into the processes and operation of the project which will optimise resource management and reduce redundancy, improving the end product and ensuring the best value for money spent.

*Competitive procurement*

The third factor for the value for money factors for PPPs scale accounted for 14.0% of total variance and had two items loading above 0.5 onto it. These items are competitive bid process (.840) and clear output specification (.808). This factor was labelled "Competitive procurement." Competitive bid loaded high on the competitive procurement factor for achieving value for money objectives of PPP models. It indicates that a competitive bid process is critical in order for the project to deliver value for money. Due consideration must be given to all stages of the bid process from the pre-qualification to the final close to ensure that the best tenderer is awarded the project.

Clear output specifications also loaded high on the competitive procurement factor. In order for the procurement process to contribute to the value for money objectives of a PPP project, output specifications must be clearly stated in the contract rather than relying solely on input specifications. This is important because input specifications change over time and open an area for unnecessary disputes.

*Benefits to the public*

The fourth factor for the value for money factors for PPPs scale accounted for 13.4% of total variance and had three items loading above 0.5 onto it. These items are

Reduced negative environmental impact (.750) Early service delivery (.687), and Improved facilities to the users (.593). This factor was labelled "Benefits to the public." A high loading was given to reduced negative environmental impact onto the benefits to the public factor indicating that it is a critical value for money target from the public perspective. Consideration for environmental risks are likely to reduce the financial implications associated with their occurrence and will likely gain more public support for the project.

Early service delivery is perceived as an important benefit to the public and leads to the achievement of the value for money objective. It is expected that early delivery of the project will solve certain issues related to services in demand, will expedite the cash inflows which will relieve repayment process of the debt, and reduce the cost associated with the development of the project.

Improved facilities to the users is the lowest variable that loaded onto benefits to the public factor. Value for money is achievable from the public's perspective when the PPP project leads to improved facilities for them. This is possible because PPPs bring funds which make it possible for governments to overcome the issue of budget restraints and therefore deliver the required facilities. PPPs also bring new ideas and technologies in for the development of the project, leading to creating improved facilities and more value for money.

##### *5.2.7.2.3 Critical success factors*

All factors of the eighteen items of the critical success factors produced through the utilisation of SPSS satisfied the correlation requirements since they all had partial correlations above 0.3 with other factors. (Appendix C, Table C-5)

The value for the Kaiser-Meyer-Olkin measure of sampling adequacy was 0.728 (Appendix C, Table C-6), suggesting that the sample is factorable (Brace et al., 2012; Kaiser, 1981).

Bartlett's Test of Spherisity was large (Chi-Square = 583.14, significant = 0.000), therefore, it is unlikely that the correlation is an identity matrix. The Anti-image correlation of all factors was satisfactory with an MSA greater than 0.5 for all items. Therefore, there was no need to eliminate any factor, and factor analysis should proceed to the next step of analysis.

**Table 21: UK CSF- Total Variance Explained**

| | *Initial Eigenvalues* | | | *Rotation Sums of Squared Loadings* | | |
|---|---|---|---|---|---|---|
| *Component* | *Total* | *% of Variance* | *Cumulative %* | *Total* | *% of Variance* | *Cumulative %* |
| *1* | *6.566* | *36.479* | *36.479* | *2.902* | *16.125* | *16.125* |
| *2* | *1.909* | *10.604* | *47.083* | *2.737* | *15.206* | *31.330* |
| *3* | *1.466* | *8.146* | *55.230* | *2.620* | *14.557* | *45.888* |
| *4* | *1.274* | *7.076* | *62.305* | *2.118* | *11.768* | *57.655* |
| *5* | *1.180* | *6.557* | *68.863* | *1.598* | *8.875* | *66.530* |
| *6* | *1.019* | *5.660* | *74.523* | *1.439* | *7.992* | *74.523* |
| *7* | *.872* | *4.843* | *79.365* | | | |
| *8* | *.637* | *3.542* | *82.907* | | | |
| *9* | *.597* | *3.315* | *86.222* | | | |
| *10* | *.530* | *2.947* | *89.169* | | | |
| *11* | *.464* | *2.580* | *91.749* | | | |
| *12* | *.400* | *2.224* | *93.973* | | | |
| *13* | *.319* | *1.772* | *95.745* | | | |
| *14* | *.203* | *1.129* | *96.873* | | | |
| *15* | *.174* | *.966* | *97.840* | | | |
| *16* | *.153* | *.848* | *98.687* | | | |
| *17* | *.143* | *.795* | *99.482* | | | |
| *18* | *.093* | *.518* | *100.000* | | | |

When Eigenvalue is set to be greater than one, six factors could explain 74.5% of the total variance; the remaining twelve factors together accounted for 25.5% of the variance (Table 21). Therefore, a structure of six factors is adequate to represent the critical success factors to consider when adopting PPP models.

The data was analysed by means of principal component analysis (Appendix C, Table C-7), where factor grouping through a Varimax rotation was conducted.

*Project delivery*

The first primary factor accounted for 16.1% of the total variance in the critical success factors. Four items loaded above 0.5 onto this factor without loading onto other factors. These are strong private consortium (.851), shared authority between the public and private sector (.742), transparent procurement process (.665), and political support (.514) (Appendix C, Table C-8). Factor one was labelled "Project delivery."

Strong private consortium loaded very high on the project delivery factor. This indicates that it is a very critical success factor for the safe completion of the project. The consortium typically consists of engineering consultants, contractors, and financial institutions. The more experience and strength the team has, the more success can be expected from the PPP project. This is because there will be better capability to design the project according to the output specifications, improved control on cost and time on the project delivery by the contractor, and access to the required funds with the optimum capital outlay design and repayment structure by the financial partner.

The second item loading high on the project delivery factor was Shared authority between the public and private sectors. This variable indicates the importance of the leadership both parties should exhibit for the successful delivery of the project. There must be a mutual understanding of the importance the involvement of both parties in running the PPP project to maximise the chances for achieving the output specifications and minimise risks and their associated circumstances on the project. However, the scope of each party ensuring sharing of the leadership of the project should be clearly detailed and agreed on before the signing of the agreement to avoid any conflicts.

A lower loading is given to transparent procurement process. This implies that transparency in the procurement process is a critical success factor for the delivery of PPP projects. The chance for the successful delivery of the project depends significantly on the bid winner. The bid winner should be the one that is established to deliver the best value for money of the project. All bidders must be involved in rigorous negotiations and must be given the information required for revising their bid proposals to advance to the next stage of the procurement process.

The last item loaded onto the project delivery factor was Political support. PPP projects are characterised by being long-term projects that span over 25 years for most cases. Political support for the projects should be durable throughout the duration of the project and not only through the legislative term. Change of politics might reduce the chances for success of the project. This can be in the form of rallying the public against the project or by creating legislation capping service charges, adding more taxes, removing any tax relief, or stopping any subsidy support.

*Commitment of public and private parties*

The second factor accounted for 15.2% of total variance. Three items loaded above 0.5 onto this factor without loading on other factors. These items are committed and competent public agency (.864), commitment of public and private parties (.763), and appropriate risk allocation (.540). Factor two was labelled "Commitment of public and private parties."

Committed and competent public agency loaded highest onto the commitment of public and private party's factor, indicating that the public agency will increase the success rate of the project when it possesses the required authority and skills to support the project from the pre-qualification stage of the project all the way to the handing over of the asset. Having a committed and efficient public agency reflects the public party's commitment to the success of the project.

Commitment of Public and private parties loaded high on the second factor. Government bodies must show their commitment to the project by ensuring a smooth procurement process and an efficient management process of the development stage of the project; this can be achieved by ensuring a transparent and competitive procurement process, facilitating negotiations and renegotiations of contract terms, dealing positively with variations and eventualities, and ensuring that the conditions for the success of the project are maximised, such as the required permits, legislation, access to the project, etc. The private party, on the other hand, must appreciate all the facilities provided by the public party to complete the project successfully and must ensure the value for money objective of the project. This includes the introduction of new ideas for improved services and facilities to the public, reduction of the cost associated with project, and early completion to satisfy the end users.

The last item that loaded onto the second factor was appropriate risk allocation. Risk should be allocated to the party that is capable of dealing with its consequences best, which will lead to a more successful PPP project. This is because risk occurrences will be minimised and the cost of remedying them will be reduced as well.

*Value for money*

The third factor accounted for 14.5% of total variance. Four items loaded above 0.5 onto this factor where one factor loaded on other factors; government guarantees did load, but lower on the sixth factor. These items are local financial market (.807), government guarantees (.620), project technical feasibility (.603), and macro-economic conditions (.539). The third factor was labelled ‘Project feasibility.’

Local financial market loaded highest onto the project feasibility factor for implementing PPP models. In order for the PPP project to deliver more value when compared to other conventional procurement methods, a local market for fundraising is very critical to the success of the project. It allows the private party the ability to structure the most optimal capital outlay structure that will provide more value using the full variety of funding the mature local market can offer. It also plays a significant role in the repayment of the loan and debt servicing process, where efficiency can be generated when there are more options in the local market.

Government guarantees are very critical for feasibility of the PPP projects. When the government offers guarantees to the private party by protecting the funds involved through sovereign guarantees or by guaranteeing the cash flows of the project by, for instance, signing an off-take agreement, it encourages the private party to commit more resources to the project which increases the success rate of the project. It also leads to more involvement of private sector investors into public projects, where more projects can be developed for the community and more value can be expected.

The third item that loaded onto the project feasibility factor was project technical feasibility. The study of the available tested technologies for developing the project and the technical risks that are expected to occur throughout the life cycle of the project plays a significant role in the delivery of the objectives of the PPP project. It is therefore very critical to conduct the technical feasibility study to set a direction from the early stages of the project; by doing this, the success rates of the project can be increased and the project will be more feasible.

The last item that loaded onto the project feasibility factor was Macro-economic conditions. Factors such as economic growth, GDP, inflation, interest rates, and unemployment must be in good condition to increase the success expected from the PPP project. The condition of these factors is considered critical to the feasibility of the PPP project.

*Favourable local conditions*

The fourth factor accounted for 11.7% of the total variance. Three items loaded above 0.5 onto this factor, where one of them loaded but lower on the third factor. These items are favourable legal framework (.847), good governance (.808), and sound economic policy (.527). The fourth factor was labelled 'Favourable local conditions.'

A favourable legal framework had a very high loading associated with it on the favourable local conditions factor. The legal capacity for affecting the agreements, issuing policies and legislation, and resolving conflicts, among others, must be perceived as favourable by the private sector in order for them to commit resources and funds to long-term projects like PPPs.

Good governance also had a very high loading onto the favourable local conditions factor. The ability to effectively manage public affairs, to integrate with other governmental bodies, and ensure the decisions made by the government are implemented efficiently and effectively are favourable conditions for the success of the PPP project and will attract more investors into the market.

The lowest loading variable onto the favourable local conditions was sound economic policies. When the government implements economic policies where all sectors are integrated in order to produce economic growth and a systematic identification of opportunities for development is established, more confidence will be felt by the private sector to participate in such projects. It is a favourable condition that maximises participation and contributes to the success of PPP projects.

*Effective procurement*

The fifth factor accounted for 8.8% of total variance and consisted of two items that loaded above 0.5 onto this factor without loading on other factors. These items are detailed cost/ benefits assessment (.839) and competitive procurement process (.548). The fifth factor was labelled 'Effective procurement.'

Detailed cost/ benefits assessment was loaded high onto the effective bid management factor. Cost and benefit studies are very critical to the success of PPP projects, as they give an early indication of the true value of the project and whether or not it is worth pursuing this particular project over others considered for development. These studies also identify alternatives for consideration to maximise value for money. It is an integral part of the project appraisal process and complements the other studies, such as commercial and economic viability, project feasibility, technical feasibility, and financial appraisal.

The other variable loaded onto the effective bid management factor was Competitive procurement process. The procurement process is considered competitive and contributes to the effectiveness of the bid process when the output specifications are clearly defined where only a shortlist of best tenderers are invited, clear stages and timelines are predefined, and transparent negotiations are offered. Competitive procurement is critical to the success of PPP projects.

*Multi-benefit objectives of all stakeholders*

The sixth and last factor accounted for about 8% of total variance in the critical success factors and consisted of a single item that loaded above 0.5 onto this factor without loading on other factors. This item is multi-benefit objectives of all stakeholders (.807). The sixth factor was labelled "Multi-benefit objectives of all stakeholders." The multi-benefit objectives of stakeholders is a single variable factor.

The objective of delivering the most effective and efficient facilities and services by the public party coupled with achieving the highest returns on the investment by the private party, along with the optimised facility and services expected by the public, must be acknowledged and worked for by all parties. The integration of objectives of all stakeholders is a very critical success factor for developing PPP projects.

## 5.3 Results and analysis of the qualitative interviews

### 5.3.1 Introduction

This section presents open, axial, and selective coding and the substantive theory development based on this coding process. Ten interviews were consecutively conducted with senior practitioners in the research reactors industry, until sufficient data was collected. The semi-structured interviews were transcribed and imported into the NVIVO software. In the open coding process, the initial step was to create nodes for storing the statements of the interviewees according to the topic. The next step was to compare the statements for theoretical coding. The concepts that emerged from the constant comparison were outlined in an open coding template to enable the formation of a category that best describes these concepts. Then each category was defined in terms of properties to enable the commencement of the axial coding process. The coding process of the interviews yielded seven open categories: future demand, justification process effectiveness, government and political interventions, ineffective project initiation work, underutilisation, local context, and regional collaborations (Walker & Lloyd-Walker, 2014).

The axial coding process, through the utilisation of the coding paradigm model, connects the categories identified in the open coding process and establishes their relationships. The seven open categories became five main categories where combinations of two were possible to guide the interpretation of the conditions influencing the phenomenon.

The selective coding followed the axial coding process and was intended to refine the main categories and their subcategories so that it was possible to introduce propositions, which enabled the creation of the storyline. The storyline described the phenomenon, what influenced that phenomenon, and what strategies were required and what improvements were expected, which led to the development of the substantive theory.

### 5.3.2 Open coding

The interviews were collected and analysed simultaneously, where theoretical sampling was prompted accordingly. All interview transcripts were imported into the NVIVO software and collected data was broken down into statements; statements were compared to each other to establish a link between them in order to classify them under certain themes. The themed categories were later analysed through the open coding process. Open coding is "the analytic process through which concepts are identified and their properties and dimensions are discovered in data" (Strauss & Corbin, 1998, p. 101). Strauss and Corbin (1998, p. 102) stress the importance of the open coding process by stating "without this first analytic step, the rest of the analysis and the communication that follows could not occur." They further explain the process of open coding by stating, "During open coding, data are broken down into discrete parts, closely examined, and compared for similarities and differences" (provide citation with page number)

The conceptually similar thoughts or events as explained by the interviewees are grouped under a category. A category is a set of concepts that represents particular phenomena. "Events, happenings, objects, and actions/interactions that are found to be conceptually similar in nature or related in meaning are grouped under more abstract concepts termed categories" (Strauss & Corbin, 1998, p. 102). The process includes finding the recurring concepts, naming categories, and defining the properties and dimensions of such categories. A concept is "… an abstract representation of an event, object, or action/interaction that a researcher identifies as being significant in the data." (Strauss & Corbin, 1998, p. 103). Strauss and Corbin (1998, p. 101) define properties as "Characteristics of a category, the delineation of which defines and gives it meaning," and dimensions as "The range along which general properties of a category vary giving specification to a category and variation to the theory."

The concepts of the imported data were constantly compared and analysed to check for their similarities in order to categorise them in unique groups. This was aided by memo writing, which enabled moving from the descriptive state of similar concepts to theorising their relationships. "Memos serve multiple purposes within a grounded theory project, including clarification, category saturation, theoretical development, and transparency" (Bringer et al., 2006; Van Os, Van Berkel, De Gilder, Van Dyck & Groenewegen, 2014).

The imported transcripts recorded in NVIVO were analysed microscopically, sentence by sentence, for the generation of the open categories. Strauss and Corbin (1998, p. 57) define microscopic analysis as "the detailed line-by-line analysis necessary at the beginning of a study to generate initial categories (with their properties and dimensions) and to suggest relationships among categories." The coded sentences were compared and listed as concepts for each category. Then, the properties of each category, based on the enlisted concepts, were defined, and the dimensions of each of the defined properties were presented. This open coding process was conducted for each question so that the analysis could proceed to the axial coding process, and was detailed for each question.

For the open coding of each semi-structured interview question, the recurring statements that could be grouped under a common theme led to the development of the common concept; the concepts were later grouped under a common group called a category. Figure 7 is a screen shot from NVIVO of the statements stored under research reactors future in response to question 1. Table 22 is the open coding of the first question, showing the concepts established, the category, and the properties of the category.

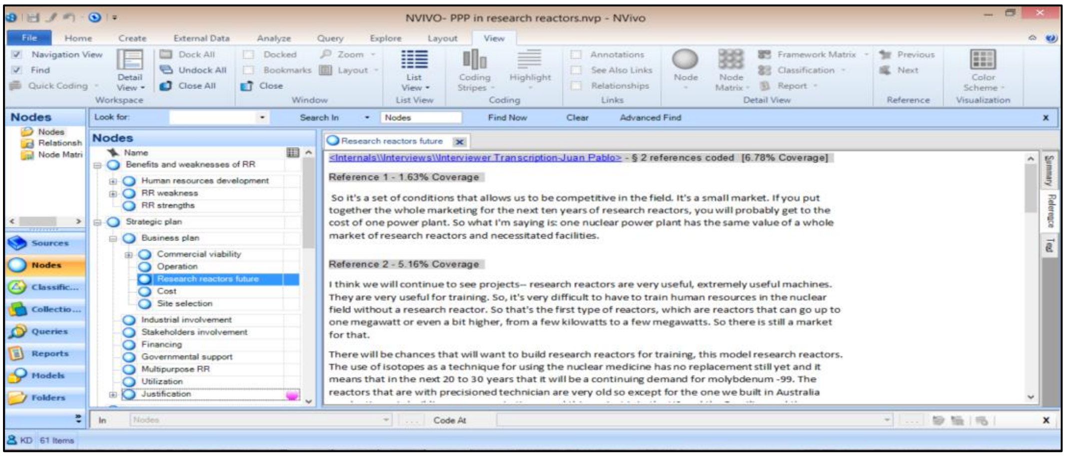


**Figure 7: Open coding for the future prospects of research reactors**

The following are responses of the participants on the first question. The recurring statements that will form the concepts for the open coding process are bolded:

> *"I think we will continue to see projects-- **research reactors are very useful, extremely useful machines**. They are very useful for training. So, it's very difficult to have **to train human resources** in the nuclear field without a research reactor. So that's the first type of reactors, which are reactors that can go up to one megawatt or even a bit higher, from a few kilowatts to a few megawatts. So there is still a market for that. **The use of isotopes as a technique for using the nuclear medicine has no replacement** still yet and it means that in the next 20 to 30 years that it will be a continuing demand for molybdenum -99. ... So there may be room for more reactors still in the world to cover **the future demand** once the actual, the present reactors that are presently supplying this demand are out of operation."*

*" **The research reactors future is bright**. They **always will be useful**, mainly for countries with a nuclear power program."*

*"**they have and will play a fundamental role in the development of nuclear power programs**."*

*"**new research reactors are going to be built in the future**. If a country wants **to train their own people** or if they want to do test and understand the results, they will need a research reactor."*

*"**A research reactor is a fundamental tool for the training of human resources** for a country to have a successful nuclear program."*

**Table 22: Concepts and category formation for the future prospects of research reactors**

| **Open Coding Template** | |
|---|---|
| **1. Tell me please how you see the future prospects of research reactors.** | |
| **Concepts** | • Research reactors are very useful facilities.<br>• The production of isotopes especially Molybdenum- 99 has no other economical alternatives.<br>• Current reactors do not cover future demand.<br>• They play a fundamental role in the development of nuclear power programs.<br>• Human resources development for future power plant applications.<br>• Particular uses for research reactors cannot be found in other alternatives.<br>• Capacity of the reactors available do not support the potential markets. |
| **Category** | **Future demand** |
| **Properties** | • **Usefulness of research reactors**<br>• **Availability of alternatives**<br>• **Reliance of nuclear industry on RRs** |

In relation to question two, the following are sample quotes from the participants in response to the second question; it highlights the concepts and category that emerged from the constant comparison of all other responses to this question. Figure 8 is a screen shot from NVIVO of the statements stored under "justification" in response to question one. Table 23 is the open coding of the second question showing the concepts established, the category, and the properties of the category.

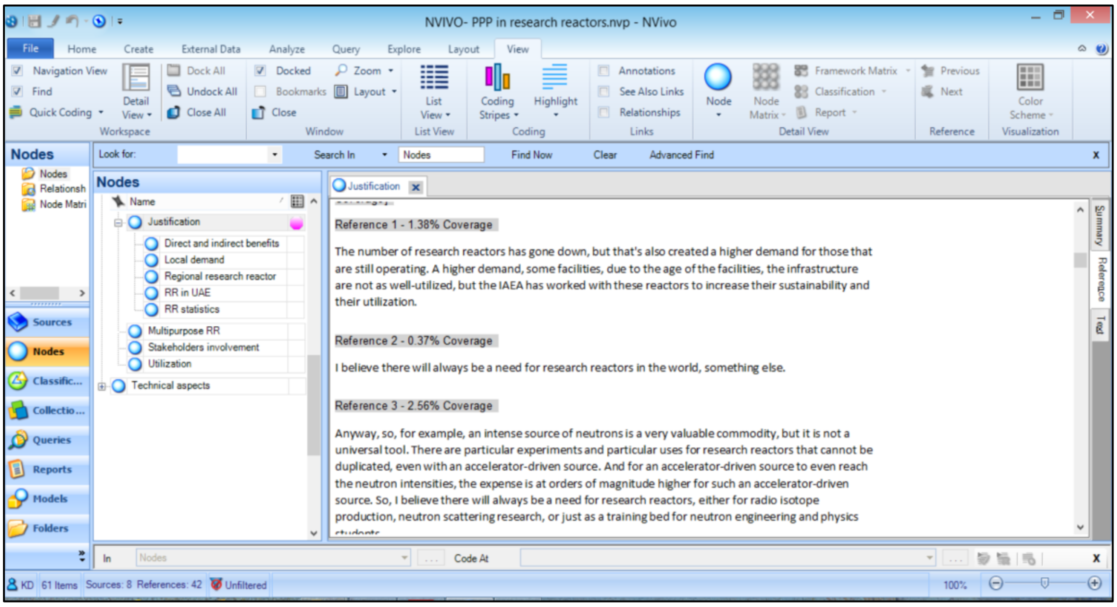


**Figure 8: Open coding for the justification for building a research reactor**

*"The real value of the research reactors is a kind of **stepping stone for nuclear power developing countries** - for newcomers."*

*"Now, are you aware that **any research reactors so far have been developed at no commercial success?**"*

*"**Operating a research reactor is not a good business**; since for **most of its service is not possible to put a value**. To operate a research reactor you **will always need some support from the government.**"*

*"The justification for Tanzania, for example, would be that, as I said earlier**, human resources development** for future power plant applications"*

*"the research reactor could be a very good tool **to develop human capacity** for nuclear power applications. That is our justification and objectives."*

*"So, for **human resources capacity building**, that would be a very good stepping stone, that is if you have a nuclear power plant in mind."*

*". There are particular experiments and **particular uses for research reactors that cannot be duplicated**, even with an accelerator-driven source."*

*"But the planning of **how much will it cost to operate this facility** at a particular level of operation, some minimal level of operation. Is that sustainable over the long-term?"*

***"NPP program, by having such a large program, that requires you have a location to train."***

*"The only issue I see is that the **capacity of the reactors available do not support the potential markets.**"*

*"**It's very useful to have a research facility for training &education, ageing management, even maintenance, regular maintenance of your NPPs**."*

**Table 23: Concepts and category formation for the justification for building a research reactor**

| **Open Coding Template** | |
|---|---|
| **2. Would you like to elaborate on the justification for building a research reactor?** | |
| **Concepts** | • Research reactors are mostly not commercially viable.<br>• Research reactors are prerequisites for nuclear power program development.<br>• Radioisotope production, neutron scattering research, and training will always require RRs.<br>• Value adds to economic growth.<br>• Demand outweighs supply internationally.<br>• NPP human resources sustainability.<br>• A nuclear power plant cannot be used for training.<br>• Lack of alternatives for the current uses of RRs. |
| **Category** | **Justification process effectiveness** |
| **Properties** | • **Feasibility-based decision**<br>• **Operations sustainability**<br>• **Industrial integration** |

In relation to question three, the following are sample quotes from the participants in response to this question. Figure 9 is a screen shot from NVIVO of the statements stored under "Weakness of RRs" in response to question three. Table 24 is the open coding of the third question, showing the concepts established, the category, and the properties of the category.

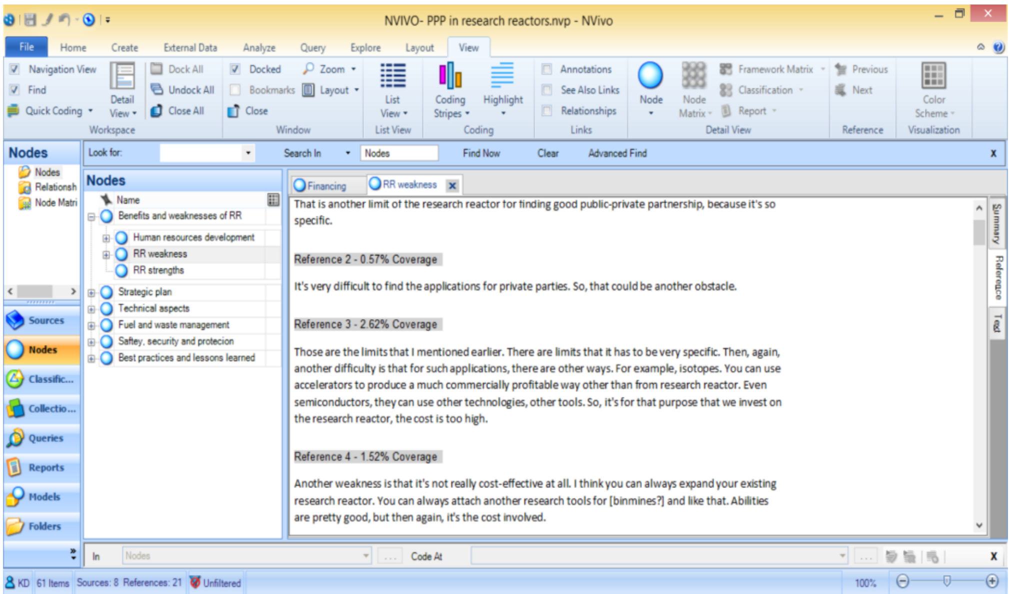



**Figure 9: Open coding for the weaknesses of research reactors**

*"That is another limit of the research reactor for finding good public-private partnership, because **it's so specific**."*

*"There are limits that **it has to be very specific**."*

*"So, it's for that purpose that we invest on the research reactor, **the cost is too high."***

*"Another weakness is that **it's not really cost-effective at all.**"*

*"I would say, to my last-- what? 15, 20 years' experience with research reactors, **they often are very unreliable**. Shut down due to many different issues, often related to some malfunction of some system."*

*"**And it's about making a reactor more reliable:** how the operations are done, how the safety, how the maintenance, how this is carried out with a bigger margin for not-- had to shut down."*

*" I would say many countries, but some feature of many national organisations is that they get budget for capital cost, and then **it's difficult to justify a budget for the operating cost."***

*"I'm not an expert on this but for sure the main weakness - it's a nuclear object so **when you have a nuclear facility somewhere there is a lot of safety features** of course to take into account and I think this is the main issue of any facility"*

*"Yes, **the weakness of a research** reactor for any research you want to do with will come from **its nuclear behaviour**."*

*"**the biggest weakness is utilisation**, and the reason for the utilisation weakness is the advanced planning."*

*"In Africa and developing countries in Southeast Asia, the nuclear **reactor is a symbol of development status**."*

*"but there are countries that have **built reactors as a matter of national pride** and then they have a reactor, but they didn't have a sustainable program to maintain that reactor."*

**Table 24: Concepts and category formation for the weaknesses of research reactors**

| **Open Coding Template** | |
|---|---|
| **3. What are the weaknesses of research reactors?** | |
| **Concepts** | • Uses correspond solely to original tailor-made design.<br>• Qualified personnel require years of development.<br>• Expensive operations while some uses unutilised.<br>• Unreliability and constant shutdowns.<br>• Heavy reliance on governmental support.<br>• Inaccurate operation cost forecasts.<br>• Safety and security risks.<br>• National pride driven decisions.<br>• Under-utilisation. |
| **Category** | **Government and political interventions** |
| **Properties** | • **National pride justification**<br>• **Operation interferences**<br>• **Safety and security interventions** |

Question four bore the majority of the information needed for establishing the success factors for research reactors, responding to one of the main objectives of this research. It was not surprising that the majority of the interviews centred on it.


**Figure 10: Sample open coding using word tree function**

The respondents elaborated vividly on their opinions about success factors. Therefore, it was warranted for the sake of analysis to break down the replies to this question into segments corresponding to each factor to deal with the large amount of data received.

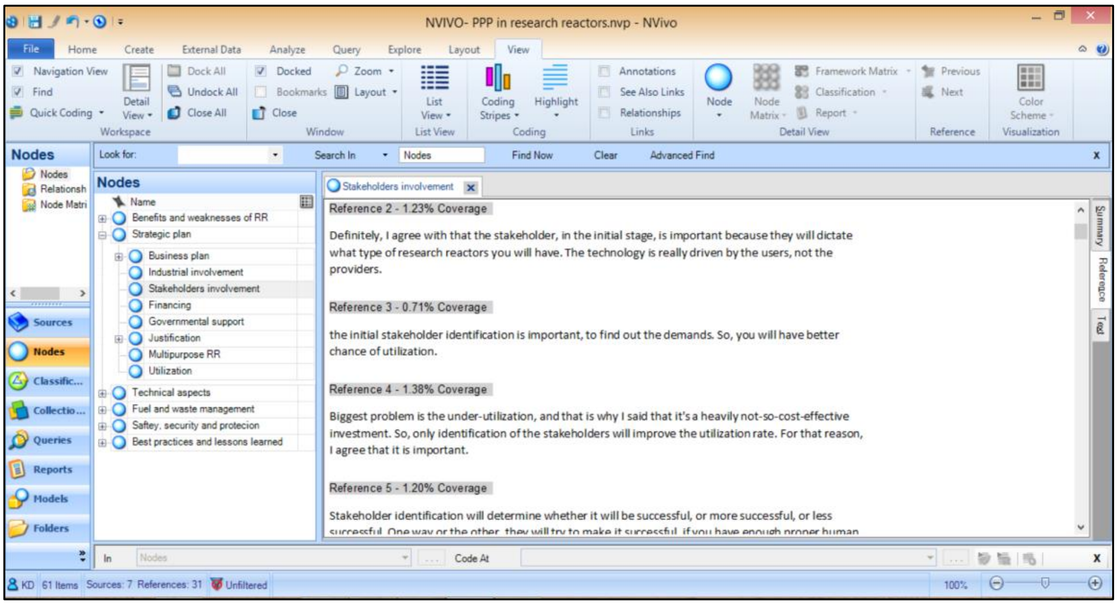



**Figure 11: Sample open coding of question (stakeholders)**

A screenshot from NVIVO of a sample open coding using word tree search is illustrated in Figure 10 and, using the references function in Figure 11, is related to one group of concepts: "Stakeholders."  Table 25 is the open coding of the fourth question, showing the concepts established for each factor, the category, and the properties of the category.

**Table 25: Concepts and category formation for the success factors for research reactors**

| **4. What are the success factors for research reactors in your opinion?** | |
|---|---|
| **Concepts** | • Stakeholders<br>○ Stakeholders' involvement from the beginning.<br>○ Early users' identification improves utilisation.<br>○ Users are the most significant stakeholders.<br>○ Regulatory bodies' early involvement is fundamental.<br>○ Users' requirements drive reactor's specifications.<br>○ Stakeholders needs essential for business plan modelling.<br>○ Early users' financial contributions and |

| | |
|---|---|
| | commitment are required.<br>• Life-cycle funding and financing<br>o A sustainable long-term financing plan is critical.<br>o Contributions and commitment of the government are fundamental.<br>o Users' financial involvement.<br>o Business plans must focus on operational cost.<br>o Diversification of streams for project finance.<br>• Nuclear safety and security<br>o Security and safety is the most important factor in the industry.<br>o A balance of security and accessibility of the facility should be maintained to ensure utilisation.<br>o Level of safety and security depends on the strength of the regulatory body.<br>o Safety success level depends on size of the reactor.<br>o Safety and security mainly related to fuel and waste management.<br>o Safety and security plan to be completed at the early feasibility stages of the project.<br>o Accidents should not inhibit scientific advancement, benefits outweigh the risks.<br>o Safety and security depends on the experience on the country in the nuclear field.<br>o Promote safety culture.<br>o Safety and security of RR is of less significance as compared to NPP as the fuel and produced waste is very minimal.<br>• Site selection<br>o Site location should correspond to the use and security risks.<br>o Proximity should be within campuses for training and education, and away from the public for more detailed uses.<br>o Accessibility should be maintained without excessive security measures.<br>o Site selection if often dictated by the need for cooling water and logistics.<br>• Fuel and waste management<br>o Dealing with spent fuel is a major obstacle for new comers. |

| | |
|---|---|
| | ○ Heavy security systems are required for the fuel management.<br>○ A plan for the final disposal of the spent fuel must be in place before the initiation of the project.<br>○ A secure temporary storing facility must be ensured in the site.<br><br>• Human resources development<br><br>○ Research reactors are essential for developing nuclear human resources capacity.<br>○ A plan is required to ensure human resources sustainability.<br>○ Local human resources development is strategic to the national interest.<br>○ Qualified personnel from users' side are essential.<br>○ Integration of personnel from design phases will improve the skills required for each design.<br><br>• Environmental and radiation protection<br><br>○ Public opinion dictates future of nuclear facilities.<br>○ Regulatory bodies ensure the minimum environmental and radiation protection parameters.<br>○ Impact from research reactors is negligible.<br>○ Environmental impact study is essential for public support.<br>○ The biggest concern is the disposal of used fuel.<br><br>• Utilisation<br><br>○ The biggest concern in research reactor's operations is under-utilisation.<br>○ Stakeholders' early identification is key in proper utilisation of research reactors.<br>○ Utilisation is affected by the age of the reactor.<br>○ Operators from the reactor and from the users' side play a significant role in the utilisation of the research reactor.<br>○ Users change of objectives impact severely the purpose-made reactor.<br>○ International nuclear incidents impact the operations of research reactors.<br>○ The research reactor must be built as part of a strategic plan to serve users. |
| **Category** | **Ineffective project initiation work** |

| | |
|---|---|
| **Properties** | • **Stakeholders' importance**<br>• **Regulatory body effectiveness**<br>• **Financial sustainability**<br>• **Business plan thoroughness**<br>• **Government support**<br>• **Safety culture and security precautions**<br>• **Site selection impact**<br>• **Fuel and waste management**<br>• **Public involvement**<br>• **Environmental impact studies** |

Figure 12 is a screen shot from NVIVO of the statements stored under "Commercial viability" in response to question five.

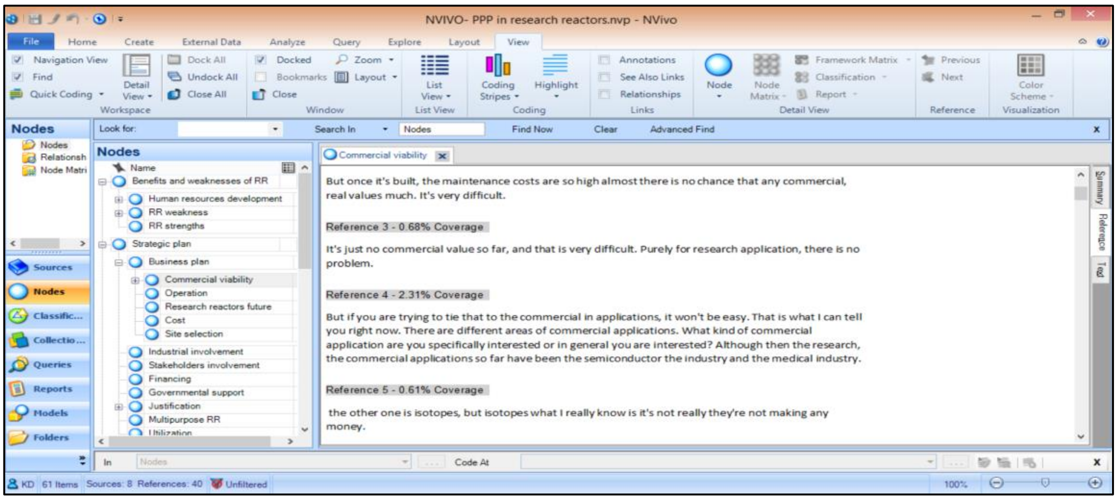



**Figure 12: Open coding for commercial viability of research reactor**

Table 26 is the open coding of the fifth question, showing the concepts established, the category, and the properties of the category.

**Table 26: Concepts and category formation for commercial viability of research reactor**

| **Open Coding Template** | |
|---|---|
| **5. What makes a research reactor commercially viable for investors?** | |
| **Concepts** | • Research reactors are not commercially viable.<br>• Most benefits are intangible.<br>• Commercial value is possible in semiconductor.<br>• Radioisotopes, especially Molybdenum-99 for health industry, are commercially viable.<br>• The commodity for commercialization is nuclear radiation.<br>• State funding will always be needed.<br>• The industry pays for experiments.<br>• Users prefer not engage financially and pay only when they use the plant.<br>• High quality commercial production requires highly qualified manpower.<br>• Tailor-made designs make it harder to engage in PPPs.<br>• Early industrial involvement under PPP mechanism.<br>• There are large companies partnering with governments and PPPs are promising.<br>• There must be a constant stream of products to attract private partners.<br>• PPP concept might work better with certain uses of research reactors.<br>• Smaller entities can merge under a single umbrella and partner with government.<br>• Benefits of partnership must be presented to stakeholders at the feasibility phase of the project.<br>• Involving private partners will depend mostly on the level of risk involved. |
| **Category** | **Underutilisation** |
| **Properties** | • **Users involvement**<br>• **Governmental support requirement**<br>• **Human resource sustainability** |

Figure 13 is a screen shot from NVIVO of the statements stored under "RRs for the UAE" in response to question six.

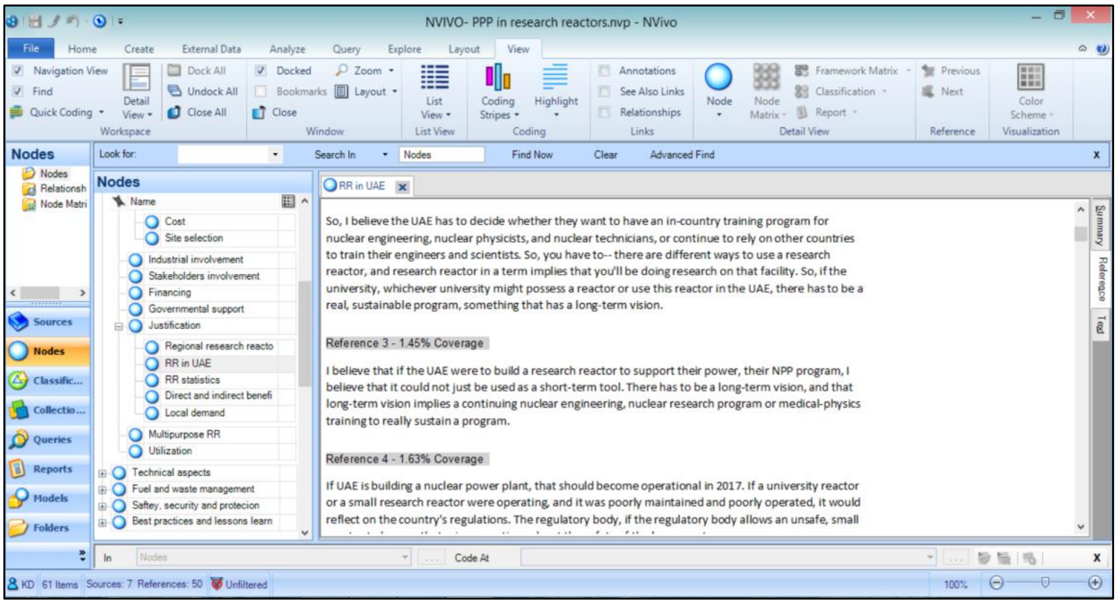



**Figure 13: Open coding for consideration when developing RR in the UAE**

Table 27 is the open coding of the same question, showing the concepts established, the category, and the properties of the category.

**Table 27: Concepts and category formation for consideration when developing RR in the UAE**

| **Open Coding Template** | |
|---|---|
| **6. Any particular issues for consideration when developing RR in the UAE?** | |
| **Concepts** | • Human capacity is the biggest challenge for the UAE.<br>• The size and uses of the research reactor must correspond to the actual need.<br>• Building the human resources base abroad could work but there must be a clear strategy.<br>• The UAE should consider the viability of a regional research reactor.<br>• Competitiveness with alternatives available locally to the users should be considered to attract business.<br>• Education and training small reactor is the most suitable one for UAE.<br>• UAE is the first to start NPP without first having RR, considerations are unique for RR.<br>• Must benefit from lessons learned from international practices. |

| | |
|---|---|
| | • If you do not have an in house sustainable manpower development program, operations of power plants will always be a challenge.<br>• Knowledge building will require an academic system that works in tandem with RR. |
| **Category** | **Local context** |
| **Properties** | • **Reliance on foreign support**<br>• **Viability to alternatives**<br>• **Frequency of utilisation** |

Figure 14 is a screen shot from NVIVO of the statements stored under "Regional RRs" in response to question seven.

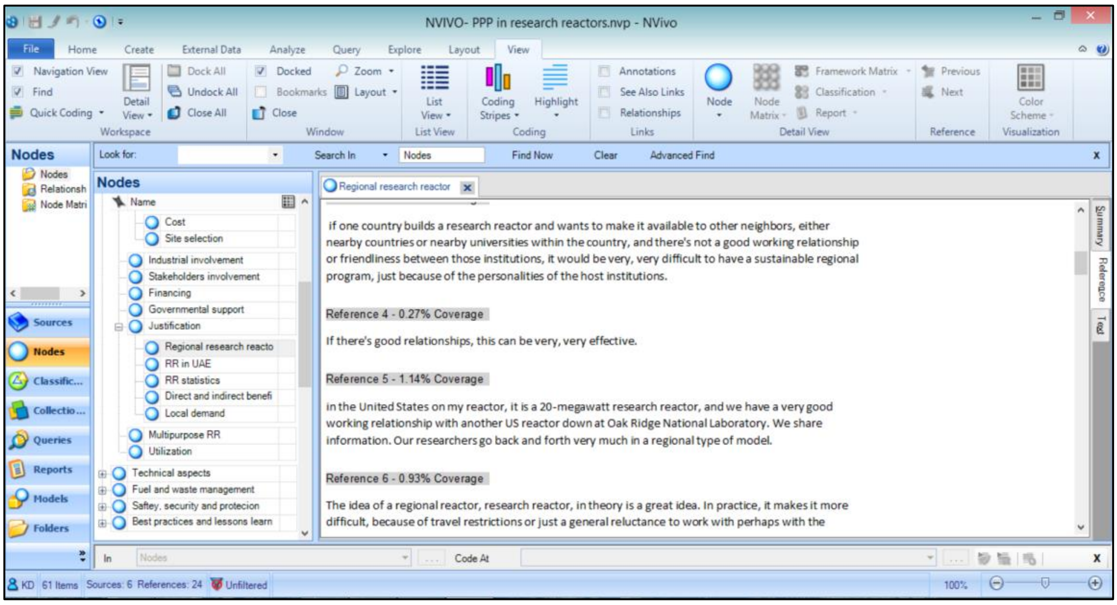



**Figure 14: Open coding for regional research reactors**

Table 28 is the open coding of the seventh question, showing the concepts established, the category, and the properties of the category.

**Table 28: Concepts and category formation for regional research reactors**

| **Open Coding Template** | |
|---|---|
| **7. Regional research reactors. (additional from content of interviews)** | |
| **Concepts** | • Regional research reactors are hindered by different interests.<br>• National pride plays a significant role in the failure of regional research reactor proposal.<br>• Change of political systems impact the objectives of regional research reactors.<br>• Volatilities and regional conflicts render the idea unfeasible.<br>• The idea is aimed at improving the utilisation of existing under-utilised research reactors.<br>• Each country could adopt a different type and collaborate with the others.<br>• Decision-making and utilisation of the plant might make it a very hard idea to implement. |
| **Category** | **Regional collaborations** |
| **Properties** | • **Impact of politics on the success of regional RRs**<br>• **The significance of national pride on regional RRs**<br>• **Regional collaborations impact on utilisation** |

Therefore, the open categories of the open coding phase are:

1. Future demand
2. Justification process effectiveness
3. Government and political interventions
4. Ineffective project initiation work
5. Underutilisation
6. Local context
7. Regional collaborations

### 5.3.3 Axial coding

Axial coding is the process of rearranging data after it has been broken down to smaller pieces during the open coding process. "It is the act of relating categories to subcategories along the lines of their properties and dimensions" (Strauss & Corbin, 1998, p. 124). Within the realm of grounded theory, there is an assumption that each open category has links to other categories. Axial coding process is represented through the establishment of relationships between the categories of the open coding process of the interviews.

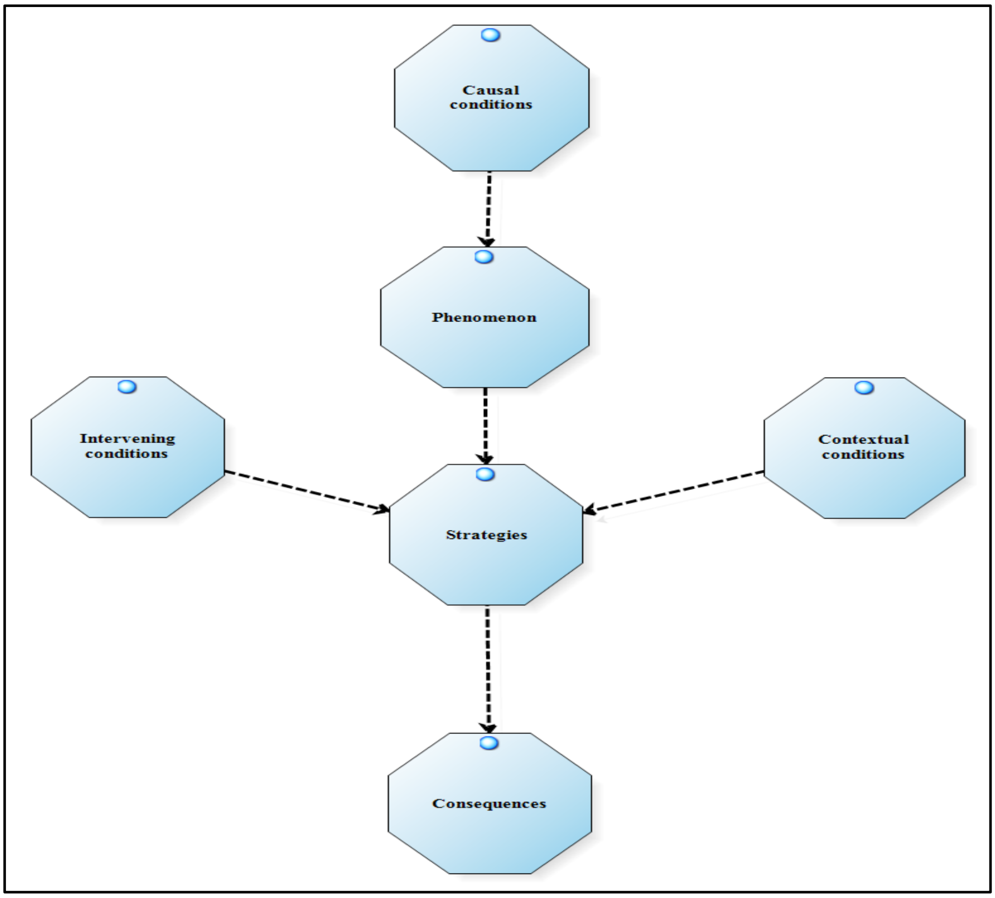



**Figure 15: The coding paradigm**

### *5.3.3.1 Coding paradigm*

To assist with axial coding process, Strauss and Corbin (1998, p. 123) recommend the use of the paradigm model, which is "[A]n analytic tool devised to help analysts integrate structure with process." Structure is the conditional context surrounding the phenomenon, where the process is the action/ interaction sequences over time pertaining to the studied issues (Strauss & Corbin, 1998).

The coding paradigm (Figure 15) offers an organisational scheme where a continuous integration of structure and process of data is provided for researchers to deal with the dynamism of events (Strauss & Corbin, 1998).

### *5.3.3.2 The phenomenon*

Phenomenon gives an answer to the question of what is going on by "looking for repeated patterns of happenings, events, or actions/interactions that represent what people do or say, alone or together, in response to the problems and situations in which they find themselves" (Strauss & Corbin, 1998, p. 130).

Through constant review of data collected from the participants, and particularly the responses received for the fifth question, which was related to the viability of research reactors for partnerships, underutilisation of research reactors emerged as the phenomenon. The significance of this phenomenon is widely acknowledged in the research reactor publications by IAEA. "Underutilization of research reactors around the world persists as a primary concern to global research and development, and threatens the sustainable operation of individual research reactors" (IAEA, 2014a, p. 4). Another publication by IAEA discusses the implications of this phenomenon and the importance of its remediation. "Underutilized research reactors not only waste resources but they can also become a safety, security and environmental hazard if there is an associated shortfall in maintenance funding" (IAEA, 2012, p. 5) . Adelfang (2014) reported that fifty percent of research reactors are currently heavily underutilised. Therefore, the emergence of underutilization as the phenomenon to be studied to answer the third objective of this research, which is to establish the critical success factors for research reactors, is supported. The phenomenon of underutilisation of research reactors included the properties of the constant requirement of governmental support to sustain the long-term operations, the calibre and availability of the human resources required to optimize the performance, and the early involvement of the users in shaping up the utilisation of research reactors. In literature, the reasons for the underutilsation of research reactors are related to the "lack of funding and subsequent loss of skilled and motivated personnel, inability to effectively train new staff and obsolescence of facilities and equipment, among other consequences" (Peld & Ridikas, 2014, p. 2). Although in literature there are other reasons for underutilization, such as the aging of the facility and the obsolescence of technologies, it is assumed that the respondents focussed on future research reactors, as the study is about the UAE, and did not see the significance in the obsolescence of old technology and facilities. However, this issue should not be under estimated when it comes to new technologies and application alternatives for future research reactors.

There is an evolution in the isotope production methodologies, specifically the separation of 99mTc from 99Mo, the most important medical isotope. The real threat to research reactors is the plan to replace the HEU used in research reactors for security reasons. "Nuclear non-proliferation and security concerns have led to advanced discussions around the world in evolving possible alternative strategies to produce 99Mo without HEU" (Dash, Knapp & Pillai, 2013, p. 173). The design of research reactors must ensure the commercial viability of isotope production, "otherwise, the current suppliers will move to more financially successful programs, a move that is already on the horizon as seen from their enthusiasm in developing positron emission tomography (PET)-based alternatives" (Pillai et al., 2013, p. 321). The threat of accelerators is not very viable at the time being due to technological, economical, and political reasons. Still, research reactors have the upper hand due to "government subsidies and the government support of the research reactors" (Dash et al., 2013, p. 321), and that the methods used in research reactors are "inexpensive, realistic, implementable in a short time frame, and capable of producing pharmaceutical-grade 99mTc." (Pillai et al., 2013, p. 320).

Therefore, technological evolutions in the development of alternatives for research reactors' applications should not be overlooked, and constant improvements to research reactors' designs must be adopted to cope with the economic challenges. "From technical and economic perspectives, the global demand for 99Mo could readily be met using (n,g)99Mo produced in existing research reactors. These reactors would require few design changes, and they have good geographic distribution around the world" (Pillai et al., 2013, p. 320).

The establishment and preservation of nuclear workforce to sustain normal operations may take decades to reach a satisfactory stage (NEA, 2012). NEA (2012) highlighted the vital role of governmental support and funding, among other players, in averting the decline in the qualified workforce needed for the nuclear industry. NEA (2012, p. 7) further recommended, "Governments should support educational institutions and nuclear technology students at technical colleges to ensure there is a well-rounded workforce available for all of the nuclear careers". Bode (2012, p. 279) confirms the importance of ensuring the sustainability of qualified workforce in research reactors by stating "The lack of continuity in staffing and a missing adequate overlap period for retiring staff and newcomers may be the most serious threat to sustainability".

The majority of the interviewed participants believed that government support will always be required in order for research reactors to reach sustainable utilization. IAEA's (2012, p. 13) report titled 'Specific Considerations and Milestones for a Research Reactor Project', concurs with participants' that "strong government support is vital to the successful implementation of a first research reactor project and the intention to develop such a programme should be announced and supported at the most senior level of government". Moreover, a research reactor project cannot be transferred fully to the liability of the investors. There are many factors leading to this dependency on the government. First, the concept that a nuclear facility be totally operated by the private sector was not considered until recently when governments faced financial situations prompting easing the regulations on nuclear facilities. Second, the research reactor is a long-term project that will survive generations, and the support of consecutive governments is required. Third, fuel procurement is dependent on international conventions and regulations for transport and storage, and only governments can handle disposal of waste and related activities. Moreover, private entities can go bankrupt at any time throughout the life cycle of the project, and a research reactor cannot shut down at will; the repercussions for waste, for example, will last many decades after the shut down, and this will require a long-term financial plan. Another form of government support is through the issuance of regulations that support the sustainability of research reactors and shields them against political changes through the presence of an efficient and effective regulatory body. These factors are what most of the interviewees felt were relevant in supporting their stance that government support will always be required.

The availability of qualified human resources was highlighted by the respondents as an important property that defines the phenomenon of underutilization. Specialized training is required by the operating authority to ensure the satisfaction of the minimum requirements for the efficient operations of the research reactor. Shokr et al. (2012) confirm the importance of this property and believe that "[T]he regulatory body should start developing the competences needed for establishing regulations and performing regulatory review, licensing and inspection". They further detail the training to include "project management, performance of safety assessment, reactor commissioning, operation, maintenance, and utilization." specialised training is also needed in "reactor physics, thermal-hydraulic, radiation protection, core management and fuel handling, quality assurance, and safety culture" (Shokt et al., 2012, p. 6).

The last property to the underutilisation category, as identified from the responses of the participants, was the involvement of users. There was a consensus from the responses gathered that early identification and involvement of users is fundamental for the commercial utilisation of research reactors. Early involvement of the users is necessary for the creation of business plans for the project, which will indicate its level of viability so that an informed decision for moving forward can be made. Another issue highlighted by the participants was that the proper utilisation of the reactor depends significantly on the users, as research reactors are designed according to users' requirements and specifications. Many research reactors were built without involving the industry and that has resulted in limited uses offered, as the users seek specific uses of neutron products. Another weakness highlighted was that the involvement of users is solely related to their requirements, and does not include discussions of long-term commitment or their direct financial contribution to the cost and operations of the projects. The issue of attracting investors to research reactors projects will improve the way the research reactors are handled, as private sector parties seek efficiency and innovation in operations to maximise the return on their investments. Attracting private investors to research reactor projects seems to be a challenging task to most of the participants. Investors from the private sector seek opportunities that generate the highest return with the least risk involved, which is not the case in research reactors. The cost of development and operations are very high, and for certain uses the cost can never be recovered. The risks are also very high, as the operation of the plant could be interrupted for various reasons, such as  risks related to the handling of fuel and disposal of waste, radiation and environmental concerns, political, and financial risks. Therefore, in the view of the respondents, the minimum conditions of good returns and balanced risks could never be achieved for attracting private investors to research reactor projects. This situation is slightly better in industrialized countries, where a high and constant demand for radioisotopes and other industrial uses are present. The more demand on the products provided by the research reactor, the more viable they become to investors.

Industries that are heavily dependent on research reactors can be easily involved financially, and not only relegated to the role of future users of the reactor. Some participants actually highlighted successful practices in partnerships where, for example, a chemical company in the United States owns a full research reactor as they use it for testing their materials and enhancing their quality and competitiveness, which is a direct return on their investment. Another respondent from Korea highlighted the partnership of a major electronics company with a research reactor in Korea to handle their R&D requirements. All of these examples show potential areas for analysis to improve the utilisation and commercial viability of research reactors.

### 5.3.4 Condition

The conditions that create the situation pertaining to the phenomenon of underutilisation must be discovered and their impact must be identified. This is necessary to link such conditions to the phenomena in an explanatory fashion, and to explain why and how the respondents reacted accordingly. "Conditions are sets of events or happenings that create the situations, issues, and problems pertaining to a phenomenon and, to a certain extent, explain why and how persons or groups respond in certain ways" (Strauss & Corbin, 1998, p. 130). There are different types of conditions, and they include causal, intervening, and contextual conditions. Causal conditions are the events or happenings that directly affect the phenomena. Intervening conditions are the events that alter the influence of causal conditions on the phenomena. Finally, contextual conditions are the ones that arise from unforeseen circumstances (Strauss & Corbin, 1998).

#### *5.3.4.1 Causal conditions*

Concerning causal conditions, emphasis was given to studying the phenomena while simultaneously checking for the events and happenings that created the situation for the phenomenon to happen. The causal conditions for underutilisation of research reactors, as identified by the respondents, were related to a group of factors that are included in the 'strategic planning' terminology as identified in IAEA's (2012) document, which is supposed to be completed at the early stages of the research reactor project. The causal conditions, as identified by the participants, included many concepts related to stakeholders, life-cycle financing and funding, nuclear safety and security, site selection, fuel and waste management, environmental and radiation protection, human resources development, and the regulatory body. These groups of concepts had the following properties: stakeholders' importance, regulatory body effectiveness, finance sustainability, business plan thoroughness, governmental support, safety and security precautions, safety culture, site selection impact, fuel and waste management, public involvement, environmental impact studies, and strategic plan for sustainable operations.

The main features of PPP will improve the sustainable operations of research reactors. "PPP arrangement provides assets and delivers services by allocating responsibilities and business risks among the various partners. In this arrangement, government remains actively involved throughout the project's life cycle. The private sector is responsible for the more commercial functions such as project design, construction, finance and operations. This distinction of responsibilities is secured by agreements." (Chisa, Ojo, Ikeni & Gambo, 2015, p. 54)

Such features add efficiency and effectiveness to the project, including the risk sharing, the life-cycle approach, the incentivised structure, the use of private funds, and the utilisation of the private sector's experience and innovation. In particular, the direct involvement of stakeholders as partners ensures their long-term commitment to the project (Alfen et al., 2009; EU, 2003; PPPC, 2011). Chisa et al. (2015, p. 66) offer the following conditions for a PPP project to be sustainable: "ensure conformance with government aims, ensure that projects are in public interest, ensure that project reflects environmental and economic sustainability, ensure that project is viable, not seek to place onerous condition upon government." These conditions are already included as prerequisites in PPP contracts. PPPs therefore might contribute to improved utilization and sustainability of a research reactor through the efficiency, effectiveness, and commitment the stakeholders bring to the project. Such features also "strengthen the network of funders, stakeholders and interested parties that will underpin the reactor's success and sustainability" (IAEA, 2012, p. 24). Furthermore, Blanken and Dewulf

(2010, p. s39) highlighted that PPP contracts can last "over as many as 50–60 years", which is suitable for a research reactor's life span including the decommissioning. In general, recent PPP contracts include renegotiation clauses that allow for even a longer extension of contract if required. This will "ensure that the private sector partner takes a whole life-cycle view for the development of the asset. The asset is then designed, constructed, operated, and maintained such that the whole life-cycle cost of the project is minimized and the private sector operator ensures that the asset is well-maintained throughout its entire economic life." (Chisa et al., 2015, p. 56)

A strategic plan for sustainable operations of the research reactors is of paramount importance to their success and play a significant role in affecting their utilisation. The government must create a strategic plan for the objectives it is seeking from developing a nuclear program, where a research reactor is part of that plan and is well integrated within all other elements in the strategic plan. Such objectives include providing a platform for training of workers needed in the nuclear industry, facilitating economic growth through allowing the industries to test and improve their products, producing commodities needed for the health sector, etc. Once the identified objectives and the justified need for a research reactor is coupled with early stakeholder's involvement, it will improve the utilization rate of the research reactor (Dodd, Dolan, Laraia & Ritchie, 2002).

Stakeholders' importance was highlighted by the participants as a major factor that influences the utilisation of research reactors. The respondents identified the operators, the users, and the regulatory bodies as the most important stakeholders in the field of research reactors. The operators are all those required in order for the facility to perform efficiently. It includes the management board and the qualified workers needed for the operation of the reactor. Some respondents highlighted the importance of engaging the staff from the initial stages of the project so that they acquire specific skills needed for the tailor made reactor. The users are those who utilise the reactor for their specific needs. The primary uses of research reactors are related to education and training (Adelfang, 2014). "Education and training programmes can encompass all facets of civil society, from primary students and the general public through public tours to university courses and power reactor operator training" (IAEA, 2014b, p. 3). Neutron Activation Analysis (NAA) is the second most popular application of research reactors (Adelfang, 2014; IAEA, 2014b). "NAA is a method for the qualitative and quantitative determination of elements based on the measurement of characteristic radiation from radionuclides formed directly, or indirectly, by neutron irradiation of the material" (IAEA, 2014b, p. 15). The industrial applications are ranked in the third place (IAEA, 2014b). The industrial applications are mostly for medical radioisotope production, silicon doping, and neutron activation for material research to test new materials. Research applications include neutron scattering research and training of neutron engineering and physics students, where the users for this research are mostly the nuclear industry and universities. The participants identified regulatory bodies among the most significant stakeholders in research reactor projects. A competent regulatory body will ensure the safety and security measures will be complied with, which will enhance the operations of the nuclear facility while safeguarding the public's interest. A regulatory body, among others, ensures the requirements for the development of a research reactor, which takes into consideration the full life-cycle of the project, even years later the decommissioning, to deal with the storage of the spent fuel (Ahearne, 2011; Cho & Kim, 2009; Mengolini & Debarberis, 2008).

Financial sustainability, as identified by the participants, influences the attractiveness of the research reactor to the private sector and the roles of the industrial users in the operation of the reactor and plays not only a significant role in the success of the program, but also the security of the country. The respondents stressed on the issue that a research reactor could not simply shut down for any reason due to the long-term implications related to the nuclear industry. For instance, as mentioned earlier, waste management lasts for decades after the decommissioning of the reactor, and that comes at a very high expense. Site security is of the highest concern, and the measures to ensure the security of the site comes at a price. Financial sustainability is important to ensure the continuous operation of the reactor regardless of the cycles of demands that can fluctuate according to economic situations. Therefore, as mentioned earlier, the financial obligations must be shared with the users of the research reactor. This is possible by engaging them at the early stages of the project after involving them in the outcomes of the feasibility study. On the other hand, governmental support should be present at all times of the project. If the research reactors did not cover its cost and the users were to default, the government should step in, as the outcomes of continual operation on the economy are significant, especially for the uses that were mentioned earlier. Another point that the respondents felt was very critical was the underestimation of the operation cost. Most research reactors are operating on a much higher cost than what was anticipated at the inception stage, which exposes the project to serious threats of shut down (IAEA, 2012; Iracane, 2006; Schimank, 1990).

Safety culture and security precautions were identified by the participants as properties for the causal conditions influencing the problem of underutilisation of research reactors. Participants highlighted the emphasis on safety and security issues as mandated by IAEA, as they are deemed to be the most important factors. The safety and security measures could impair operations and the proper utilisation of the research reactor. They stressed that there must be a balance between security measures and accessibility to the site by the users to enable a normal operation of the reactor and to cater to their daily industrial needs. Users might consider other options if their access is restricted which will influence the utilisation of the research reactor. The safety for some respondents was not as significant as advocated by IAEA. They claim that safety depends on the safety culture that the staff have, which depends on their origins. A respondent mentioned that the European culture of safety is reflected in the practice of any industry, and therefore it is present in the nuclear industry without magnifying its impact, stressing that safety and security of research reactors are "under control." However, this culture is not present in other developing countries or new comers to the research reactor projects. There was almost a complete consensus that the experience of the country in the nuclear industry indicates the significance of the level of security and safety measures.

The respondents coupled the issue of safety and security properties with the measures taken for handling fuel and waste management, as the security is mostly related to the handling of fuel. Once the fuel is stored onsite, rigorous security systems are implemented to ensure the safe storage of the fuel. This issue is multiplied in magnitude once the fuel is spent and stored onsite. Most respondents felt that this is a major issue for new comers, who do not have previous experience in handling the fuel. However, they stressed that for countries that have nuclear power plants, the spent fuel is not a major issue, as the quantity is very small compared to that of NPPs and could be stored if needed with the waste of the nuclear power plants.

The responses to the question of the critical success factors for research reactors identified the importance of environmental impact studies and the public involvement in the process of developing the research reactor project. The incidents and radiation accidents related to the nuclear power plants worldwide influence significantly the future of the nuclear industry. The respondents highlighted how the Fukushima incident changed the way the public looked at nuclear projects and how vulnerable people felt once the incident happened. The utilisation is undoubtedly influenced by these incidents. Some respondents cited the German decision to shut down all nuclear power plants within 10 years due to public pressure. Moreover, others cited that many countries have slowed down their plans for new plants to avoid any conflicts with the public, as the memories of the Fukushima accident are still vivid in their minds.

Environmental impact studies serve many purposes and lead to improved chances for sustainable operations of research reactors. The respondents mentioned that the public wants assurances, for instance, that the cooling towers will not contaminate the water sources in the area, or release radiation into the air. Raj, Prasad and Bansal (2006, p. 914) maintain that "the underlying objective that governs the management of all such waste is protection of man and environment. Environmental impact studies can show exactly how the cooling will be conducted and what measures are taken to ensure environmental protection. However, the most important factor is to actually make the public's role an integral part of the process and to involve them in the decision making process related to environmental protection.  This will ensure that they will act more positively towards the sustainability of nuclear projects.

#### *5.3.4.2 Intervening conditions*

Intervening conditions, as mentioned earlier, are the influence or the impact of causal conditions (Brown, Stevens, Troiano & Schneider, 2002). "Intervening conditions are those that mitigate or otherwise alter the impact of causal conditions on phenomena" (Strauss & Corbin, 1998, p. 131). The intervening conditions that are found to affect the influence of the causal conditions on the phenomenon were government and political interventions, including its properties: national pride justification, operation complications, and safety and security interventions. The causal conditions influencing the phenomenon, which are related to the ineffective project initiation work, are heavily influenced by interventions by the government or the political system. The interviews related to the weaknesses of research reactors revealed that most of the weaknesses had connections with the outcomes of the decisions made by the government or the political system. The participants highlighted a situation where countries develop research reactor projects for national pride and not for reasons related to local demands or future preparations of nuclear power generation programs. Such decisions led to embarking on developing research reactor projects without considering feasibility studies that focus on accurate demands for the services of research reactors, which led to the underutilisation of these research reactors (Jackson, 2009). Moreover, the underutilisation also occurred because the designs of reactors were not a result of detailed consultations with the users, and therefore the research reactor could not satisfy their specific requirements.

Another political intervention that alters the causal conditions on the phenomenon is related to operations interferences. The sustainability of research reactor operations depends significantly on the political systems, which are constantly changing during the long life cycle of research reactors. Every new government comes with a new agenda for the country, and this could affect the operations of research reactors in many areas. First, the national strategy for the nuclear industry could change in response to economic situations, which may influence the funding of nuclear research programs. Second, the support of nuclear activities may diminish due to public demands in response to nuclear accidents. Third, the program might discontinue if it is part of a previous economic growth plan and is no longer needed by the new government. Last, the new political system could make fundamental modifications to the regulatory body, which would directly influence the operations of research reactors. (Jackson, 2009; Ogilvie-White, 2010; Rogner & Abdel-Hamid, 2008).

Safety and security interventions are another example of how the outcome of project initiation work could be impacted. A few respondents highlighted the extreme measures that their governments imposed on their research reactors in response to the accident at Fukushima. Although research reactors are operating with no significant incidents, as the fuel used is very small in quantity, governments are including them in any measures taken for the safety and security of the much larger nuclear power plants. These interventions undoubtedly bear a severe impact on the operations of research reactors and minimize the outcomes identified in their feasibility study (Broinowski, 2014).

#### *5.3.4.3 Contextual conditions*

The contextual conditions explain why the phenomenon is occurring in a certain fashion. "Contextual conditions are the specific sets of conditions (patterns of conditions) that intersect dimensionally at this time and place to create the set of circumstances or problems to which persons respond through actions/interactions" (Strauss & Corbin, 1998, p. 132). The contextual conditions that create the circumstances for the action/ reaction were found to be the local regional considerations including their properties: reliance on foreign support, viability to alternatives, and frequency of utilization.

The local context for the UAE is unique. All of the participants interviewed highlighted the situation where the UAE has started its power generation program before starting first with a research reactor, which in their view was a brave move, as they could not recall any other country doing the same. This move, in their view, bore unforeseen circumstances. The training and experimenting for the much larger and expensive power plants are normally conducted in research reactors, and there are no viable alternatives to them for these scopes. Therefore, it is either that the government conducted its power plant related experiments and trained the staff abroad, or the power plant design is a replica of a successful model, and the operating workers were imported with the plant and had their training at their previous job. Local human capacity is needed for the sustainability of operations of nuclear power plants; the respondents voiced their concern over the situation where foreign workers could leave at any time for many different reasons, such as political or economic changes in the region. Therefore, it is a strategic option to have a sustainable and reliable place for developing a local base of experts in nuclear disciplines (Hamilton, Kazem, He & Dumolo, 2013; Liu B. et al., 2014).

The idea of regionalization was discussed as well by the majority of the interviewees as a viable option for the region. The uses of research reactors are diverse, and each country in the region has a particular objective for using research reactors. Since local demand is satisfied currently by external options, regional countries could collaborate on a single multipurpose reactor, or multiple research reactors, with specific purposes within the region being available for the participating countries. This could be looked at as an interim development period until each country gains the skills required, realises a sustainable demand locally, and decides on having a local research reactor. The interviewees voiced their concerns over the political situation between regional countries that could affect the sustainability of operations of regional research reactors. The Middle East is a volatile region, and the issue of research reactor regionalization should be assessed carefully, as the benefits of this move could be undermined by the political situations. (Ridikas et al., 2011; Shaker, 2014).

The products and uses of a new research reactor must be competitive and take into consideration the alternatives available currently to local users. Oil and gas companies, healthcare facilities, universities, and chemical production companies all require the services of research reactors. There must be an alternative currently available to them and a feasibility plan for the new research reactor should look into the viability of competing with these alternatives (Peld & Ridikas, 2014). However, there are new technologies that must be assessed to establish the viability of initiating a research reactor project. Such technologies, although not suitable for all uses of research reactors, can provide an alternative for the users if they provide cost effective products. Such as the spallation neutron sources. "A spallation neutron sources comprise typically a source of high energy protons produced either by a cyclotron, a synchrotron or a linear accelerator" (IAEA, 2012, p. 84). According to IAEA, these technologies are yet to be tested and improved to cover the other uses offered by research reactors, and to justify their associated high cost. "When compared to a research reactor, the capital and operating costs of a spallation neutron source are significantly higher" (IAEA, 2012, p. 85). IAEA (2012, p. 84) cited the weaknesses of spallation sources, for instance, "they are normally not designed for continuous operation and have not been used for the routine production of radioisotopes". However, this issue should not be overlooked by the decision makers while assessing the alternatives and the viability of the new research reactor, due to the technological evolutions that may improve the viability of accelerators to research reactors.

Another contextual property related to the local context is the frequency for using the research reactor by the local authority. If there will be reliance on international research reactors and the plan is only for occasional training and staggered research uses, then this will never justify the high cost associated with the operations of a research reactor. As mentioned earlier, to run research reactors there are many factors to take care of, such as the recruitment of skilled operators, the safety and security measures, spent fuel management, and others. So if the uses of the plant will not justify the high cost associated with such uses, there will be no viability for having a research reactor project.

#### *5.3.4.4 Strategies*

Actions and interactions are the process of interventions for how situations should be handled by a person, organisation, etc. There are two types of actions and interaction, strategic and routine actions/ interactions (Bryce & Macmillan, 2005; Strauss & Corbin, 1998). Strauss and Corbin (1998, p. 133) claim that "Strategic actions/ interactions are purposeful or deliberate acts that are taken to resolve a problem and in so doing shape the phenomenon in some way," but go on to clarify that routines are actions/interactions that tend to more habituated ways of responding to occurrences in everyday life such as having an established protocol to follow when the number of staff members is low. In organisations, these would take the form of rules, regulations, policies, and procedures (Strauss & Corbin, 1998, p. 133).

This part of the study is focused on the utilisation aspects of research reactors, as they encompass the success factors for their operations. The strategies required to respond to the conditions affecting this phenomenon are determined to be the enforcement/improvement of the justification process effectiveness of research reactor projects. Justification process effectiveness was found from the comparative analysis of data to include the properties of feasibility-based decision, operations sustainability, and industrial integration.

Project feasibility studies should be the cornerstone when deciding pursuit of a research reactor project. These studies must be completed with due diligence to ensure they encapsulate all the elements that can affect the attainment of the objectives set for the development of the project. They should include all aspects contributing to the success of the research reactor project such as social, economic, political, and environmental considerations. The decision for developing a research reactor project should not ignore these factors, nor should it consider any political stunts related to public opinion or prideful ones for international considerations. Relaxing the feasibility requirements or seeking prideful objectives will always affect the outcomes of research reactors and will lead, among others things, to underutilisation or shutdown of the facility, which will bear severe, long-term financial implications on the government (Izhutov et al., 2009).

Operation sustainability of research reactors must be ensured to improve its viability. Operations viability can be achieved through ensuring, during the feasibility stage, that the factors for the sound operation and durability of services are satisfied. Such factors include designing the planned research reactor according to the uses required by the users, securing sustainable demand locally by the industries and institutions, and having a strategic long-term plan for the development of the work force needed for the efficient and effective operations of the reactor. Moreover, governmental support in the form of financial contributions and the durability of desired regulations must be ensured throughout the long life cycle of the project (Ridikas et al., 2010).

Industrial integration must be considered at the early stages of the project. This is one of the integral elements that the decision for developing a research reactor must be built on. Integration of the users from the first stages will ensure that the design of the research reactor, and therefore the uses, are corresponding to the particular need of the local users. Another important issue in this integration is that involving the users from the beginning will improve the accuracy of the feasibility study, as it will be based on actual demand and not an approximated one. Furthermore, the financial integration of the users must be considered. Most of the collaboration models currently are based on full reliance on the government for bearing the cost of building the research reactor, and the users pay only when they use the facility. This model must be reconsidered; many countries are now thinking of engaging the users financially throughout the development of their research reactors. This financial involvement must be introduced to potential users at the early stages of the project, and substantiated by feasibility studies to highlight the benefits from the potential partnership (IAEA, 2012).

#### *5.3.4.5 Consequences*

The final step in the coding paradigm process is consequences. Whenever there is an action or a reaction taken in response to a problem, there are consequences expected from such intervention.

Consequences have inherent properties, such as being singular or many, immediate or cumulative, foreseen or unforeseen, having varied durations, or other properties. Moreover, their impact on the situation may be narrow which affects part of it, or be more widespread. Consequences correspond to the larger picture related to the situation, rather than just direct implications of the actions or reactions taken (Kendall, 1999; Strauss & Corbin, 1998).

The consequences of implementing the strategy for improving the justification process for the research reactor project, which are intended for the improvement of utilisation of research reactors, were found from the analysis to be local demand justifications, viability of alternatives, and potential partnerships.

Improved local demand justification is expected to significantly improve the utilisation of research reactors. Interview respondents highlighted the importance of thorough feasibility studies that take into consideration all factors that can affect the success chances of research reactors. As discussed earlier, this includes, in addition to local demand, regulatory systems, stakeholders, funding, safety and security, human resources development, environmental and radiation protection, fuel management, etc. Once all elements of the feasibility studies are analysed and found favourable to move forward, local authorities can make an informed decision accordingly. Decision for developing a research reactor project based on incomplete project initiation work or based on political motivations and national pride has proved to be catastrophic for many countries that ended up with underutilized or shutdown reactors, bearing their long-term financial implications sometimes decades after the shutdown (IAEA, 2012).

Improved operations of research reactors are expected to be achieved when the justification work has taken due time. The justification work will ensure that the research reactor is designed according to the specific requirements of the users and that the research reactor provides services to users that are competitive with their current alternatives. Moreover, it will ensure that there is a sustainable human resources development plan to sustain its competitiveness compared to other alternatives, so it caters to the needs of skilled personnel for the long duration of operations of the research reactor. Proper justification of the research reactor project through detailed project initiation work, where there is no political interventions, will improve the chances of commercial viability for the research reactors. The users might see long-term partnership benefits in the facility rather than paying for usage only (Dodd, et al., 2002; IAEA, 2012). The research reactor to be commercially viable must integrate the users from the initiation stages, so that they contribute its sustainability through providing the required specifications, and the financial resources to enable such long-term sustainability. Any type of research reactors can satisfy all training and education requirements, although critical facilities may be not offer the full range required by research. However, for a new research reactor for the UAE that will be lightly utilized and gradually will pick up momentum as more scopes will be added to it, education and training is a feasible issue. IAEA (2014b, p. 8) stated "Education and training in radiation protection and radiological engineering for students and technicians is an activity that can be undertaken by reactor facilities of all power levels. However, the exercises can be more complex at facilities where highly activated materials are produced and potentially some radioactive effluents are possible." And, regarding the education and training in critical facilities, IAEA (2014b, p. 4) further added "even critical facilities can be successful in this area of application, although they might not be able to reap the full benefits a research program can offer"

Although not all uses can be commercialized, a starting point will be the emphasis on the profit generating uses, such as radioisotope production, and silicon doping. Companies can be invited to partner individually or as a group of companies. It will all depend on the outcome of feasibility studies, where the users can see the financial benefits of being partners in the project. In all cases, an improvement to the relationship between the users and the government can be expected. Figure 16 summarises the full axial coding process discussed above.

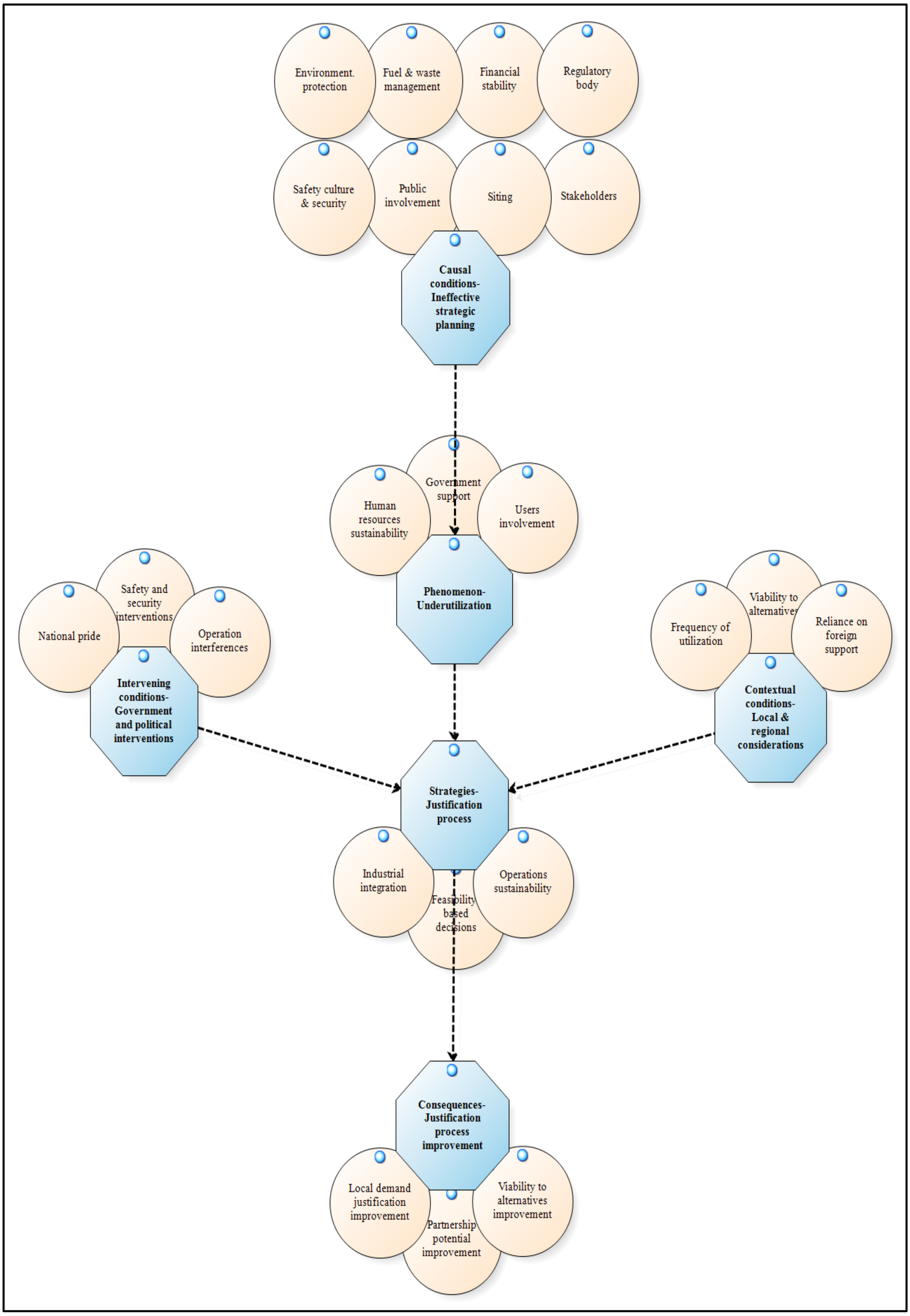



**Figure 16: Axial coding paradigm**

### 5.3.5 Selective coding

As mentioned earlier, the process of refining and integrating categories to relate them to core categories is called selective coding. This is necessary for building the basis for the emerging grounded theory. The process is similar to the axial coding process, but with a higher level of abstraction. In selective coding, there is more emphasis on the relationship of the core category to the other categories (Boychuk & Morgan, 2004; Gasson, 2004; Strauss & Corbin, 1998).

The integration of the seven open categories was possible through the utilisation of the coding paradigm model, which helped in the identification of the relationships among all categories. This identification process merged the seven open categories into five categories, namely Justification process (industrial integration, feasibility based decisions, and operations sustainability); Political interventions (national pride, operation complications, and safety and security interventions); insufficient project initiation work (stakeholders, financial stability, nuclear safety culture and security, site selection, fuel and waste management, environment protection, and regulatory body); underutilisation (governmental support, human resources stability, and early users involvement); and, local and regional contexts (reliance on foreign support, frequency of utilization, and viability to alternatives). The analysis process of grounded theory involves a single core category at a time. A core category is a category which lies in the core of the theory under development and explains significantly the variation in the patterns of behaviour (Gasson, 2004; Hallberg, 2006). Once these relationships among the categories are identified, a theory will start to emerge in the data, prompting further analysis and comparison to confirm such a theory (Hallberg, 2006; Strauss & Corbin, 1998). During the process of the axial coding paradigm, underutilisation of research reactors was identified as the core category and was identified as a primary reason for failures in research reactors; it is also a deterrent of future partnerships between governments and the private sector. The rest of the coding paradigm was identified as follows: Causal conditions (ineffective project initiation work), Context (local and regional considerations), Intervening conditions (government and political interventions), Strategies (justification process), and Consequences (Local demand justifications, viability to alternatives, partnership potential).

Each category and subcategory of the coding paradigm is to be evaluated individually, confirming its relationship to the core category. The paradigm model was checked again after reviewing more data, and further interviews were conducted to confirm its structure and the relationships of its categories. Therefore, all categories and subcategories in the model were rechecked for their relationships with the core category. The validity of the relationships in the coding paradigm requires the establishment of propositions to test the relationship between the core category and other categories and subcategories. (Bartlett & Payne, 1997; Hallberg, 2006; Strauss & Corbin, 1998)

The theoretical propositions for the relationships between the categories in the paradigm model will be based on the following established relationship.

#### *5.3.5.1 Causal conditions*

There are many important conditions to be considered in the project initiation work for the research reactor project that affects directly the utilisation of such reactors. Insufficient project initiation work and its properties influence the level of utilisation the research reactor project can have. These conditions are related to the stakeholders, life-cycle financing and funding, nuclear safety and security, site selection, fuel and waste management, environmental and radiation protection, human resources development, and the regulatory body. These properties, which were discussed in detail earlier in the axial coding section, shape, individually or collectively, the outcomes of research reactors and therefore create the value that private investors could be attracted to. For instance, not having a sustainable human resources development plan will directly affect the utilisation of the research reactor and therefore could pose a viable threat that operations could be interrupted during the lifecycle of the project. Another example is the early involvement of users in the design and finance of the project. This is a multidimensional factor that is focussed on the impact of a group of properties. Early identification of users leads to designing the reactor according to their needs so that the required uses are secured, in addition to the establishment of the actual local demand. "The users and other stakeholders of the research reactor are essential to its long term viability, and should be closely involved in the specification of the research reactor capabilities, as well as consulted on important design decisions" (IAEA, 2012, p. 37). This will enable the development of the project according to an actual economic feasibility, and will offer a diversified stream of funding by engaging the users into a partnership relationship.

#### *5.3.5.2 Intervening conditions*

The intervening conditions, as mentioned earlier, are those conditions that alter or mitigate the influence of causal conditions. Government and political interventions were identified as the intervening conditions that alter the outcomes of project initiation work, which, when not done properly or are not considered when making the decision for developing the research reactor project, influence significantly the operations of research reactors. The investors or users will only be attracted to the project if there is a clear financial reward for their participation, and having a project that was commissioned based on political decisions related to national pride or a local politics campaign will undoubtedly undermine the benefits sought after in the feasibility studies. Feasibility studies give an early indication of the soundness of the project, and their outcomes form the basis for negotiations with potential partners. All of this determines the viability of the project.

The value of project initiation work is also affected by the political decisions related to new regulations, spending cuts, etc. which lead to implications for the manpower development program, the level of safety and security measures, and the utilisation capacity that the research reactor can handle. Moreover, feasibility conditions are influenced by the measures the government takes in response to nuclear incidents or terrorism threats, which influence all the good preparation through detailed feasibility studies and reduce significantly the commercial viability of the facility.

#### *5.3.5.3 Contextual conditions*

The utilisation of a research reactor in the UAE has been determined to be influenced by the context of local and regional considerations and its properties: reliance on foreign support, viability of alternatives, and frequency of utilisation. Given that if all project initiation work was satisfactory with no governmental or political decisions hindering the outcomes of such studies, still there are conditions that are unique to the local practice that can negatively affect the utilisation of the research reactor. Although project initiation work could highlight the importance of local human resources development for the sustainability of operations, the country might opt for training its work force abroad and not consider the strategic importance of having control of the training program. Another issue is the frequency of use. It has important to consider if local demand substantiates the operational cost of research reactors, and if the local research reactor can be a competitive alternative for the current users. All of these issues add a different dimension to the conditions that influence the level of utilisation and viability for the project (Bode, 2012; Hamilton et al., 2013; Liu B. et al., 2014; Ridikas et al., 2011).

#### *5.3.5.4 Strategies*

The actions/interactions that are required to respond to the conditions affecting the utilization of the research reactor is the improvement of the justification process of the projects, including its properties: feasibility-based decisions, operations sustainability, and industrial integration. The improvement of the feasibility process is for ensuring that all properties are studied and found feasible to move the project forward, making sure that any decision is based on the outcomes of such feasibilities and not based on other factors, such as government and political interventions. Such interventions could also impact the sustainability of the project by altering the training programs or imposing spending cuts, etc. Finally, having a strategy in place to involve the users early on in the project ensures, among other things, that the research reactor is built according to the specific requirements of the users; the uses will correspond to local demand and the financial partnership potential with the users (Ridikas et al., 2010). "The users and other stakeholders of the research reactor are essential to its long term viability, and should be closely involved in the specification of the research reactor capabilities, as well as consulted on important design decisions" (IAEA, 2012, p. 37). All of these actions are expected to improve the conditions influencing the utilisation and viability of the research reactor.

#### *5.3.5.5 Consequences*

The improvement of the justification process through the strategies implemented is expected to improve the local demand justifications, the viability of alternatives, and the PPPs' potential, all of which leads to improvements in the utilisation of research reactors. The improvement to the local demand justification process is expected to take into consideration the value for money criteria before moving ahead with the project. This will include the justification for the project, meaning that it will have sufficient demand to justify the high operational cost, and that the project is a result of actual needs and not of a political decision. It will also show that the uses and products from the research reactor are competitive compared with current options available to the users. All of these factors will ensure that the utilisation potential is maximised.

### 5.3.6 Theoretical propositions

Through the constant refinement of the relationships in the coding paradigm model, the following propositions (relationships) were generated:

*Intervening proposition*

- Government and political interventions alter the value of the justification process and influence directly the utilisation and subsequently, the potential for users' integration in research reactors. Government and political interventions include national pride justifications, operations interferences, and safety and security measures.

*Contextual proposition*

- The proper utilisation of research reactors depends on the influence of local and regional justifications and on the outcomes of the project initiation work. Local and regional justifications include local demand justifications, viability of other alternatives, and partnership potential.

*Strategies proposition*

- The strategies in response to the justification process that influence the utilisation of research reactors are expected to address the issues of feasibility-based decisions, sustainability of operations, and industrial integration.

*Consequences proposition*

- The consequences of the strategies taken to improve the justification process lead to improvements to the utilisation of research reactors, and they include demand justification improvement, viability of available alternatives improvement, user integration, and the PPP's potential improvement.

## 5.4 Conclusions

This chapter presented the results and analysis of the three segments of the conducted methodology as introduced in chapter 4.

Through the utilisation of the Nvivo software, content analysis was conducted between the best practices selected for this research, which led to the identification of the underlying concepts and their associations with other functions in the PPP mechanism. Such mechanism consisted of five phases: establish the PPP framework, PPP implementation, contract design, bid management, and PPP contract management phases. These phases consist of groups of functions and sub-groups of functions.

The results of the surveys in the UAE and the UK were analysed, and the comparative analysis of the same showed a significant similarity in the practice between the two countries. A ranking of each CSF was established so that more emphasis is given to the highest-ranking ones when deciding on using the PPP mechanism locally. The private sector's skills and experience ranked as the most important factor for preferring PPPs to conventional procurements. The second important factor was private sector's funds, and third was value for money factors. The same four factors were chosen as the most important ones by both countries out of the sixteen factors for delivering value for money outcomes. These factors were optimised risk allocation, competitive bid process, improved services to the community, and clear output specification. Both countries ranked the same nine factors as the most significant ones out of the eighteen critical success factors for implementing PPPs. These factors were commitment of public and private parties, appropriate risk allocation, committed and competent public agency, transparent procurement process, strong private consortium, competitive procurement process, political support, detailed cost/benefits assessment, and good governance.

The last segment was the analysis and results of the grounded theory process to identify the success factors and commercial viability of a research reactor, with particular focus on the UAE. Open coding of the interviews was conducted, where 7 groups emerged: future demand, justification process effectiveness, government and political interventions, ineffective project initiation work, underutilisation, local context, and regional collaborations. Then axial coding and selective coding were conducted to establish the core phenomenon, the intervening and contextual conditions, the strategies required for overcoming the phenomenon, and the consequences expected from the implementation of the strategies. Underutilisation was identified as the core category, ineffective project initiation work was the main causal condition influencing the utilisation of research reactors, governmental and political interventions were the intervening conditions, the local/regional justification and viability were the contextual conditions, and improved justification process was the strategy required to improve the utilisation of research reactors. The grounded theory process concluded in this chapter with the formulation of the theoretical propositions that will be used in the discussion chapter to create the storyline for the development of the substantive theory.

# 6. DISCUSSION

This chapter will discuss the results and findings of the fifth chapter, and link them to the objectives of this research.

## 6.1 The PPP generic framework

Qualitative content analysis work was conducted for the development of the generic PPP framework for the UAE. The approach offered by Zhang and Wildemuth (2009) was utilised for this process to achieve the first objective of this research, which is to "Study the best practices of PPPs to develop the UAE's generic framework."

In deciding what to benchmark, three comparative studies provided the criteria for what to look for and where. The Mediterranean comparative study provided the techniques required for the regional comparison. The British and Turkish comparative study provided insights on how the practice varied between developed and developing countries. Lastly, the Chinese and Hong Kong comparative study provided areas for political consideration.

Many frameworks and manuals were identified to provide the data required for the content analysis of the best practices. Such best practices included leading institutions and governments in the field, such as The World Bank Institute (WBI), The European PPP Expertise Centre (EPEC), the Asian Development Bank (ADB), The Economic and Social Commission for Asia and the Pacific (UNESCAP), in addition to scores of other frameworks from leading PPP countries in the world.

The approach followed the following sequence as provided by Zhang and Wildemuth (2009): prepare the data, define the unit of analysis, develop categories and a coding scheme, test your coding scheme on a sample of text, code all the text, assess coding consistency, draw conclusions from the coded data. The gathering and analysis steps of the best practices allowed for content analysis between all elements of PPP practice in the best practice countries through the utilisation of Nvivo software. The results were identification of five consecutive phases that the PPP project is required to go through to improve its success rate. These phases are establishing the PPP framework, PPP implementation, contract design, bid management, and the PPP contract management phase. These phases consist of many steps within them. The content analysis of the best practices using the approach offered by Zhang and Wildemuth (2009) helped in achieving the first objective of this research, which is to "Study the best practices of PPPs to develop the UAE's generic framework." The elements of this framework were discussed in details in chapter five. A representation of this framework is illustrated in a diagram representing the generic PPP framework for the UAE (Figure 17).

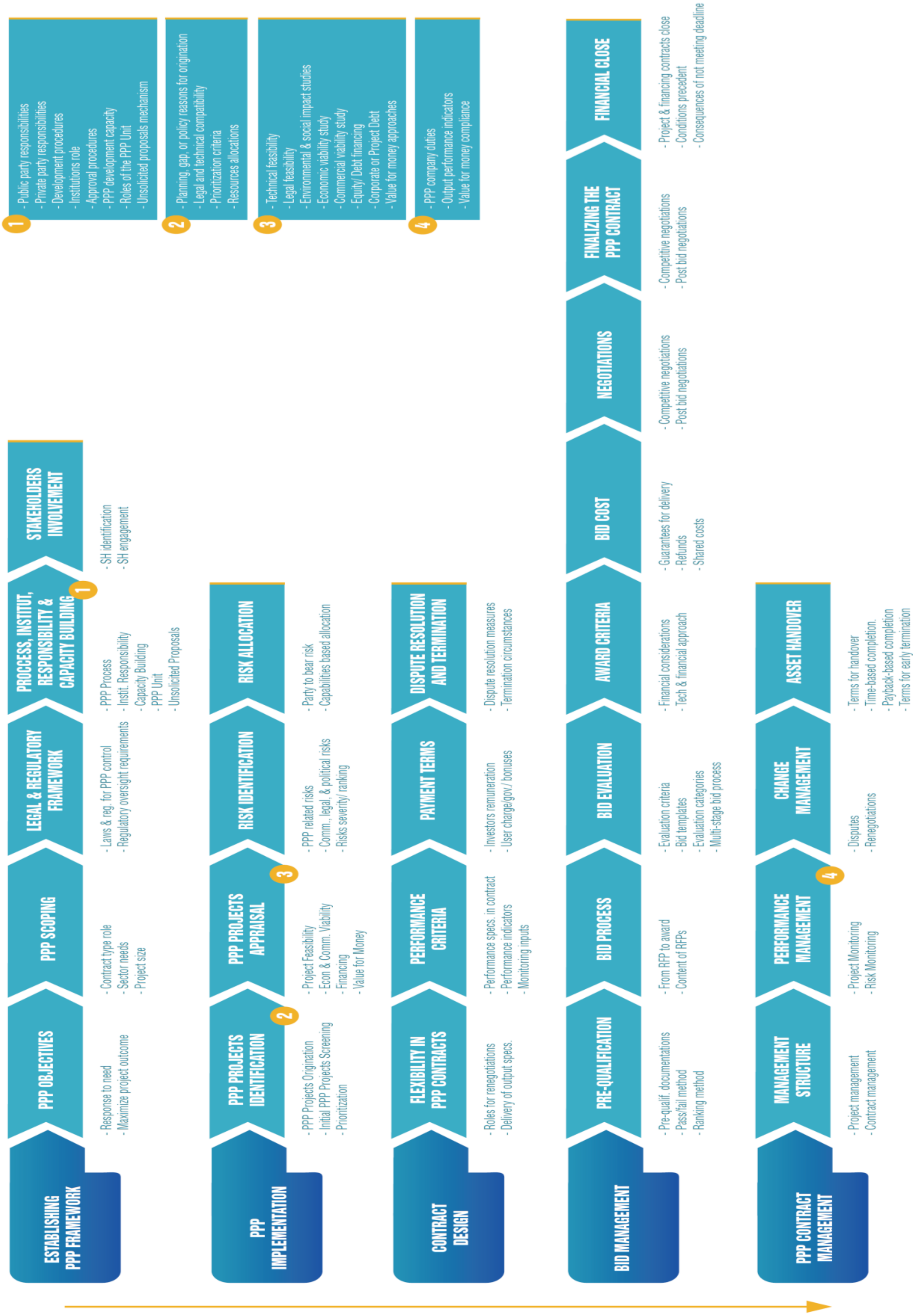



**Figure 17: Generic PPP framework**

## 6.2 PPP CSFS for the UAE

### 6.2.1 Favourable factors for adopting PPPS

The respondents see private sector skills and experience as the most important factor for adopting the PPP model in both countries. This indicates that the private party has the capability to deliver the project in the most efficient way. Efficiency can be expected from the project when the private party, who has vast experience in similar projects and the funds and the technical capabilities needed for such projects, delivers the project with the expected output specifications on time and with the least cost. The private party also integrates all phases of the project under one management system which ensures more value for money from the project (WBI, 2012; Yun et al., 2015).

The private sector's funds are seen as one of the most attractive factors for implementing PPP models in the UAE and the UK. The reason is that most governmental entities are restricted to predefined budgets which hinder their capacity to respond to public demand for additional facilitates and services. Some of these projects are classified as high risk due to the limited capacity to develop them by the public party. The private party, in this regard, provides the funds needed to fill the gap of financial deficiency and to overcome the risks. The private party will ensure the security of its money and will significantly relieve the government from the burden of finance and risk bearing (Angelides & Xenidis, 2009; WBI, 2012)

Value for money is considered one of the most important factors leading the public sector to adopt PPP models. PPPs offer value for money, as they offer efficiency in the value of the project when compared to conventional methods, or, in certain countries, when compared to a public sector comparator (PSG). Such efficiency is possible because of the capability of the private party in managing the full life cycle of the project under one integrated development system, coupled with its technical and financial facilities available for the project (Goodliffe, 2002; WBI, 2012). Value for money also is offered when there is proper risk allocation to the party that is best in managing their consequences, leading to cost control and time savings (P3, 2011).

Risk transfer to private parties is another very attractive factor leading to the adoption of PPP models. Risk transfer to the private party eases the difficulty for pursuing large projects for the government. Much needed facilities are sometimes delayed because the government does not have the capability to develop them efficiently and could run into major risks that could escalate the cost and delay of the delivery of the services to the end users. The private party plays the biggest role in this regard by taking over the responsibility of developing the project according to output specifications and by providing the required funding without exposing the government to any liabilities (Li et al., 2005; P3, 2011)

Technology transfer was the first factor that was ranked highly by the UAE respondents but not so by the UK respondents; it ranked 5$^{th}$ in the UAE and last in the UK for the favourable factors leading to the implementation of PPPs. As governmental entities in the UAE have very scarce exposure to PPP models and therefore do not have the needed resources and capabilities to develop large and complex projects that PPPs are known for, PPPs are assumed to sharpen skills and provide state of the art methodologies for developing projects in developing countries. This factor was ranked last by the UK respondents as they assumed that governmental bodies involved in the PPP/PFI process are well developed, and they did not see value in this factor being a reason for adopting PPP models (Li et al., 2005; Whangthomkum, Igel & Speece, 2006).

Project cost and the time control factor were identically ranked sixth by both groups. Cost overruns and extensions of time are common events in construction and more so in large projects, such as infrastructure projects. The partnership nature of PPP projects and the risk sharing/ allocation between the parties involved in the project maximises the chances for success of projects, as they provide a platform for joint development of the project. Such a platform ensures that the proper management structure is in place, and the project performance management of the project, through project monitoring and risk monitoring, is in place as well. The partnership nature also allows for the efficient remediation of changes in the project, which reduces the chances for disputes and provides an effective mechanism for renegotiations that are needed to put the project on track to correspond to the predefined output specifications. All of these features improve the chances for cost control/saving and timely completion of the project (Boussabaine, 2013; Oyedele, 2012; UNESCAP, 2011).

Capacity building ranked seventh in the UAE, making it a significant attractive factor for adopting PPP models, whereas it ranked second to last for the UK. It is very evident that PPPs in the UAE are looked at as opportunities for improving the structure and procedure of the government to better deliver its responsibilities to the public. Such features are not adding value for the UK, as the capacity of the government is mature, and therefore it is not a favourable feature for adopting PPP models.

Lack of government resources and experience ranked eighth in the UAE and fifth in the UK. This factor seems to be more important for the UK sample, and the reason could be that the government is always on the lookout for private funds, management, skills, manpower, and experience for developing its projects to achieve efficiency. This factor was less important for the UAE, as local governments are enjoying a satisfactory financial situation and are not seeking funding from private parties. They are conducting their tenders according to financial and technical criteria, which indicates that the lack of resources and experience is not a very attractive factor for adopting PPPs.

Stimulate financial market ranked ninth for both groups, indicating that the respondents from both groups are giving the same level of significance to this factor in relation to the other factors. PPPs are considered catalysts for economic growth for the opportunities they offer to the financial sector for participation. Such opportunities are related to the debt raising for the project. Investors design the capital outlay of the project according to their financial objectives. Therefore, they choose between commercial loans, bridge loans, subordinated loans, bonds, and other elements to achieve their objectives. Engaging the variety of debt raising options stimulates the financial market and financial institutions, leading to an improved financial sector that can cater to other economic sectors. This stimulation of economic growth through engaging the financial market is considered a favourable outcome that encourages the public sector to adopt PPP models.

Long-term engagement, economic growth, large size of projects, and cap service cost were the least ranked factors from the tenth to thirteenth places in the UAE. These are the least significant factors that would attract the UAE government to consider PPP alternatives. It seems that the long-term nature of a project and the large size of projects are not sufficient reasons to consider PPPs, as there might be other alternatives available to deal with duration and size complexities of the projects. Economic growth might not be a direct objective of local governments, and therefore this reason is not sufficient to consider the PPP option. The last ranked factor, cap service cost, might not be a significant issue for local users, as paid services are relatively new in the country and are relegated to a few services, such as parking and road tolls services, or subsidised services, such as water and electricity, whose charges are already capped by the government.

### 6.2.2 Value for money factors for adopting PPPS

Optimised risk allocation and a competitive bid process were ranked first and second by the UAE sample and second and first by the UK respondents respectively. These two factors, according to the very high significance given to them by both groups, indicate their importance in achieving the value for money objectives that make the government prefer PPP models over other, conventional methods. Risk allocation plays a significant role in maximising the success of PPP projects. Risk should be allocated to the party that is known to manage its consequences best. When the risks are allocated properly, fewer eventualities will be expected in the project, and timely remediation of their consequences will be possible as well, leading to optimised performance and more value from the project (Chou et al., 2012; P3, 2011; WBI, 2012).

A competitive bid process is so critical to the success of PPP projects and to the value they offer, as it is the process that is supposed to bring the best bidder that can deliver the objectives of the project. This process starts right after designing the output specifications of the project and consists of the prequalification of bidders, the evaluation of bids, negotiations with qualified bidders, an award to the right bidder, and financial close. All of these steps are essential for the success of the project and the maximisation of its value for money (WBI, 2012). Clear output specification also was a very significant factor; this is because PPP contracts are long-term projects where input specifications vary over time. It is important for the developers to put the products and services back on track to correspond to the adjusted specifications. These specifications must be very clear to avoid unnecessary disputes and to ensure that the public receives the right services and facilities (EPEC, 2012; Love et al., 2010).

Improved services for the community was ranked among the most important outcomes of PPPs by both groups, who believed in their significance in achieving value for money. The private party, by undertaking the type of contracts that the PPPs are, seeks to maximise its returns on its investment for the full life cycle of the project. This maximisation of benefits comes through the integration of all project phases and scopes under one integrated system where all resources are utilised efficiently. In this efficient utilisation, the private party seeks state of the art technologies and innovative ideas for the development and operation of the project, all of which leads to better services and improved facilities to the community (WBI, 2012).

Improved facilities to the users ranked fifth in the UAE and ninth in the UK. This factor is among the most important factors for achieving value for money for the UAE respondents, though not so significant for the UK's. The reason for this may be that the UAE respondents look at PPPs as providers of unique projects, especially in the areas of healthcare and infrastructure, where new technologies and innovative ideas are employed to improve the return on investment. In the UK, the services are already at the highest level of quality, as the PPP/PFI projects have been perfected over decades of practice, and the respondents did not see the added value for money in this regard. The same could be inferred on the optimisation of assets efficiency factor as well it ranked sixth and seventh in the UAE and the UK respectively. This can be attributed to the fact that the private party would look into all alternatives to maximise the utilisation of the asset, whether a new one or an existing one, to maximise the profits, leading to more facilities and improved ones for the community (Akintoye & Chinyio, 2005; WBI, 2012)

Technical innovation was ranked seventh and the private sector's project management skills eighth by the UAE respondents, but fifth and tenth respectively by the UK's respondents. Private parties involved in PPP projects employ technologies and management systems to integrate processes and optimise resource utilisation, which contributes to the sustainability of the project by reducing cost, improving efficiency, and catering for better services to the public, leading to the achievement of more value for money (Zhang, 2005; Grasman, Faulin & Lera-Lopez, 2008).

Incentives for the private party, appropriate capital structure, long-term engagement, efficient dispute resolutions, low life-cycle cost, early service delivery, reduced negative environmental impact, and low tariffs were ranked from ninth through sixteenth by the UAE respondents, who gave a significance range from 3.20 to 3.77. As for the UK respondents, all of these factors received low significance except for incentives for private party factor, which ranked sixth. All of these factors and the other factors in this study will be discussed in detail in the factor analysis section of this report. Briefly, they have a common theme, which is the sustainability of the PPP project, and it did not seem to be a concern for the respondents of either country that sustainability plays a major role in the achievement of value for money.

### 6.2.3 Critical success factors for implementing PPPS

The commitment of the public and private parties to the cause of PPP models is the most critical success factor as indicated by the respondents from the UAE and the UK. The public party must show its commitment by facilitating all means for the private party to maximise the success of the project. Such facilitation comes in the form of having established departments and processes for handling the government's scope related to the PPP project throughout the development and operation phases of the project. The public party's commitment also must be present in the handling of change management of variations to the contract and renegotiation of certain objectives in response to risk remediation or to realign the project to output specifications. The public party also must ensures that local conditions, such as permits, legislations, legal frameworks, public support, access to the financial market, etc. are provided for the project. The private party must show commitment to the project by maximising its effort to develop and manage the PPP project in the most effective and efficient way that balances the generation of profits for both parties with improved and cost-effective services for the public. The outcomes of this commitment by the public and private parties are the most significant success factors for developing PPPs/PFIs in the UAE and the UK (Chan et al., 2004; UNESCAP, 2011).

Another factor ranked as first for the UAE with the same mean score of significance of 4.70. This factor is appropriate risk allocation, and it ranked second for the UK sample with an insignificant difference to the first factor (.02), making this factor equally significant to the success of PPP projects. The main feature of PPP models is that they establish clearly the responsibilities that each party should bear during the development and operation of the project. Risk allocation should be based on very clear criteria, where the reason for allocating such risks is well established. The reason for this is that risks should be handled by the party that is known to manage their consequences best. The public party therefore should not impose risks to the private party without its approval before the commencement of the project. This will lead the minimisation of eventualities and the prompt remediation actions by the respective party, leading to time and cost savings and more effort dedicated to the project rather than to its disputes (Chou et al., 2012; P3, 2011; WBI, 2012).

Respondents from both the UAE and the UK ranked third committed and competent public agency as a very significant critical success factor for PPPs, where the associated significance was 4.43 and 4.27 respectively. Effective and efficient public agency is required in order for the PPP project to succeed. The public agency acts as the "one stop shop" for the private party to deal with all governmental departments that are involved in the project. The communication among all departments and timely response to the developer is of utmost importance. This is because large projects such as PPPs require permits and approvals throughout the development phases of the project, and facilitating such requirements will improve the chances for success of the project. The public agency also is involved in the bid management of the project. The transparency and competitiveness in handling all stages of bid management, such as replying to bidders queries, are no doubt major issues in awarding the project to the most competent and capable bidder, which will maximise the success factors for the project (Forrer et al., 2010; Hardcastle et al., 2005).

A transparent procurement process was ranked fourth by the respondents from the UAE with a mean score significance of 4.33. This indicates how important the transparency of the bid process is, as it plays one of the most significant roles in awarding the project to the right bidder. The transparency should be offered throughout the bid stages as well, and not only in the initial stage where preliminary offers are delivered, as negotiations are considered at later stages where some bidders were already eliminated or the information disclosed varies from one bidder to another (Li et al., 2005).

Respondents in the UAE gave the same significance to strong private consortium. This is another very critical success factor for developing PPP projects in the UAE and the UK. A private consortium that is going to run the project consists of all players related to the development of the project from the private parity's side. Such players are normally consultants, contractors, and financiers. The stronger the consortium, the more experience it brings to the project in designing and developing the most efficient and effective projects with the optimum capital outlay structure design; all of this ensure the maximisation of success in delivering the objectives of the project (Chan et al., 2010; Li et al., 2005).

A competitive procurement process was ranked sixth by the UAE respondents with a mean score significance of 4.27. The competitive procurement complements the transparency of bid process in providing the mechanism for the prequalification of bidders, ensuring the negotiations are focused on bringing the best bidder and not only the best financial offer. The chances for project success are always improved when the output specifications of the project are well established and given to the bidders so that they work out their best financial and technical offers (Ahadzi & Bowles 2004; Li, et al., 2005).

Political support was ranked at the seventh place by the respondents from the UAE and the UK with a mean score significance of 4.17 and 4.06 respectively. Political support is very critical to the success of PPPs; it must be durable throughout the life cycle of the PPP project regardless of change of parliaments or cabinets. The project should be protected from any changes in legislation or regulations that might affect the objectives of the project. Diminishing political support can affect the support that governments offer this type of project, such as tax breaks or subsidies, which will significantly impact the success of the project (Chan, 2010; Hardcastle et al., 2005).

Ranked eight by the respondent from both the UAE and the UK was a detailed cost/benefits assessment, where a mean score of 4.14 and 4.06 respectively was associated with its significance to the success of PPP projects. A detailed cost/ benefits assessment is an integral part of the project appraisal process and a very important factor for the success of PPP projects. These studies give an early indication of the true value of the project in order to make a decision on whether to award them or not. Such assessments also identify alternatives, such as financial and technical alternatives, in order for adoption to maximise the benefits of the project (EPEC, 2012; Li et al., 2005).

Respondents for the UAE and the UK ranked good governance ninth with a mean score significance of 4.13 and 4.05 respectively. Good governance is very important for the success of PPP projects, as the platform must be laid for the effective implementation of the project concerning aligning the objectives with the progress of the project and ensuring the smooth implementation of decisions made by the management. This will ensure the satisfaction of all stakeholders and will maximise the success chances of the project (Brinkerhoff & Brinkerhoff, 2011; Li et al., 2005).

A favourable legal framework was ranked tenth by the respondents in the UAE and fifteenth by the UK respondents. The legal framework must be satisfactory from the prospective of the investors in order for it to contribute to the success of the project. The private party will seek a legal system that guarantees the proper interpretation and implementation of the agreements it signs with the public party and with the sub-contractors.

Multi-benefit objectives of all stakeholders and project technical feasibility had an identical mean score significance of 3.97 and were ranked at the eleventh and twelfth positions. The significance of these factors lies in the importance of considering the objectives of all stakeholders to achieve success in the PPP project. The objectives of the public party are mostly related to providing a service or a facility with the least cost and with reasonable profits and satisfaction for the public, while the objectives of the private party are mostly financial. Integrating these objectives will always maximise the success of any project.

Technical feasibility is another important factor that significantly affects the success of PPP projects. A technical feasibility study is essential to the project, as it highlights the tested technologies for consideration and the technical risks that the project might encounter throughout its lifecycle.

Shared authority between the public and private sector ranked thirteenth by the UAE respondents with a mean significance score of 3.90. The significance of this factor to the success of PPP projects lies in the acknowledgement of both parties of the importance of shared leadership to correspond to the mutual interests behind developing the PPP project. This shared authority should be clearly detailed with regards to the scope and decision making process to achieve the objectives of the project and avoid any conflicts related to overlap of authority.

Social support scored a mean significance of 3.83 and was ranked fourteenth by the UAE respondents. Social support by the public is a significant factor for the success of PPP projects. The revenues of the project can suffer severely if the public does not use the services or delays their progress due to reasons such as environmental, economic, social, or political reasons. The lowest ranked factors by the UAE respondents were sound economic policy, government guarantees, macro-economic conditions, and local financial market. They scored means from 3.50 to 3.80. All of these factors have a common economic theme. Although the rank of these factors was very low, the significance of 3.50 and above is still significant.

### 6.2.4 Factors grouping

The agreement of participants on both samples was established by utilizing Kendall's coefficient of concordance, which confirmed the consistency of the rankings provided by the participants of each group. This is very important to this study, as the local sample in the UAE was relatively small and an inferential approximation would contribute to the validity of the findings. Therefore, wherever there are similarities in rankings of factors or groups of factors, it boosts the local findings.

Factor analysis was used to check the interrelationship among all factors and to identify a smaller set of factors to represent the correlated sets of variables. This is to maximise the benefit of each factor by considering the influence of other factors on its performance. Factor analysis enabled the establishment of these interrelated groups. Wherever there is a matching group in the UK sample, it indicates the validity of local grouping.

**Table 29: Factor grouping**

| Factor analysis grouping- UAE | Factor Analysis grouping- UK |
|---|---|
| **1. Favourable factors for PPP implementation** | **1. Favourable factors for PPP implementation** |
| 1.1 Cost savings | 1.1 Cost savings |
| 1.2 Benefits to the public sector | 1.2 Benefits to private party |
| 1.3 Benefits to the end users | 1.3 Benefits to the end users |
| 1.4 Economic and technical benefits | |
| **2. Value for money factors** | **2. Value for money factors** |
| 2.1 Financial efficiency | 2.1 Optimization of private party's contribution |
| 2.2 Project sustainability | 2.2 Project sustainability |
| 2.3 Optimization of private party's contribution | 2.3 Competitive procurement |
| 2.4 Benefits to the end users | 2.4 Benefits to the public |
| **3. Critical success factors** | **3. Critical success factors** |
| 3.1 Project feasibility | 3.1 Project delivery |
| 3.2 Effective bid management | 3.2 Commitment of public and private parties |
| 3.3 Favourable local conditions | 3.3 Project feasibility |
| 3.4 Commitment of public and private parties | 3.4 Favourable local conditions |
| 3.5 Government involvement | 3.5 Effective procurement |
| 3.6 Project delivery | 3.6 Multi-benefit objectives of all stakeholders |
| 3.7 Effective leadership | |

The thirteen factors for the favourable factors could be regrouped into four groups for the UAE (cost savings, benefits to the public sector, benefits to the end users, and economic and technical benefits), and three groups for the UK (cost savings, benefits to private party, and benefits to the end users). There are two groups matching: cost savings and benefits to the end users (Table 29).

The sixteen items of the value for money factors scale could be regrouped into four groups for the UAE (financial efficiency, project sustainability, optimization of private party's contribution, and benefits to the end users), and four groups as well for the UK (optimization of private party's contribution, project sustainability, competitive procurement, and benefits to the public). There were two groups matching between the two samples, and they are optimization of private party's contribution and project sustainability.

The eighteen items for the critical success factors scale could be regrouped into seven groups for the UAE (project feasibility, effective bid management, favourable local conditions, commitment of public and private parties, government involvement, project delivery, and effective leadership), whereas, for the UK, they could be grouped into six groups (project delivery, commitment of public and private parties, project feasibility, favourable local conditions, effective procurement, and multi-benefit objectives of all stakeholders). There was a match between four groups: value for money, favourable local conditions, commitment of public and private parties, and project delivery.

The grouping of factors should be considered by the public party when considering the adoption of PPP models. The favourable factors represent the foundation that must be secured before engaging in this mechanism. The value for money factor represents the strategic objectives for considering the PPP model as a procurement method over the conventional ones. Lastly, the critical success factor groups represent the most important areas that must be considered by the public party in order to achieve the objectives of the PPP project and how those objectives will be achieved.

## 6.3 Critical success factors for research reactors

Theory develops through the constant comparison of the theoretical constructs and the new sets of data. "Theory denotes a set of well-developed categories (e.g., themes, concepts) that are systematically interrelated through statements of relationship to form a theoretical framework that explains some relevant social, psychological, educational, nursing, or other phenomenon" (Strauss & Corbin, 1998, p. 22). The development of the theory will be through the interplay of the inductive and deductive processes. The inductive process includes the derivation of concepts, their properties, and the dimensions of those properties, whereas the deductive process is the hypothesis about the identified relationships between the category and its concepts and the relationships between all categories in the paradigm model. "Once concepts are related through statements of relationship into an explanatory theoretical framework, the research findings move beyond conceptual ordering to theory" (Strauss & Corbin, 1998, p. 22).

### 6.3.1 Core category interpretation

There is a significant influence of underutilisation of research reactors on the sustainable operations and success of such reactors. Ineffective project initiation work related to stakeholders, life cycle financing and funding, nuclear safety and security, site selection, fuel and waste management, environmental and radiation protection, human resources development, and the regulatory body, embolden this influence of underutilisation. The actions that are expected to improve the utilisation and sustainability of research reactors are related to improving the justification process that considers feasibility-related decisions, operations sustainability, and industrial integration. The consequence of the actions taken is influenced by intervening factors, such as national pride justifications, operations interferences, and exaggerated safety and security measures.

Based on the above interpretation of the relationships in the paradigm model guided by the established propositions, a storyline can be generated to develop the theoretical framework (Finch, 2002; Mills, Chapman, Bonner & Francis, 2007; Sandelowski, 1995). Storyline is a technique used to facilitate the "identification of the central category and the integration of concepts" (Strauss & Corbin, 1998, p. 148).

### 6.3.2 STORYLINE

The unsustainable operation and shut downs of research reactors worldwide highlights the influence of the ineffective project initiation work of these research reactors concerning their utilisation. The underutilisation of research reactors included the properties of users' involvement, government support, and the role of human resource sustainability. Factors that facilitate the underutilisation of research reactors are ineffective project initiation work related to stakeholders, life cycle financing and funding, nuclear safety and security, site selection, fuel and waste management, environmental and radiation protection, human resources development, and the regulatory body, all of which are conditions that have a negative influence on the utilisation and sustainability of research reactors. The justification process that focuses on feasibility findings, the sustainability of operations, and the integration of users mitigate the negative influence on the utilisation and sustainability of research reactors. Government and political interventions are the intervening conditions that alter the feasibility-based decisions, sustainability of operations, and industrial integration of the research reactors. Government and political interventions include national pride justifications, operations interferences, and exaggerated safety and security measures. Consequently, through demand justification improvement - viability of alternatives improvement, user integration, and PPP potential improvement - the outcome of the effective justification process leads to improved utilisation and sustainability of research reactors.

### 6.3.3 Substantive theory

The building of a substantive theory for the success factors, and their integration and influence on the utilisation and sustainability of research reactors, was achieved through employing the grounded theory techniques. Data was collected and analysed simultaneously through the different coding stages of grounded theory. During the open coding stage, seven open categories emerged from the analysis of the concepts identified from the transcribed interviews, and they are: future demand, justification process effectiveness, government and political interventions, ineffective project initiation work, underutilisation, local context, and regional collaborations. The axial coding stage started right after the identification of the seven open categories, where the coding paradigm model was utilized to establish the relationships, properties, and dimensions of all categories. This process led to five main categories being derived from the seven open categories, and they are ineffective project initiation work, underutilisation of research reactors, justification process, government and political interventions, and local/ regional justification and viability. Then the selective coding process was engaged. In selective coding process, the categories and their relationships that were established through the paradigm model were subjected to detailed analysis by further interviews with participants. Saturation of data was reached. "Saturation is more a matter of reaching the point in the research where collecting additional data seems counterproductive" (Strauss & Corbin, 1998, p. 136). Through the interplay of inductive and deductive techniques, the development of a theory for underutilisation of research reactors and the relationship with other subcategories started to emerge (Glaser, 2008; Hallberg, 2006; Mills et al., 2008; Urquhart et al., 2010).

The substantive theory is related to: the success factors for the utilisation of research reactors, what phenomena is hindering such success, the relationships between these factors, and how they are affecting the success of the utilisation and sustainability of research reactors. The influence of underutilisation was identified as the core category; causal conditions were the ineffective project initiation work, intervening conditions were the governmental and political interventions, contextual conditions were the local/ regional justification and viability, and strategies and consequences were related to improving the justification process.

The substantive grounded theory can be introduced as follows:

- A strategic plan where the government gives high consideration to the objectives for developing a nuclear program, stakeholders identification, facility specifications, financing strategy, management system… etc., where a research reactor is part of that plan and is integrated within its elements, influences positively the justification of the project, and minimizes the chances for the intervening conditions of government interferences. Such project initiation work will ensure the proper utilisation and therefore the commercial viability of the research reactor for potential partnerships.

- Ineffective project initiation work has a direct influence on underutilisation of research reactors. Project initiation work that does not include a financial strategic plan, where funding mechanisms, estimated project and contingency cost, and fuel cycle and back end procedures are not properly considered, will lead to underutilisation of research reactors.

- The regionalization of research reactors influences the successful utilisation and sustainability of these reactors. The context of local and regional justifications of the demand and viability to other alternatives governs the impact on utilisation, which could be negative for newcomers.

- There is full reliance locally on other countries for the requirements of human resources development for the nuclear industry. This is probably because local authorities do not appreciate the strategic dimension of having a sustainable plan locally. Consequently, the justification for a local research reactor is undermined by this local condition.

- There is a direct relationship between the non-feasibility based decisions and the underutilisation of research reactors. Research reactor projects that are the result of national pride or political decisions will lack the integration within a strategic nuclear development plan and will not consider users requirements from the beginning. These intervening conditions will lead to operational complications and underutilisation of these reactors.

- The intervening condition of exaggerated safety and security measures in response to public demands or nuclear incidents have a negative impact on the utilisation of research reactors. Such measures lead to accessibility restrictions and operation interruptions, making them less viable for investor integration. Emergency plans and written procedures must be in place to govern the actions of the operators, regulators, and any other authority involved in response to any incidents to minimize government interventions and its negative influence on the utilisation of the reactor. Interfacing safety and security and the users of the reactors is required to mitigate the impact of interventions situations.

- The contextual conditions related to overestimation of local demand and ignoring how these demands are currently met for newcomers will influence the justification of the value for money and the level of risks involved in the research reactor project, which will undermine the commercial viability and therefore the users' integration and the potential for partnerships.

- There will always be influence of government support on the sustainability of research reactors as the long duration of the project will survive many government terms, and sustaining the ideal operations context will always require the support of the government. This support comes in the form of maintaining favourable legislations, having a competent regulatory body, and ensuring a clear and well defined procedure for licensing, certifications, and inspections.

- Systematic identification and continual involvement of stakeholders are fundamental for the effectiveness of project initiation process. This causal condition improves the justification process of the research reactor by allowing for the integration of stakeholders' interests and therefore improving their long-term commitment by becoming partners. Maintaining the interest of stakeholders for the lengthy initiation phase of a research reactor project is a serious challenge to the completion of the project. Changes in the government structure, economic policies, technological advancements, and education and training infrastructure, among others, play a significant role in level of interest in the project. The stronger interest stakeholders have the more heavily involved and committed they are. Early involvement of the users will facilitate the generation of more accurate business plans and will also ensure that the uses will be according to the requirements and specifications of the users, which will improve the sustainability of operations. Financial sustainability throughout the lifecycle of the project influences positively the utilisation and improves the attractiveness of the research reactor project to the private sector. This causal condition mitigates the risks associated with funding and identification of means of funding for the design, construction, operation, and support services from the government. This condition also makes it more likely for industries that are heavily dependent on the applications of research reactors to have more financial involvement in the project.

- The particular mitigation of the conditions related to fuel and waste management risks for newcomers regarding the establishment of regulations for waste management and planning for the processing and disposal of low and intermediate level waste influences the outcomes of the justification process, which improves the success rate, utilisation and viability of the research reactor. For countries with an NPP program, radioactive waste generated from the research reactor's operation (including spent fuel) is minimum when compared with the waste generated at a NPP, therefore its management could be merged with the waste from the NPP.

- Public integration from the early stages of the project and satisfying their needs through ensuring measures to minimize their exposure and the workers to radiation during research reactors operations will mitigate their intervening influence on the utilisation of the research reactor. It will also maximise the chances for public support for the full duration of the project, which will include less stringent measures in response to global nuclear incidents.

- The contextual condition of local human capacity building has a direct influence on the sustainability of operations of nuclear power programs, which will always depend on the level of reliance on the local work force trained in local research reactors. It is a strategic option to have a sustainable and reliable place for developing a local base of experts in nuclear disciplines. The foreign workers could leave at any time for various reasons, such as political and economic changes in the region. The sustainability of operations influences directly the utilisation, commercial viability, and success of research reactors.

- The high demand for medical radioisotopes, especially Molybdenum-99, makes the commercialisation of research reactors very viable. Depending on the mitigating influence of viability and availability of local alternatives, a consortium of investors from the users or from the public may develop a research reactor project through the public private partnership mechanism for the production of these commodities. The government's benefit from the partnership, in addition to the financial rewards, will include the use of the facility for particular uses, such as training or nuclear experimenting.

- Newcomers may benefit from strategies that focus on improving the justification process effectiveness that are based on actual demand, viability of current alternatives available to users, and the provisions for the financial integration of users. These strategies mitigate the intervening effects of government interventions and lead to improvements to the justification process, utilisation, and the viability of attracting partners.

## 6.4 Framework for PPP in RR project

According to the research framework for achieving the aim of this study, which is to develop a framework for establishing a research reactor project in the UAE through the utilisation of public private partnerships, CSFs of PPPs and RRs must be added to the generic PPP framework developed earlier. Therefore, the findings from objectives 2 & 3 will be merged with the first objective. The findings of the second objective, establish the favourable outcomes factors, the value for money factors, and the critical success factors of PPPs for the UAE, can be introduced as follows:

The favourable factors sought after the implementation of PPP projects total thirteen factors as discussed previously in this study. Participants from the UAE and the UK associated significance to each factor, and the mean score for the four highest favourable factors for PPP implementation in the UAE ranged from 4.07 to 4.57 and the same for the UK, from 4.18 to 4.40, making them very significant factors. Both countries ranked highest the same four factors, which are private sector's skills and experience, private sector's funds, value for money, and risk transfer to private party.

Sixteen main factors influence the achievement of value for money in PPP projects. The respondents in both countries selected the same four factors as the most important ones in shaping the value for money outcomes. These factors were optimised risk allocation, competitive bid process, improved services to the community, and clear output specification.

Regarding the critical success factors for implementing PPPs, respondents from the UAE and the UK associated almost identical significance to the factors. Both groups ranked highest the same nine factors. The mean scores for the nine highest critical success factors for PPP implementation in the UAE and the UK were all above 4.00, making them very significant. These factors are commitment of public and private parties, appropriate risk allocation, committed and competent public agency, transparent procurement process, strong private consortium, competitive procurement process, political support, detailed cost/ benefits assessment, and good governance.

The reliability of all scales in both the UAE's and UK's samples were analysed to ensure the internal consistency of all factors. Alpha results for the three scales of each sample were above the threshold of 0.70. There was no need to delete any items, and the three scales for both samples were reliable without any modifications.

Factor analysis was utilized to determine whether the factors are multidimensional and to check for the interrelationship of all factors. Factor analysis is a data reduction tool used to identify a smaller set of factors to represent the correlated sets of variables. The values for the Kaiser-Meyer-Olkin measure of sampling adequacy were above 0.5, which suggested that the samples were factorable. The values for Bartlett's Test of Spherisity were large; therefore it was unlikely that the correlations were identity matrixes. The Anti-image correlation of all factors was also satisfactory since MSA values were greater than 0.5 for all items. Therefore, there was no need to eliminate any factors. The correlation matrix of the thirteen items of the favourable factors for PPP adoption in the UAE and the UK showed that all factors had correlations with other factors since they all had partial correlations above the required 0.3.

The thirteen factors for the favourable factors could be regrouped into four groups for the UAE (cost savings, benefits to the public sector, benefits to the end users, and economic and technical benefits), and three groups for the UK (cost savings, benefits to private party, and benefits to the end users).

The sixteen items of the value for money factors scale could be regrouped into four groups for the UAE (financial efficiency, project sustainability, optimization of private party's contribution, and benefits to the end users), and four groups as well for the UK (optimization of private party's contribution, project sustainability, competitive procurement, and benefits to the public).

The eighteen items for the critical success factors scale could be regrouped into seven groups for the UAE (project feasibility, effective bid management, favourable local conditions, commitment of public and private parties, government involvement, project delivery, and effective leadership), whereas, for the UK, they could be grouped into six groups (project delivery, commitment of public and private parties, project feasibility, favourable local conditions, effective procurement, and multi-benefit objectives of all stakeholders).

The grouping of the factors should be considered by the public party when considering the adoption of PPP models to ensure that all conditions, causal, contextual, and intervening conditions are accounted for. The favourable factors represent the foundation that must be secured before engaging in this mechanism. The value for money factor represents the strategic objectives for considering the PPP model as the procurement method over the conventional ones. Lastly, the critical success factors group represents the most important area that must be considered by the public party to achieve the objectives of the PPP project and how those objectives will be achieved.

Figure 18 represents the framework for developing a PPP project in the UAE. it consists of the generic PPP framework, added to it the favourable factors, value for money factors, and the critical success factors for UAE PPP implementation, which concludes the work for the second objective; establish the favourable outcomes factors, the value for money factors, and the critical success factors of PPPs for the UAE.

The findings of the third objective, identify the success factors and commercial viability of a research reactor, with particular focus on the UAE, can be presented as follows:

The criteria for grounded theory was presented, open coding, axial coding, selective coding, and the substantive theory that emerged based on these coding processes. Using the grounded theory mechanism, the ten interviews were analysed until the data reached the saturation point. The semi-structured interviews were transcribed and imported into NVIVO software. In the open coding process, sentence by sentence comparison was conducted for theoretical coding. The concepts that emerged from the constant comparison were presented, where categories could be named and the properties of these categories were highlighted as well to enable the axial coding process. The open coding process of the interviews produced seven open categories: future demand, justification process effectiveness, government and political interventions, ineffective project initiation work, underutilisation, local context, and regional collaborations.

In the axial coding process, the coding paradigm model was used, making it possible to connect the categories identified in the open coding process and to establish their relationships. The seven open categories formed five main categories to guide the interpretation of the conditions influencing the phenomenon.

The selective coding process refined the main categories and their subcategories, which it possible to introduce propositions that are needed for the creation of the storyline. The storyline described the phenomenon, what influenced that phenomenon, what strategies were required, and the improvements expected, which led to the development of the substantive theory.

Based on the established conditions - causal, intervening, and contextual - strategies for improvements were discussed and the consequences of these strategies were offered. Based on the interpretation of the relationships in the paradigm model guided by the established propositions, a storyline was generated to develop the theoretical framework. The influence of underutilisation was identified as the core category, ineffective project initiation work as causal conditions, governmental and political interventions as intervening conditions, local/regional justification and viability as contextual conditions, and improved justification process as strategies required to remedy the situation.

Figure 18 represents the final framework for developing a research reactor project through utilising the PPP mechanism, which completes the aim of this research. It is consisting of the three objectives identified to deliver this aim. The framework consists of the generic PPP framework, plus the favourable factors, value for money factors, and the critical success factors for UAE PPP implementation, plus the critical success factors for a research reactor project in the UAE.

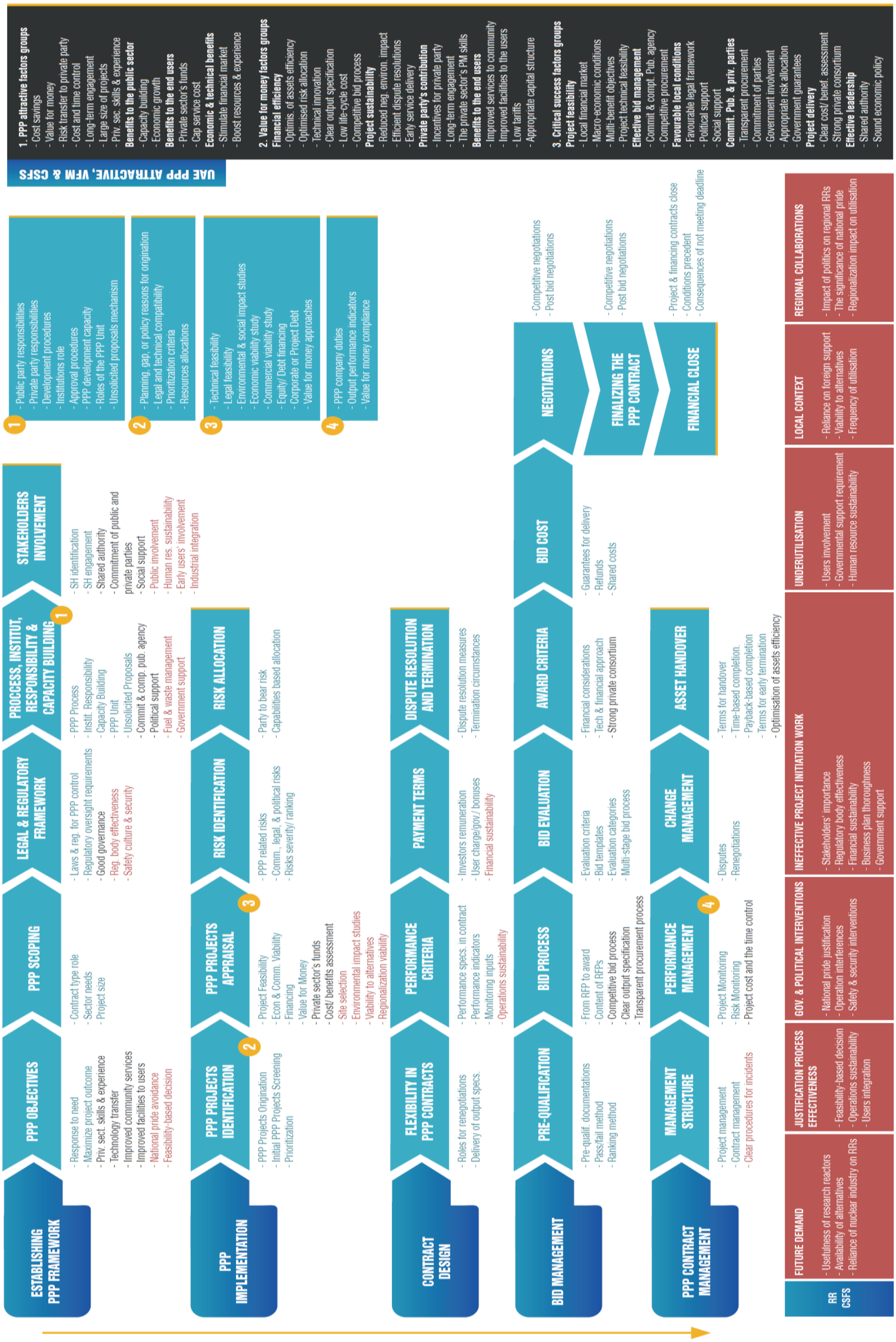



Figure 18: PPP framework for RR in the UAE

### The quantitative validation process

The last step of this research is the quantitative validation process of the PPP framework for RR in the UAE. The most significant benefit of conducting this quantitative survey validation process is that it allows a relatively faster way for reaching practitioners and researchers to incorporate their comments in the study. Such validation improves the generalizability and rigour of the findings of this study.

If the validation is successful, then this concludes the research. However, if this quantitative validation process did not confirm the suitability and value of the proposed framework, then the research must endeavour to remedy the gap identified through this validation process. The instrument that was used for the validation process was a questionnaire that was designed based on the outcome of the previous data collection processes.

Cheung (2009) employed the work of Yeung's (2007) research to validate her PPP framework for Hong Kong. Yeung's work was intended to validate the Partnering Performance Index, which is of interest to this research as it covered the same aspects to be checked for the PPP framework in the UAE. Yeung's questionnaire, which guided the design of the validation questionnaire (Appendix E), consisted of six aspects for checking the viability and applicability of the new model, and they are: "appropriateness, objectivity, replicability, practicability, reliability and suitability" (Cheung, 2009, p. 267).

The appropriateness or the comprehensiveness factor of the framework was intended to measure, from the respondents' view, whether the framework is a complete process for implementing PPPs in the UAE. The objectivity factor was intended to indicate whether there was any bias. The reliability factor was intended to measure whether the framework is capable of delivering the requirements of the users. The degree of practicality checked whether the respondents found the framework realistic for implementation. The degree of replicability checked for the potential for repeated uses. Last, the degree of adaptability checked for respondents view on whether the framework could be used for other types of PPPs.

The final framework was thoroughly explained to the representative sample and respondents were asked to rank their overall satisfaction with the framework by marking their level of satisfaction on each of the above six items on a 5-point Likert scale (1= least satisfied and 5= most satisfied). The outcome of the questionnaire established the level of satisfaction on the framework and therefore its validation. The validation process enabled the finalization of the framework, where all actions and step sequences of the framework for consistency with local development and financial practices was established.

The sample size was relatively small for various reasons. First, the initial framework at this stage reached a level of saturation, therefore it was well developed and lacked significant flaws. Second, the number of subjects surveyed who were representatives of the industry is relatively small in the UAE. Last, this validation instrument was intended to be confirmatory of the previous findings and not exploratory, thus a smaller sample was justified.

**Table 30: Validation survey respondents' details**

| No | Position | Years of Experience | Organization | Sector |
|---|---|---|---|---|
| 1 | Vice President | 16 years- PPP management | Project management/ engineering | Private |
| 2 | Senior Lecturer | 25 years- PPP projects | Education | Public/ private |
| 3 | Commercial Director | 35 years- PPP constructions | Contractor | Private |
| 4 | Partner | 18 years- PPP contracts | Legal firm | Private |
| 5 | CEO | 20 years- PPP designs | Architecture/ engineering | Private |

Invitation for participation in the validation process was sent to the same sample who participated in the quantitative survey for the UAE that established the local success factors for PPPs; therefore, the sampling criteria was already satisfied then, and no new sampling measures were required. Seven participants confirmed their acceptance, however, due to travel and engagement of a couple of the respondents, five validation sessions were held. Depending on time restrictions and the level of detail required by the validators, the sessions lasted from one hour to three hours. This researcher presented all segments of the study, the objectives, the methodology, the theoretical background for the study, the process used for developing the generic PPP frame work for the UAE, and the selection process of the best practices and their benchmarking, the comparative study based on the two samples in the UAE and the UK, the findings, etc. Although there were no members with previous experience in research reactors, the respondents were satisfied with the holistic approach used in general. The details of the participants in the validation survey are presented in Table 30**.**

**Table 31: Results of the validation process**

| No. | Validation Criteria | Respondents | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | Mean |
| 1 | Degree of comprehensiveness | 5 | 5 | 5 | 4 | 5 | 4.8 |
| 2 | Degree of objectivity | 5 | 4 | 5 | 5 | 5 | 4.8 |
| 3 | Degree of reliability | 4 | 5 | 4 | 4 | 4 | 4.2 |
| 4 | Degree of practicality | 4 | 5 | 5 | 5 | 5 | 4.8 |
| 5 | Degree of replicability | 5 | 3 | 4 | 5 | 5 | 4.4 |
| 6 | Degree of adaptability | 5 | 4 | 5 | 5 | 5 | 4.8 |

Table 31 shows the details of the validation process conducted with the participants. Based on the replies of the respondents, the six aspects of the validation template were evaluated as follows: For the degree of comprehensiveness, the mean score was 4.8. For the degree of objectivity, the mean score was 4.8. For the degree of reliability, the mean score was 4.2. For the degree of practicality, the mean score was 4.8. For the degree of replicability, the mean score was 4.4. Lastly, the degree of adaptability received a mean score of 4.8.

All of the validation aspects were ranked above 4, which indicates a very satisfactory performance of the framework as indicated by the responses. Therefore, the PPP framework for a research reactor development in the UAE was validated to be comprehensive, objective, reliable, practical, replicable, and adaptable.

## 6.5 Conclusions

This chapter restated the three methodology section's findings and analysis, and merged them together to achieve the aim of this study. First, the generic PPP framework was presented, then the rankings of the favourable, value for money, and critical success factors for the UAE were discussed detailing the significance of such ranking, and last was the discussion on the CSFs for research reactors.

Factor grouping of the PPP factors was identified to enable the decision makers to study any critical success factor among its associated set of factors that have a direct relationship among them. The thirteen pertinent factors could be regrouped into four groups (cost savings, benefits to the public sector, benefits to the end users, and economic and technical benefits), The sixteen value for money factors could be regrouped into four groups for the UAE (financial efficiency, project sustainability, optimization of private party's contribution, and benefits to the end users). The eighteen critical success factors could be regrouped into seven groups for the UAE (project feasibility, effective bid management, favourable local conditions, commitment of public and private parties, government involvement, project delivery, and effective leadership).

Core category for research reactor underutilization was presented, a storyline describing the phenomenon along with the intervening and contextual conditions, strategies, and consequences were presented to enable the emergence of the substantive theory. The storyline emphasised the factors that led to the underutilisation of research reactors, which were ineffective project initiation work related to stakeholders, life cycle financing and funding, nuclear safety and security, site selection, fuel and waste management, environmental and radiation protection, human resources development, and the regulatory body. The justification process that focuses on feasibility findings, the sustainability of operations, and the integration of users mitigates the negative influence on the utilisation and sustainability of research reactors. Government and political interventions were the intervening conditions that alter the feasibility-based decisions, sustainability of operations, and industrial integration of the research reactors. In addition, the contextual conditions were the context of local and regional considerations and its properties: reliance on foreign support, viability of alternatives, and frequency of utilisation. The storyline enabled the introduction of the substantive theory. This concluded the study, as the objectives were achieved and development of a framework for establishing a research reactor project in the UAE through the utilisation of public private partnerships is fulfilled. This chapter ended with a quantitative validation work confirming the findings of this study.

# 7. CONCLUSIONS

This chapter concludes the work of this research. In this chapter, the objectives of the study, methodology, and the findings are summarised.

This research aimed to develop a framework for establishing a research reactor (RR) project in the UAE through the utilisation of public private partnerships (PPP). This mission necessitated the development of three phases. These phases are the development of a generic PPP framework from best practices, the identification of the success factors and local context for local adaptation, and the identification of the unique success factors for research reactors to complete the proposed framework.

PPP definition and concepts were investigated through a detailed literature review to highlight the most critical factors that determine the success of this mechanism as compared to conventional procurements. This study endeavoured to highlight the favourable outcomes that could make PPPs superior to their conventional rivals and therefore make the decision-makers prefer them to the other procurement methods. The literature review also highlighted that the main theoretical construct for the process of PPP procurement is value for money. To study this construct and all factors that influenced its behaviour, the success factors, being the conditions influencing the value for money criteria, were established for detailed analysis in the quantitative segment of this research. Regarding the last segment of this study, which was the identification of the success factors for research reactors, these factors were identified in the literature review section and were analysed in the qualitative interviews section of this study.

The following will be a presentation of the findings according to the objectives outlined in this study.

## 7.1 Findings

1. Study the best practices of PPPs to develop the UAE's generic framework.

The methodology used for the identification and analysis of the best practices followed the approach provided by Zhang and Wildemuth (2009) for the qualitative content analysis between the best practices. The criteria for the identification of the best practices focused on different criteria, such as conditions governing the success of PPPs between developed and developing countries, between comparators and a certain region, and between governments within similar political systems. These criteria facilitated the selection of the best practices, which were leading banks, institutions, and governments in the practice of PPPs. The NVIVO software was utilised for the comparative analysis of the best practices, where functions such as word queries and word trees enabled the identification of the underlying concepts and their associations with other functions in the PPP process. The outcome was a generic best practice framework for PPP implementation in the UAE that consisted of five phases which further consisted of groups of functions and sub-groups of functions. These phases are establish the PPP framework, PPP implementation, contract design, bid management, and PPP contract management phases.

2. Establish the favourable outcomes factors, the value for money factors, and the critical success factors of PPPs for the UAE.

Through the literature review of peer-reviewed papers, the attractive factors for adopting PPP models, the value for money objective, and the critical success factors that influence the achievement of the value for money criteria were identified. It was vital to establish the local context of these factors so that the generic PPP framework will be adapted to the local practice. Therefore, it was warranted to study these factors from a local perspective and compare them to the UK practice, which was established as one of the best globally. The template developed by Li et al. (2005) was used to design a questionnaire. Two representative samples, from the UAE and the UK populations, were used for analysis.

Kendall's coefficient of concordance was utilised to measure the agreement of the two groups on the assignment of significance to the factors of PPPs in their respective territories. The mean score technique was used to measure the mean score of each factor for PPP implementation. This method established ranking of importance for each factor, which helped to triangulate the rankings from samples of respondents from the UAE and the UK. Kendall's coefficient of concordance was utilised to measure the agreement of the two groups on the ranking of the factors.

The favourable factors sought after in the implementation of PPP projects are thirteen factors as discussed previously in this study. Participants from the UAE and the UK associated significance to each factor.

Both countries ranked highest the same four factors, and they are private sector's skills and experience, private sector's funds, value for money, and risk transfer to the private party. The mean scores for the four highest favourable factors for both countries were very significant and ranged from 4.07 to 4.57 for the UAE, and 4.18 to 4.40 for the UK.

The private sector's skills and experience ranked as the most important factor for preferring PPPs to conventional procurements, which indicates that the private party has the capability to deliver the project in the most effective and efficient way.

The second significant factor for adopting PPPs in the UAE was private sector's funds. The reason is that most governmental entities are restricted to predefined budgets which hinders their capacity to respond to public demand for additional facilities and services, in addition to the high risk of certain projects where governments prefer not to gamble with their own funds.

Value for money ranked third in the significance level of the factors leading the public sector to adopt PPP models. PPPs offer value for money when they offer efficiency in the value of the project when compared to conventional methods. Such efficiency comes from the capability of the private party in managing the full life cycle of the project under one integrated development system coupled by its technical and financial facilities available for the project.

The same four factors were chosen as the most important ones by both samples out of the sixteen factors for delivering value for money outcomes. These factors were optimised risk allocation, competitive bid process, improved services to the community, and clear output specification. The mean scores for both countries were very significant and ranged from 3.94 to 4.20.

Optimised risk allocation ranked first as the most significant factor for the achievement of value for money criteria by adopting the PPP mechanism. Risk allocation to the party that is more capable of managing its consequences maximises the success of PPP projects. When there is proper risk allocation, fewer eventualities are expected, and the timely remediation of their consequences is improved, leading to optimised performance and more value from the project.

A competitive bid process ranked second in the UAE in its significance to the achievement of value for money in the adoption of PPP mechanisms. The process of bringing the most suitable bidder for delivering the value expected from the project is very critical to the success of the PPP project. The steps of the bidding process are the prequalification of bidders, evaluation of bids, negotiations with qualified bidders, award to the right bidder, and financial close.

Improved services to the community ranked third in the UAE of the most important factors of PPPs for achieving value for money. This is achieved from the allocation of skills of the private party and the utilisation of its innovative ideas for reducing the cost while providing improved services and facilities for the public.

Both countries ranked the same nine factors as the most significant ones out of the eighteen critical success factors for implementing PPPs. The mean scores for the nine highest critical success factors for PPP implementation in the UAE and the UK were very significant, as all of the nine factors were above 4.00. These factors are commitment of public and private parties, appropriate risk allocation, committed and competent public agency, transparent procurement process, strong private consortium, competitive procurement process, political support, detailed cost/ benefits assessment, and good governance.

The commitment of the public and private parties for achieving the benefits sought after the development of PPP models ranked first as the most critical success factor as indicated by the respondents from the UAE and the UK. The public party's commitment is through providing the ideal contexts for the private party to maximise the outcomes of the PPP project. Such commitment comes in the form establishing departments and processes for handling the government's scope related to the PPP project and in the handling of change management of variations to the contract. The private sector's commitment is through committing sufficient resources, work force, funds, technologies, and other resources. that are deemed sufficient for delivering the outcomes of the project.

Appropriate risk allocation tied as the first most significant success factor for the development of PPPs in the UAE. The private party should handle the risks that are within its capability to control, as the more risk transferred to the private party, the higher the cost to handle them from the project expenses, which means less financial efficiency is expected to be received.

Committed and competent public agency ranked third as the most significant critical success factor in the UAE and the UK. The public agency acts a "one stop shop" for liaising all project issues with government departments, and therefore its efficiency in handling this role is very critical for the timely completion of the project.

The reliability of all scales in both the UAE's and UK's samples were analysed to ensure the internal consistency of all factors. Alpha results for the reliability of the three scales of both samples were above 0.70. There was no need to delete any items, and the three scales for both samples were reliable without any modifications.

Factor analysis was utilized to determine whether the factors are multidimensional and to check for the interrelationship of all factors. Factor analysis identified smaller sets of factors to represent the correlated sets of factors. The samples were factorable since the values for the Kaiser-Meyer-Olkin measure of sampling adequacy were above 0.5. It was established that it was unlikely that the correlations were identity matrixes since values for Bartlett's Test of Spherisity were large. The Anti-image correlation of all factors also was satisfactory since MSA values were greater than 0.5 for all items. Therefore, there was no need to eliminate any factors. The correlation matrix of the thirteen items of the favourable factors for PPP adoption in the UAE and the UK showed that all factors had correlations with other factors since they all had partial correlations above the required 0.3.

The thirteen factors for the favourable factors could be regrouped into four groups for the UAE (cost savings, benefits to the public sector, benefits to the end users, and economic and technical benefits), and three groups for the UK (cost savings, benefits to private party, and benefits to the end users). The sixteen items of the value for money factors could be regrouped into four groups for the UAE (financial efficiency, project sustainability, optimization of private party's contribution, and benefits to the end users), and four groups as well for the UK (optimization of private party's contribution, project sustainability, competitive procurement, and benefits to the public). The eighteen items for the critical success factors could be regrouped into seven groups for the UAE (value for money, effective bid management, favourable local conditions, commitment of public and private parties, government involvement, project delivery, and effective leadership), whereas, for the UK, they could be grouped into six groups (project delivery, commitment of public and private parties, value for money, favourable local conditions, effective procurement, and multi-benefit objectives of all stakeholders).

The grouping of the factors is important for public entities when they decide to adopt the PPP mechanism. This grouping ensured that all conditions that influence the PPP practice are taken under consideration. Such conditions include the causal, contextual, and intervening conditions. The favourable factors represent the criteria that must be achieved before adopting PPP models; the value for money factors represent the strategic objectives for considering the PPPs, and the critical success factors groups represent conditions that influence the achievement of the PPP objectives. The factor analysis for the UK's sample was intended to draw comparison and show similarities of the grouping of the factors which were significant.

3. Identify the success factors and commercial viability of a research reactor, with particular focus on the UAE.

The last segment of this study was the identification process of the success factors for research reactors. The methodology used for this objective was qualitative grounded theory analysis of ten interviews conducted with experts in the field of research reactors. The semi-structured interviews were transcribed and were subjected to the coding process of the grounded theory: open coding, axial coding, selective coding, and the substantive theory. In open coding process, sentence-by-sentence comparison was conducted for theoretical coding where categories could be named and the properties of these categories were identified to move the analysis to the next step of coding, which is axial coding process. NVIVO software was used for data management and provided visual diagrams that enabled the initial establishment of the relationships between the concepts of the open coding process. The open coding process produced seven open categories: future demand, justification process effectiveness, government and political interventions, ineffective project initiation work, underutilisation, local context, and regional collaborations. In the axial coding process, the coding paradigm model was used to connect the categories identified in the open coding process and their relationships. The seven open categories were merged into five main categories to guide the interpretation of the conditions influencing the phenomenon. Using the coding paradigm model, the establishment of the phenomenon, causal conditions, contextual conditions, intervening conditions, strategies, and consequences was possible. The next coding process was the selective coding process, which refined the main categories and their subcategories and made it possible to introduce propositions needed for the creation of the storyline. The storyline described the phenomenon, what influenced that phenomenon, what strategies were required to improve it, and the improvements expected.

Based on the interpretation of the relationships in the paradigm model guided by the established propositions, a storyline was generated to develop the theoretical framework. The influence of underutilisation was identified as the core category, ineffective project initiation work was identified as the main causal conditions influencing the utilisation of research reactors, governmental and political interventions were identified the intervening conditions, the local/regional justification and viability were identified as the contextual conditions, and improved justification process were identified as the strategies required to improve the utilisation of research reactors.

The findings of the qualitative process for establishing the success factors and commercial viability for research reactors can be summarised and interpreted as follows:

Project initiation work is the most important success factor for the implementation of research reactor projects. Careful attention by the government to satisfy the various elements of the project initiation work is necessary for the success of research reactors. Such elements include the objectives for developing a nuclear research reactor project, stakeholders identification, facility specifications, financing strategy, management system, … etc. And then the integration of these elements within a higher nuclear program, which will influence positively the justification of the project, and minimize the chances for the intervening conditions of government interferences. Such project initiation work will ensure the proper utilisation and integration with users and industries requiring the services of the research reactor. Therefore, the commercial viability of the research reactor for potential partnerships will be established. Ineffective project initiation work has a direct negative influence on the utilisation of research reactors. Project initiation work that does not include a financial strategic plan, for instance, where funding mechanisms, estimated project and contingency costs, and fuel cycle and back end procedures are not properly considered, will expose the project to critical financial risks during its life cycle. Such risks will lead to significant underutilisation of research reactors prompting the probability of early shutdowns and their long-term expensive liabilities.

The regionalization of research reactors is a viable option for the UAE. One of the criteria for the success of research reactors is to establish a local demand from users and industries and to establish the viability of the services compared to the available alternatives. The main obstacle for developing regional research reactors, as was found from the analysis of the interviews, is the political situation in the region. However, this obstacle does not have solid ground in the UAE, as the country has enjoyed centuries of good relationships with its neighbours and shares, for example, strategic oil and gas projects with them, where no disputes have been recorded. A viable option would be to establish a few research reactor projects in regional countries where each country will host specific uses; an integration of such uses will benefit the participating countries and any other country that is interested in using their services. This will establish a sustainable utilisation of these regional reactors and will build a strong foundation for future nuclear programs, especially for those countries considering the development of a nuclear power generation program.

Nuclear power generation programs will always require some sort of support of research reactors, which are considered as the stepping-stone for embarking on a nuclear power program. However, this was not the approach in the UAE, where NPPs are currently under construction without having a research reactor in the country. The operations of these NPPs will have to start before a holistic evaluation of this brave move can be established. However, there are invaluable uses that research reactors can provide for NPPs that cannot be replicated by any other options. Training of staff required for NPPs, continuous programs improvement, safety assurance, testing of materials and maintenance requirements for NPPs, are some of the scopes that NPPs cannot accommodate within their structures without operations disruption. Therefore, there must be a local research reactor to cater for these scopes, as it is obvious that there is full reliance on other countries for the requirements of human resources development for the nuclear industry. This is probably because local authorities did not fully recognise the importance of research reactors for the sustainability of NPPs and did not appreciate the strategic dimension of having a sustainable human resources development plan locally. Consequently, the justification for a local research reactor is undermined by this local context condition.

Embarking on research reactor projects for national pride or political motives will undermine the issues highlighted and mitigated by the project initiation work of research reactors. Decisions for developing a research reactor project that do not consider the feasibility work required to establish the viabilities of these projects and their potential users,  lack the integration within a strategic nuclear development plan, and will fail to match users requirements as they were not engaged from the beginning. Such intervening conditions will lead to operational complications and underutilisation of the reactors as this study established that there is a direct relationship between the non-feasibility based decisions and the underutilisation of research reactors. Ignoring feasibility work will also lead to overestimation of local demand and ignoring how these demands are currently met for newcomers. This contextual condition will influence the justification of the value for money and the level of risk involved in the research reactor project, which will undermine the commercial viability and the potential for partnerships.

There must be a balance between the safety and security measures to safeguard the public and maintain the efficient operation of the research reactor or the nuclear facilities in general. Exaggerated safety and security measures in response to public concerns or nuclear accidents related to NPPs have an adverse impact on the utilisation of research reactors, which are more controllable and have a relatively clean accident record with an almost negligible scale of nuclear radiation risk. Such exaggerated measures lead to accessibility restrictions and operation interruptions that industrial users cannot tolerate, making them less viable for investors integration. Therefore, a clear process, where there are emergency plans and written procedures must be in place to govern the actions of the operators, regulators, and any other authority involved in the response to any incidents. This is to minimize the unnecessary interference of governments, as they are deterrents to potential partners, and they ensure the interfacing of safety and security with users.

Research reactors will always require some sort of government support for their sustainability. The long duration of the research reactor project will require sustainability of the ideal contexts for operations throughout the lifecycle of the project, which will witness many government terms, and the support of these governments is essential for the maintenance of these conditions. There are various types of government support for research reactor projects, such as the maintenance of favourable legislation, the appointment of a competent regulatory body, and the facilitation of clear and well-defined procedures for licensing, certifications, and inspections.

Another form of government support is the financial support that should be available should the circumstances call for such intervention. However, a research reactor project must be financially sustainable throughout the lifecycle of the project, which influences positively the utilisation and improves the attractiveness of the research reactor project to the private sector. This causal condition mitigates the risks associated with funding of the project through the identification of means of funding for the design, construction, operation, and support services from the government. This financial sustainability plan makes the research reactor project more financially viable to the users who might see more value in becoming involved financially in the project.

Satisfying the project initiation work issues related to the systematic identification and continual involvement of stakeholders are fundamental for the proper utilisation of research reactors. Such stakeholders include the government, regulatory body, upper management, personnel, academics, commercial users, the public and international atomic agencies. The early involvement and the satisfaction of stakeholders' requirements improve the justification process of the research reactor by allowing for the integration of the industries, the satisfaction of the requirements of the agencies, the required staff for operations, etc. This will ensure the sustainability of proper utilisation of the research reactor project, as such satisfaction of the requirements will ensure compliance with the regulations, facilitate the generation of more accurate business plans, and will ensure that the uses will be according to the requirements and specifications of the users. The integration of the public from the early stages of the project, satisfying their needs, and having public relations and outreach programs will always prove to be necessary for the sustainability of the project. Ensuring measures to minimize the publics and the workers exposure to radiation during operations will mitigate the risk of their intervening influence on the utilisation of the research reactor. It will also maximise the chances for public support for the full duration of the project and will minimise the chances for imposing stringent measures in response to global nuclear incidents.

The particular mitigation of the conditions related to fuel and waste management risks for newcomers is very essential for the utilisation of the research reactor project. Such mitigation will require the establishment of regulations for waste management and planning for the processing and disposal of low and intermediate level waste, the outcome of which will improve the success rate, utilisation, and viability of the research reactor. For countries with an NPP program, the amount of radioactive waste generated from the research reactor's operation, including spent fuel, is negligible when compared with the waste generated by the NPP; therefore, the management of such waste could be merged within the waste management of the NPP.

The high demand for medical radioisotopes, especially Molybdenum-99, makes the commercialisation of research reactors viable. Although recent technologies allow for the commercial production of medical radioisotopes in accelerators, such production is more viable when coupled with other products and uses of research reactors. Depending on the mitigating influence of viability and the availability of local alternatives, a consortium of investors from the users or from the public may develop a research reactor project through the public private partnership mechanism for the production of these commodities and the other industrial applications, among other uses. The government may expand its line of benefits from such partnerships by utilizing the facility for its training and experimenting needs whenever the need calls for it, as the cost will be borne by the private party, who will also mitigate the utilisations risks by the proper involvement of the users, marketing, and the deployment of state of the art operations technologies. Alternatively, the government may opt for a miniature reactor at a university campus to satisfy the education and training needs, and expand in the future once there is a need for other scopes, and a local capacity for undertaking more complex applications is satisfied. However, this option is not the focus of this study as it is not commercially viable for attracting investors nor is it large enough to benefit from the characteristics of PPP method. This study is focusing on research reactors with commercial applications. The government will not enjoy much benefits from partnering to develop a miniature research reactor.

4. Establish a framework for implementing PPPs for RR in the UAE.

Based on the model provided by Cheung (2009) for developing a PPP framework for Hong Kong, this research followed the same approach. Cheung added the CSFs to the existing process, this research established a local practice by first developing a generic framework, and then adapting it to the local context through a quantitative process, and for project context through a qualitative process.

As indicated by the findings of this research, the UAE government can use the framework proposed when it considers the development of a research reactor project to compliment the nuclear power generation program that is currently under construction. This study provided a unique PPP framework to be used in the UAE for developing general projects in the UAE, as the generic framework generated from best practices was adapted to the local practice through engaging local and British practitioners in a survey. Furthermore, the benefits, uses, success factors, and other relevant factors were identified for consideration when using PPPs in developing a research reactor project, as these projects are unique in their considerations, as detailed in chapter six.

5. Validate the framework for implementing PPPs for RR in the UAE.

The framework was validated on two different levels, first one for the quantitative approach, and the second for the qualitative one. Yeung's (2007) Partnering Performance Index was used for the validation process of the PPP framework for the UAE. based on five validation interviews conducted, the PPP framework for a research reactor development in the UAE was validated to be comprehensive, objective, reliable, practical, replicable, and adaptable.

Although the findings of the grounded theory work are considered validated by reaching the theoretical saturation point, two interviewees were engaged to assess the overall findings, which in their view were "adequate".

## 7.2 Implications

The findings of this research produced a best practice framework for developing research reactor projects in the UAE. This framework is the first to lay the foundations for a standardised PPP practice in the UAE for practitioners. Investigations into the local practice and interviews with PPP practitioners indicated that there are no frameworks for developing PPPs in the UAE. There is limited and isolated PPPs practice in the UAE as each department within the different Emirates has its own interpretation of what PPPs are and how to approach them. Such approaches are based on imported practices that do not take into consideration the local context. This has inhibited the success of the very few PPP tenders and will always deter any potential for successful and sizable implementations of public private partnerships. The proposed framework is not a full process for developing PPP projects. However, it lays the foundations for such a practice. The framework draws from best practices the approaches to be followed from the inception to the handover of projects. It highlights the most important factors for the success of PPP projects, such as risk sharing and allocation, renegotiations, and the roles of the public and private parties. Through the empirical work conducted locally and in the UK, the framework highlights the most important factors to look for when deciding to develop projects through the PPP mechanism, as conventional procurements are more suitable for certain projects. The findings of the local surveys, when compared to the UK sample, highlighted that the local PPP practice and its surrounding conditions are almost similar to the ones in the UK, and therefore it could be inferred that any processes and measures that prove their success within the UK could have similar results in the UAE.. Furthermore, the value for money criterion, as the main objective of PPPs, and the critical success factors, being the conditions that influence the achievement of this criterion, were identified locally and were contrasted with ones in the UK to establish the local context and adapt the best practices model to the local practice. There was no such detailed and empirical work for PPP practice, and comparing it to a sample conducted in the best practice country, the UK, has not been done before in the UAE. Therefore, this framework is expected to benefit the upper management of local government departments and the federal ministries to understand the full process for local PPPs and to help them make informed decision for what to develop as PPPs and how to develop them.

This systematic approach to the development of PPPs in the UAE is expected to increase the number of PPP tenders, as there will be more awareness on what PPPs stand for, how they balance risks, improve efficiency and effectiveness of projects, improve facilities and services, etc. This awareness will undoubtedly attract the private party to PPP tenders or will open the door for unsolicited tenders, where ideas to improve the welfare of the community can be developed without strains on government budgets.

As a framework will not be complete without a specific application on a sector or a project, the nuclear industry sector and, specifically, research reactor projects, were selected for this study. The selection was based on various reasons. First of all, in order for this framework to be applicable to most development projects, a complex project was selected so that other, less complex projects will follow the same process. The second reason was that research reactors are not only complex projects to develop, but also complex ones to fund, as they do not fully satisfy the project finance criteria. Lastly, the UAE embarked on its nuclear power generation program, and this research has highlighted for the officials that a research reactor project is a very viable option to complement the NPP sustainability as detailed earlier. Therefore, this framework is suitable for all decision makers and practitioners in the fields of public private partnerships, engineering and development, and nuclear research reactors.

The PPP framework for research reactors is a new area, and there are no empirical studies that this researcher could find in the open domain or as confirmed from the interviews with the nuclear experts, that studied PPP framework for RRs before. Therefore, this study is significant and opens a new area to improve the partnership practice in research reactors.

The contributions of this research to the body of knowledge can be summarised in different areas. First of all, this study contributed to research in the field of PPPs in the UAE and the UK. The comparative analysis between the two countries highlighted the similarities and differences in the practice and opened areas for future consideration. Second, this study reused a survey template conducted in the UK in 2003 and reexamined a large sample. Such results highlighted the progression in the UK PPP practice, which was significant, and opens areas for detailed research on such progression. Last, the study considered the underutilisation phenomenon of research reactors and identified the critical conditions influencing such phenomenon to improve the operations of research reactors. Such conditions could be scrutinised further by considering other factors and local contexts for new comers to the RR industry.

## 7.3 Limitations

This research intended to look at specific areas in both PPPs and RRs. These areas are only related to the finance and management of a research reactor project. It focused on utilising PPP characteristics for developing research reactor projects, which are known for their high risk and cost. Therefore, this research did not include any technical aspects of RRs or any other types of nuclear projects that are not part of research reactors. The research did not consider any subject groups outside the PPP and research reactor scopes. This study only focused on the UAE, and no other sites or locations were considered in this study.

Regarding the PPP questionnaire conducted in the UAE, the final accepted sample was thirty questionnaires. The pool of PPP practitioners and researchers was small and did not allow for improving this figure. Another limitation was the lack of public sector participation. Although this researcher contacted decision makers and practitioners in charge of PPPs within the country, not a single person participated in the survey. Therefore, this framework did not obtain the opportunity to be validated by public stakeholders.

Regarding the research reactor experts, although the minimum number of interviews was achieved, a larger sample could have highlighted more areas for consideration, especially in the areas of partnerships with the private sector, as most experts interviewed come from a solid technical background.

## 7.4 Recommendations

The PPP framework developed in this research should be validated among a wider audience to establish the value of its findings and to highlight any areas for improvement. This could also be done to general PPP projects and for research reactors separately, as the framework can be used for any type of PPPs.

The survey used in the UAE could be repeated with a larger sample to ensure that the findings of the small representative sample who participated in the survey are valid. Emphasis on the participation of the public sector must be considered, as their input is very valuable since they will be the ones deciding which projects to be tendered under the PPP mechanism and which methods will be used for implementing them.

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# APPENDIX A THE QUESTIONNAIRE

# Public-Private Partnerships (PPP) Framework for the UAE Questionnaire (P)

## Part one: General information

Please tick one answer

**1) You are a: ***

- ☐ Public sector practitioner
- ☐ Researcher
- ☐ Private sector practitioner
- ☐ Other (please specify):

**2) Organizational level ***

- ☐ Top management
- ☐ Middle management
- ☐ General staff
- ☐ Other (please specify):

**3) Years of experience ***

- ☐ Less than 5 years
- ☐ 6-10 years
- ☐ 11-20 years
- ☐ Above 21 years

**4) Have you been involved in UAE's PPP Projects? ***

- ☐ Yes
- ☐ No

Comments:

**5) Have you been involved in UK's PFI projects as well? ***

- ☐ Yes
- ☐ No

**A.1: Questionnaire sample**

Comments:

## Part two: Research questions

Please rate the following statements based on a 5-point Likert scale (Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree)

### 6) The main reasons for adopting PPP models are: *

| | Not significant | Fairly significant | significant | Very significant | Most significant |
|---|---|---|---|---|---|
| Capacity building | ☐ | ☐ | ☐ | ☐ | ☐ |
| Cap service cost | ☐ | ☐ | ☐ | ☐ | ☐ |
| Project cost and time control | ☐ | ☐ | ☐ | ☐ | ☐ |
| Economic growth | ☐ | ☐ | ☐ | ☐ | ☐ |
| Lack of government resources & experience | ☐ | ☐ | ☐ | ☐ | ☐ |
| Large size of projects | ☐ | ☐ | ☐ | ☐ | ☐ |
| Long term engagement | ☐ | ☐ | ☐ | ☐ | ☐ |
| Private sector's funds | ☐ | ☐ | ☐ | ☐ | ☐ |
| Private sector's skills and experience | ☐ | ☐ | ☐ | ☐ | ☐ |
| Risk transfer to private party | ☐ | ☐ | ☐ | ☐ | ☐ |
| Stimulate financial market | ☐ | ☐ | ☐ | ☐ | ☐ |
| Technology transfer | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | | | | |
|---|---|---|---|---|---|
| Value for money | | | | | |

Comments:

### 7) Achievement of Value for Money (VFM) objectives is enhanced by: *

| | Not significant | Fairly significant | Significant | Very significant | Most significant |
|---|---|---|---|---|---|
| Clear output specification | | | | | |
| Competitive bid process | | | | | |
| Early service delivery | | | | | |
| Efficient dispute resolutions | | | | | |
| Reduced negative environmental impact | | | | | |
| Appropriate capital structure | | | | | |
| Improved facilities to the users | | | | | |
| Optimised risk allocation | | | | | |
| Improved services to the community | | | | | |
| Incentives for private party | | | | | |
| Long-term engagement | | | | | |
| Low life-cycle cost | | | | | |
| Low tariffs | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Optimisation of assets efficiency | ☐ | ☐ | ☐ | ☐ | ☐ |
| Private sector's project management skills | ☐ | ☐ | ☐ | ☐ | ☐ |
| Technical innovation | ☐ | ☐ | ☐ | ☐ | ☐ |

Comments:

### 8) The critical success factors for PPPs in your opinion are: *

| | Not significant | Fairly significant | Significant | Very significant | Most significant |
|---|---|---|---|---|---|
| Appropriate risk allocation | ☐ | ☐ | ☐ | ☐ | ☐ |
| Commitment of public and private parties | ☐ | ☐ | ☐ | ☐ | ☐ |
| Committed and competent public agency | ☐ | ☐ | ☐ | ☐ | ☐ |
| Competitive procurement process (specs, shortlist, etc.) | ☐ | ☐ | ☐ | ☐ | ☐ |
| Detailed cost/ benefits assessment | ☐ | ☐ | ☐ | ☐ | ☐ |
| Favourable legal framework | ☐ | ☐ | ☐ | ☐ | ☐ |
| Good governance | ☐ | ☐ | ☐ | ☐ | ☐ |
| Government guarantees | ☐ | ☐ | ☐ | ☐ | ☐ |
| Local financial market | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | | | | |
|---|---|---|---|---|---|
| Macro-economic conditions | ☐ | ☐ | ☐ | ☐ | ☐ |
| Multi-benefit objectives of all stakeholders | ☐ | ☐ | ☐ | ☐ | ☐ |
| Political support | ☐ | ☐ | ☐ | ☐ | ☐ |
| Project technical feasibility | ☐ | ☐ | ☐ | ☐ | ☐ |
| Shared authority between the public and private sector | ☐ | ☐ | ☐ | ☐ | ☐ |
| Social support | ☐ | ☐ | ☐ | ☐ | ☐ |
| Sound economic policy | ☐ | ☐ | ☐ | ☐ | ☐ |
| Strong private consortium | ☐ | ☐ | ☐ | ☐ | ☐ |
| Transparent procurement process | ☐ | ☐ | ☐ | ☐ | ☐ |

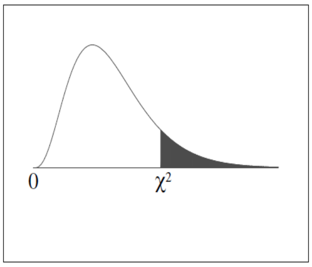
Comments:

## Participation acknowledgement

**If you wish to contribute further and want your participation to be acknowledged in the dissertation, please provide the name, affiliation, and email in the box below.**

**Table A.2: Chi-square distribution table**

# Chi-Square Distribution Table




The shaded area is equal to $\alpha$ for $\chi^2 = \chi^2_\alpha$.

| *df* | $\chi^2_{.995}$ | $\chi^2_{.990}$ | $\chi^2_{.975}$ | $\chi^2_{.950}$ | $\chi^2_{.900}$ | $\chi^2_{.100}$ | $\chi^2_{.050}$ | $\chi^2_{.025}$ | $\chi^2_{.010}$ | $\chi^2_{.005}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.000 | 0.000 | 0.001 | 0.004 | 0.016 | 2.706 | 3.841 | 5.024 | 6.635 | 7.879 |
| 2 | 0.010 | 0.020 | 0.051 | 0.103 | 0.211 | 4.605 | 5.991 | 7.378 | 9.210 | 10.597 |
| 3 | 0.072 | 0.115 | 0.216 | 0.352 | 0.584 | 6.251 | 7.815 | 9.348 | 11.345 | 12.838 |
| 4 | 0.207 | 0.297 | 0.484 | 0.711 | 1.064 | 7.779 | 9.488 | 11.143 | 13.277 | 14.860 |
| 5 | 0.412 | 0.554 | 0.831 | 1.145 | 1.610 | 9.236 | 11.070 | 12.833 | 15.086 | 16.750 |
| 6 | 0.676 | 0.872 | 1.237 | 1.635 | 2.204 | 10.645 | 12.592 | 14.449 | 16.812 | 18.548 |
| 7 | 0.989 | 1.239 | 1.690 | 2.167 | 2.833 | 12.017 | 14.067 | 16.013 | 18.475 | 20.278 |
| 8 | 1.344 | 1.646 | 2.180 | 2.733 | 3.490 | 13.362 | 15.507 | 17.535 | 20.090 | 21.955 |
| 9 | 1.735 | 2.088 | 2.700 | 3.325 | 4.168 | 14.684 | 16.919 | 19.023 | 21.666 | 23.589 |
| 10 | 2.156 | 2.558 | 3.247 | 3.940 | 4.865 | 15.987 | 18.307 | 20.483 | 23.209 | 25.188 |
| 11 | 2.603 | 3.053 | 3.816 | 4.575 | 5.578 | 17.275 | 19.675 | 21.920 | 24.725 | 26.757 |
| 12 | 3.074 | 3.571 | 4.404 | 5.226 | 6.304 | 18.549 | 21.026 | 23.337 | 26.217 | 28.300 |
| 13 | 3.565 | 4.107 | 5.009 | 5.892 | 7.042 | 19.812 | 22.362 | 24.736 | 27.688 | 29.819 |
| 14 | 4.075 | 4.660 | 5.629 | 6.571 | 7.790 | 21.064 | 23.685 | 26.119 | 29.141 | 31.319 |
| 15 | 4.601 | 5.229 | 6.262 | 7.261 | 8.547 | 22.307 | 24.996 | 27.488 | 30.578 | 32.801 |
| 16 | 5.142 | 5.812 | 6.908 | 7.962 | 9.312 | 23.542 | 26.296 | 28.845 | 32.000 | 34.267 |
| 17 | 5.697 | 6.408 | 7.564 | 8.672 | 10.085 | 24.769 | 27.587 | 30.191 | 33.409 | 35.718 |
| 18 | 6.265 | 7.015 | 8.231 | 9.390 | 10.865 | 25.989 | 28.869 | 31.526 | 34.805 | 37.156 |
| 19 | 6.844 | 7.633 | 8.907 | 10.117 | 11.651 | 27.204 | 30.144 | 32.852 | 36.191 | 38.582 |
| 20 | 7.434 | 8.260 | 9.591 | 10.851 | 12.443 | 28.412 | 31.410 | 34.170 | 37.566 | 39.997 |
| 21 | 8.034 | 8.897 | 10.283 | 11.591 | 13.240 | 29.615 | 32.671 | 35.479 | 38.932 | 41.401 |
| 22 | 8.643 | 9.542 | 10.982 | 12.338 | 14.041 | 30.813 | 33.924 | 36.781 | 40.289 | 42.796 |
| 23 | 9.260 | 10.196 | 11.689 | 13.091 | 14.848 | 32.007 | 35.172 | 38.076 | 41.638 | 44.181 |
| 24 | 9.886 | 10.856 | 12.401 | 13.848 | 15.659 | 33.196 | 36.415 | 39.364 | 42.980 | 45.559 |
| 25 | 10.520 | 11.524 | 13.120 | 14.611 | 16.473 | 34.382 | 37.652 | 40.646 | 44.314 | 46.928 |
| 26 | 11.160 | 12.198 | 13.844 | 15.379 | 17.292 | 35.563 | 38.885 | 41.923 | 45.642 | 48.290 |
| 27 | 11.808 | 12.879 | 14.573 | 16.151 | 18.114 | 36.741 | 40.113 | 43.195 | 46.963 | 49.645 |
| 28 | 12.461 | 13.565 | 15.308 | 16.928 | 18.939 | 37.916 | 41.337 | 44.461 | 48.278 | 50.993 |
| 29 | 13.121 | 14.256 | 16.047 | 17.708 | 19.768 | 39.087 | 42.557 | 45.722 | 49.588 | 52.336 |
| 30 | 13.787 | 14.953 | 16.791 | 18.493 | 20.599 | 40.256 | 43.773 | 46.979 | 50.892 | 53.672 |
| 40 | 20.707 | 22.164 | 24.433 | 26.509 | 29.051 | 51.805 | 55.758 | 59.342 | 63.691 | 66.766 |
| 50 | 27.991 | 29.707 | 32.357 | 34.764 | 37.689 | 63.167 | 67.505 | 71.420 | 76.154 | 79.490 |
| 60 | 35.534 | 37.485 | 40.482 | 43.188 | 46.459 | 74.397 | 79.082 | 83.298 | 88.379 | 91.952 |
| 70 | 43.275 | 45.442 | 48.758 | 51.739 | 55.329 | 85.527 | 90.531 | 95.023 | 100.425 | 104.215 |
| 80 | 51.172 | 53.540 | 57.153 | 60.391 | 64.278 | 96.578 | 101.879 | 106.629 | 112.329 | 116.321 |
| 90 | 59.196 | 61.754 | 65.647 | 69.126 | 73.291 | 107.565 | 113.145 | 118.136 | 124.116 | 128.299 |
| 100 | 67.328 | 70.065 | 74.222 | 77.929 | 82.358 | 118.498 | 124.342 | 129.561 | 135.807 | 140.169 |

# APPENDIX B UAE VFM FACTOR DATA

## Table B.1: UAE Value for money factors- Correlation Matrix

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Clear output specification | 1 | | | | | | | | | | | | | | | |
| Competitive bid process | 0.566 | 1 | | | | | | | | | | | | | | |
| Early service delivery | 0.27 | 0.302 | 1 | | | | | | | | | | | | | |
| Efficient dispute resolutions | 0.533 | 0.554 | 0.484 | 1 | | | | | | | | | | | | |
| Reduced negative environmental impact | 0.435 | 0.46 | 0.652 | 0.769 | 1 | | | | | | | | | | | |
| Appropriate capital structure | 0.419 | 0.193 | 0.208 | 0.409 | 0.403 | 1 | | | | | | | | | | |
| Improved facilities to the users | 0.396 | 0.082 | 0.299 | 0.232 | 0.249 | -0.05 | 1 | | | | | | | | | |
| Optimised risk allocation | 0.688 | 0.584 | 0.298 | 0.59 | 0.351 | 0.12 | 0.234 | 1 | | | | | | | | |
| Improved services to the community | 0.434 | 0.393 | 0.373 | 0.388 | 0.377 | -0.22 | 0.52 | 0.535 | 1 | | | | | | | |
| Incentives for private party | -0.34 | -0.3 | 0.106 | -0.15 | -0.08 | -0.17 | 0.044 | -0.16 | 0.091 | 1 | | | | | | |
| Long-term engagement | -0.25 | -0.17 | 0.097 | -0.03 | -0.14 | 0.14 | 0 | -0.2 | -0.19 | 0.609 | 1 | | | | | |
| Low life-cycle cost | 0.494 | 0.451 | 0.419 | 0.292 | 0.175 | 0.115 | 0.311 | 0.695 | 0.417 | -0.07 | -0.01 | 1 | | | | |
| Low tariffs | 0.326 | 0.288 | 0.386 | 0.112 | 0.265 | -0.13 | 0.467 | 0.471 | 0.535 | -0.21 | -0.29 | 0.467 | 1 | | | |
| Optimisation of assets efficiency | 0.568 | 0.451 | 0.168 | 0.22 | 0.201 | 0.333 | 0.239 | 0.561 | 0.426 | -0.02 | -0.03 | 0.481 | 0.512 | 1 | | |
| Private sector's project management skills | 0.191 | 0.269 | 0.317 | 0.218 | 0.256 | 0.246 | 0.124 | 0.22 | 0.236 | 0.504 | 0.581 | 0.193 | 0.008 | 0.503 | 1 | |
| Technical innovation | 0.336 | 0.369 | 0.418 | 0.328 | 0.393 | 0.378 | 0.045 | 0.466 | 0.252 | 0.124 | 0.202 | 0.451 | 0.279 | 0.651 | 0.697 | 1 |

## Table B.2: UAE Value for money factors-KMO and Bartlett's Test

| *Table 7.13: KMO and Bartlett's Test* | | |
|---|---|---|
| *Kaiser-Meyer-Olkin Measure of Sampling Adequacy.* | | *.637* |
| *Bartlett's Test of Sphericity* | *Approx. Chi-Square* | *291.141* |
| | *df* | *120* |
| | *Sig.* | *.000* |

## Table B.3: UAE Value for money factors- Total Variance Explained

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 5.784 | 36.152 | 36.152 | 5.784 | 36.152 | 36.152 | 3.854 | 24.090 | 24.090 |
| 2 | 2.533 | 15.831 | 51.983 | 2.533 | 15.831 | 51.983 | 2.930 | 18.312 | 42.402 |
| 3 | 1.851 | 11.569 | 63.553 | 1.851 | 11.569 | 63.553 | 2.491 | 15.568 | 57.970 |
| 4 | 1.437 | 8.984 | 72.537 | 1.437 | 8.984 | 72.537 | 2.331 | 14.566 | 72.537 |
| 5 | .890 | 5.563 | 78.100 | | | | | | |
| 6 | .831 | 5.196 | 83.296 | | | | | | |
| 7 | .729 | 4.559 | 87.855 | | | | | | |
| 8 | .475 | 2.967 | 90.821 | | | | | | |
| 9 | .343 | 2.143 | 92.965 | | | | | | |
| 10 | .300 | 1.875 | 94.840 | | | | | | |
| 11 | .236 | 1.472 | 96.312 | | | | | | |
| 12 | .219 | 1.371 | 97.683 | | | | | | |
| 13 | .136 | .851 | 98.534 | | | | | | |
| 14 | .098 | .610 | 99.143 | | | | | | |
| 15 | .093 | .579 | 99.723 | | | | | | |
| 16 | .044 | .277 | 100.000 | | | | | | |

## Table B.4: UAE Value for money factors- Rotated Component Matrix

| | Component | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Optimisation of assets efficiency | .880 | | | |
| Optimised risk allocation | .735 | | | |
| Technical innovation | .699 | | | |
| Clear output specification | .675 | | | |
| Low life-cycle cost | .666 | | | |
| Competitive bid process | .601 | | | |
| Reduced negative environmental impact | | .908 | | |
| Efficient dispute resolutions | | .855 | | |
| Early service delivery | | .680 | | |
| Incentives for private party | | | .843 | |
| Long-term engagement | | | .843 | |
| Private sector's project management skills | | | .790 | |
| Improved services to the community | | | | .763 |
| Improved facilities to the users | | | | .693 |
| Low tariffs | | | | .672 |
| Appropriate capital structure | | .506 | | -.571 |

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 8 iterations.

# Table B.5: UAE Critical success factors- Correlation Matrix

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Appropriate risk allocation | 1 | | | | | | | | | | | | | | | | | |
| Commitment of public and private parties | 0.21 | 1 | | | | | | | | | | | | | | | | |
| Committed and competent public agency | 0.23 | 0.46 | 1 | | | | | | | | | | | | | | | |
| Competitive procurement process (specs, shortlist, etc.) | 0.39 | 0.39 | 0.65 | 1 | | | | | | | | | | | | | | |
| Detailed cost/ benefits assessment | 0.06 | 0.4 | 0.24 | 0.31 | 1 | | | | | | | | | | | | | |
| Favourable legal framework | 0.09 | 0.19 | 0.21 | 0.21 | 0.07 | 1 | | | | | | | | | | | | |
| Good governance | -0.2 | 0.29 | 0.03 | -0.1 | 0.12 | 0.61 | 1 | | | | | | | | | | | |
| Government guarantees | -0.3 | 0.24 | 0.37 | 0.25 | 0.12 | 0.36 | 0.39 | 1 | | | | | | | | | | |
| Local financial market | -0.1 | 0.04 | 0.09 | 0.22 | 0.3 | 0.23 | 0.25 | 0.52 | 1 | | | | | | | | | |
| Macro-economic conditions | -0.2 | -0 | -0.1 | -0 | 0.32 | 0.15 | 0.26 | 0.36 | 0.79 | 1 | | | | | | | | |
| Multi-benefit objectives of all stakeholders | -0.3 | 0.06 | -0.2 | -0.3 | 0.24 | 0.09 | 0.27 | 0.42 | 0.59 | 0.68 | 1 | | | | | | | |
| Political support | -0.1 | 0.34 | 0.24 | 0.19 | 0.11 | 0.63 | 0.41 | 0.52 | 0.49 | 0.48 | 0.42 | 1 | | | | | | |
| Project technical feasibility | -0.1 | 0.28 | 0.03 | -0.1 | 0.09 | 0.24 | 0.35 | 0.32 | 0.52 | 0.46 | 0.57 | 0.44 | 1 | | | | | |
| Shared authority between the public and private sector | -0.3 | 0.1 | -0.1 | 0.05 | 0.22 | -0.3 | -0.2 | 0.14 | 0.19 | 0.12 | 0.39 | -0.1 | 0.39 | 1 | | | | |
| Social support | 0.14 | 0.23 | 0.43 | 0.3 | 0.06 | -0.3 | -0.2 | 0.27 | 0.25 | 0.03 | 0.04 | -0.2 | 0.11 | 0.28 | 1 | | | |
| Sound economic policy | -0.1 | 0.13 | 0.22 | 0.13 | 0.32 | 0.26 | 0.44 | 0.54 | 0.64 | 0.47 | 0.27 | 0.25 | 0.42 | -0.2 | 0.26 | 1 | | |
| Strong private consortium | -0.2 | 0.21 | 0.28 | 0.18 | 0.47 | 0.12 | 0.31 | 0.44 | 0.3 | 0.31 | 0.28 | 0.31 | 0.02 | 0.12 | 0.04 | 0.29 | 1 | |
| Transparent procurement process | 0.31 | 0.42 | 0.13 | 0.18 | 0.25 | 0.25 | 0.23 | -0.2 | 0.05 | -0.1 | -0.1 | 0.09 | 0.36 | 0.12 | 0.04 | 0.07 | 0.18 | 1 |

# Table B.6: UAE Critical success factors- KMO and Bartlett's Test

| | | |
|---|---|---|
| *Kaiser-Meyer-Olkin Measure of Sampling Adequacy.* | | *.541* |
| *Bartlett's Test of Sphericity* | *Approx. Chi-Square* | *296.064* |
| | *df* | *153* |
| | *Sig.* | *.000* |

## Table B.7: UAE Critical success factors- *Total Variance Explained*

| | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| Component | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 5.012 | 27.844 | 27.844 | 5.012 | 27.844 | 27.844 | 3.623 | 20.130 | 20.130 |
| 2 | 2.807 | 15.595 | 43.439 | 2.807 | 15.595 | 43.439 | 2.617 | 14.538 | 34.668 |
| 3 | 2.127 | 11.818 | 55.258 | 2.127 | 11.818 | 55.258 | 2.121 | 11.785 | 46.452 |
| 4 | 1.595 | 8.861 | 64.119 | 1.595 | 8.861 | 64.119 | 1.858 | 10.322 | 56.774 |
| 5 | 1.274 | 7.075 | 71.194 | 1.274 | 7.075 | 71.194 | 1.715 | 9.529 | 66.303 |
| 6 | 1.147 | 6.375 | 77.569 | 1.147 | 6.375 | 77.569 | 1.608 | 8.935 | 75.238 |
| 7 | 1.018 | 5.658 | 83.227 | 1.018 | 5.658 | 83.227 | 1.438 | 7.989 | 83.227 |
| 8 | .648 | 3.600 | 86.826 | | | | | | |
| 9 | .548 | 3.046 | 89.872 | | | | | | |
| 10 | .447 | 2.485 | 92.357 | | | | | | |
| 11 | .355 | 1.975 | 94.331 | | | | | | |
| 12 | .314 | 1.745 | 96.077 | | | | | | |
| 13 | .238 | 1.321 | 97.397 | | | | | | |
| 14 | .150 | .833 | 98.230 | | | | | | |
| 15 | .109 | .606 | 98.836 | | | | | | |
| 16 | .086 | .477 | 99.314 | | | | | | |
| 17 | .069 | .385 | 99.699 | | | | | | |
| 18 | .054 | .301 | 100.000 | | | | | | |

## Table B.8: UAE Critical success factors- Rotated Component Matrix

| | Component | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| *Local financial market* | *.905* | | | | | | |
| *Macro-economic conditions* | *.875* | | | | | | |
| *Multi-benefit objectives of all stakeholders* | *.761* | | | | | | |
| *Project technical feasibility* | *.653* | | | *.579* | | | |
| *Committed and competent public agency* | | *.870* | | | | | |
| *Competitive procurement process (specs, shortlist, etc.)* | | *.796* | | | | | |
| *Favourable legal framework* | | | *.808* | | | | |
| *Political support* | | | *.756* | | | | |
| *Social support* | | *.589* | *-.655* | | | | |
| *Good governance* | | | | | | | |
| *Transparent procurement process* | | | | *.854* | | | |
| *Commitment of public and private parties* | | *.504* | | *.589* | | | |
| *Appropriate risk allocation* | | | | | *-.814* | | |
| *Government guarantees* | | *.533* | | | *.562* | | |
| *Detailed cost/ benefits assessment* | | | | | | *.826* | |
| *Strong private consortium* | | | | | | *.761* | |
| *Shared authority between the public and private sector* | | | | | | | *-.771* |
| *Sound economic policy* | *.599* | | | | | | *.629* |

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 27 iterations.

# APPENDIX C UK SURVEY ANALYSIS

## Table C.1: UK Value for money factors- Correlation Matrix

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Clear output specification | 1 | | | | | | | | | | | | | | | |
| Competitive bid process | 0.694 | 1 | | | | | | | | | | | | | | |
| Early service delivery | 0.423 | 0.357 | 1 | | | | | | | | | | | | | |
| Efficient dispute resolutions | 0.443 | 0.361 | 0.253 | 1 | | | | | | | | | | | | |
| Reduced negative environmental impact | 0.327 | 0.331 | 0.553 | 0.57 | 1 | | | | | | | | | | | |
| Appropriate capital structure | 0.409 | 0.245 | 0.292 | 0.634 | 0.625 | 1 | | | | | | | | | | |
| Improved facilities to the users | 0.406 | 0.358 | 0.497 | 0.464 | 0.573 | 0.56 | 1 | | | | | | | | | |
| Optimised risk allocation | 0.527 | 0.436 | 0.345 | 0.475 | 0.462 | 0.457 | 0.527 | 1 | | | | | | | | |
| Improved services to the community | 0.374 | 0.301 | 0.363 | 0.548 | 0.624 | 0.619 | 0.616 | 0.608 | 1 | | | | | | | |
| Incentives for private party | 0.366 | 0.386 | 0.317 | 0.421 | 0.368 | 0.39 | 0.335 | 0.596 | 0.597 | 1 | | | | | | |
| Long-term engagement | 0.545 | 0.366 | 0.559 | 0.559 | 0.503 | 0.566 | 0.546 | 0.496 | 0.558 | 0.656 | 1 | | | | | |
| Low life-cycle cost | 0.381 | 0.278 | 0.209 | 0.461 | 0.266 | 0.371 | 0.501 | 0.359 | 0.45 | 0.347 | 0.563 | 1 | | | | |
| Low tariffs | 0.141 | 0.131 | 0.339 | 0.353 | 0.38 | 0.367 | 0.534 | 0.151 | 0.393 | 0.185 | 0.353 | 0.697 | 1 | | | |
| Optimisation of assets efficiency | 0.39 | 0.2 | 0.193 | 0.472 | 0.295 | 0.459 | 0.487 | 0.318 | 0.531 | 0.38 | 0.576 | 0.636 | 0.509 | 1 | | |
| Private sector's project management skills | 0.485 | 0.382 | 0.438 | 0.587 | 0.431 | 0.522 | 0.497 | 0.472 | 0.508 | 0.526 | 0.597 | 0.363 | 0.316 | 0.646 | 1 | |
| Technical innovation | 0.399 | 0.281 | 0.365 | 0.446 | 0.35 | 0.558 | 0.504 | 0.318 | 0.4 | 0.417 | 0.599 | 0.353 | 0.446 | 0.669 | 0.667 | 1 |

## Table C.2: UK Value for money factors- KMO and Bartlett's Test

| | | |
|---|---|---|
| *Kaiser-Meyer-Olkin Measure of Sampling Adequacy.* | | *.824* |
| *Bartlett's Test of Sphericity* | *Approx. Chi-Square* | *631.230* |
| | *df* | *120* |
| | *Sig.* | *.000* |

## Table C.3: UK Value for money factors- Total Variance Explained

| *Component* | *Initial Eigenvalues* | | | *Rotation Sums of Squared Loadings* | | |
|---|---|---|---|---|---|---|
| | *Total* | *% of Variance* | *Cumulative %* | *Total* | *% of Variance* | *Cumulative %* |
| *1* | *7.715* | *48.216* | *48.216* | *3.938* | *24.610* | *24.610* |
| *2* | *1.545* | *9.656* | *57.873* | *3.073* | *19.203* | *43.814* |
| *3* | *1.124* | *7.026* | *64.898* | *2.251* | *14.070* | *57.883* |
| *4* | *1.025* | *6.404* | *71.302* | *2.147* | *13.419* | *71.302* |
| *5* | *.904* | *5.651* | *76.953* | | | |
| *6* | *.780* | *4.877* | *81.830* | | | |
| *7* | *.548* | *3.423* | *85.254* | | | |
| *8* | *.454* | *2.841* | *88.094* | | | |
| *9* | *.414* | *2.586* | *90.680* | | | |
| *10* | *.367* | *2.292* | *92.972* | | | |
| *11* | *.291* | *1.822* | *94.794* | | | |
| *12* | *.246* | *1.539* | *96.333* | | | |
| *13* | *.216* | *1.348* | *97.681* | | | |
| *14* | *.159* | *.991* | *98.673* | | | |
| *15* | *.118* | *.736* | *99.409* | | | |
| *16* | *.095* | *.591* | *100.000* | | | |

## Table C.4: UK Value for money factors- Rotated Component Matrix

| | Component | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| *Incentives for private party* | *.714* | | | |
| *Improved services to the community* | *.707* | | | |
| *Appropriate capital structure* | *.687* | | | |
| *Efficient dispute resolutions* | *.651* | | | |
| *Optimised risk allocation* | *.645* | | | |
| *Private sector's project management skills* | *.611* | | | |
| *Long-term engagement* | *.557* | | | |
| *Low tariffs* | | *.794* | | |
| *Low life-cycle cost* | | *.789* | | |
| *Optimisation of assets efficiency* | | *.781* | | |
| *Technical innovation* | | *.591* | | |
| *Competitive bid process* | | | *.840* | |
| *Clear output specification* | | | *.808* | |
| *Reduced negative environmental impact* | *.500* | | | *.750* |
| *Early service delivery* | | | | *.687* |
| *Improved facilities to the users* | | | | *.593* |

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 11 iterations.

## Table C.5: UK Critical success factors- Rotated Component Matrix

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Appropriate risk allocation | 1 | | | | | | | | | | | | | | | | | |
| Commitment of public and private parties | 0.504 | 1 | | | | | | | | | | | | | | | | |
| Committed and competent public agency | 0.404 | 0.692 | 1 | | | | | | | | | | | | | | | |
| Competitive procurement process (specs, shortlist, etc.) | 0.234 | 0.37 | 0.403 | 1 | | | | | | | | | | | | | | |
| Detailed cost/ benefits assessment | 0.237 | 0.3 | 0.261 | 0.4 | 1 | | | | | | | | | | | | | |
| Favourable legal framework | 0.116 | 0.293 | 0.243 | 0.261 | 0.239 | 1 | | | | | | | | | | | | |
| Good governance | 0.137 | 0.317 | 0.271 | 0.379 | 0.278 | 0.62 | 1 | | | | | | | | | | | |
| Government guarantees | 0.183 | 0.128 | 0.15 | -0.146 | 0.249 | 0.29 | 0.376 | 1 | | | | | | | | | | |
| Local financial market | 0.335 | 0.21 | 0.23 | 0.014 | 0.184 | 0.303 | 0.116 | 0.442 | 1 | | | | | | | | | |
| Macro-economic conditions | 0.353 | 0.405 | 0.444 | 0.219 | 0.513 | 0.4 | 0.201 | 0.415 | 0.526 | 1 | | | | | | | | |
| Multi-benefit objectives of all stakeholders | 0.124 | 0.377 | 0.462 | 0.129 | 0.181 | 0.18 | 0.3 | 0.356 | 0.238 | 0.376 | 1 | | | | | | | |
| Political support | 0.564 | 0.394 | 0.481 | 0.196 | 0.199 | 0.242 | 0.276 | 0.217 | 0.282 | 0.365 | 0.229 | 1 | | | | | | |
| Project technical feasibility | 0.283 | 0.142 | 0 | 0.148 | 0.474 | 0.432 | 0.258 | 0.406 | 0.433 | 0.344 | 0.125 | 0.413 | 1 | | | | | |
| Shared authority between the public and private sector | 0.397 | 0.342 | 0.286 | 0.291 | 0.217 | 0.49 | 0.19 | 0.321 | 0.339 | 0.48 | 0.321 | 0.529 | 0.518 | 1 | | | | |
| Social support | 0.342 | 0.342 | 0.458 | 0.21 | 0.056 | 0.316 | 0.01 | 0.098 | 0.216 | 0.237 | 0.193 | 0.311 | 0.195 | 0.465 | 1 | | | |
| Sound economic policy | 0.334 | 0.418 | 0.422 | 0.328 | 0.449 | 0.655 | 0.42 | 0.252 | 0.485 | 0.595 | 0.084 | 0.468 | 0.514 | 0.422 | 0.307 | 1 | | |
| Strong private consortium | 0.37 | 0.347 | 0.328 | 0.392 | 0.183 | 0.29 | 0.161 | 0.135 | 0.113 | 0.466 | 0.35 | 0.453 | 0.277 | 0.595 | 0.329 | 0.254 | 1 | |
| Transparent procurement process | 0.383 | 0.557 | 0.431 | 0.357 | 0.258 | 0.436 | 0.354 | 0.186 | 0.1 | 0.372 | 0.375 | 0.432 | 0.284 | 0.419 | 0.395 | 0.324 | 0.693 | 1 |

## Table C.6: UK Critical success factors- KMO and Bartlett's Test

| | | |
|---|---|---|
| *Kaiser-Meyer-Olkin Measure of Sampling Adequacy.* | | *.728* |
| *Bartlett's Test of Sphericity* | *Approx. Chi-Square* | *583.148* |
| | *df* | *153* |
| | *Sig.* | *.000* |

## Table C.7: UK Critical success factors- Total Variance Explained

| Component | Initial Eigenvalues Total | Initial Eigenvalues % of Variance | Initial Eigenvalues Cumulative % | Rotation Sums of Squared Loadings Total | Rotation Sums of Squared Loadings % of Variance | Rotation Sums of Squared Loadings Cumulative % |
|---|---|---|---|---|---|---|
| 1 | 6.566 | 36.479 | 36.479 | 2.902 | 16.125 | 16.125 |
| 2 | 1.909 | 10.604 | 47.083 | 2.737 | 15.206 | 31.330 |
| 3 | 1.466 | 8.146 | 55.230 | 2.620 | 14.557 | 45.888 |
| 4 | 1.274 | 7.076 | 62.305 | 2.118 | 11.768 | 57.655 |
| 5 | 1.180 | 6.557 | 68.863 | 1.598 | 8.875 | 66.530 |
| 6 | 1.019 | 5.660 | 74.523 | 1.439 | 7.992 | 74.523 |
| 7 | .872 | 4.843 | 79.365 | | | |
| 8 | .637 | 3.542 | 82.907 | | | |
| 9 | .597 | 3.315 | 86.222 | | | |
| 10 | .530 | 2.947 | 89.169 | | | |
| 11 | .464 | 2.580 | 91.749 | | | |
| 12 | .400 | 2.224 | 93.973 | | | |
| 13 | .319 | 1.772 | 95.745 | | | |
| 14 | .203 | 1.129 | 96.873 | | | |
| 15 | .174 | .966 | 97.840 | | | |
| 16 | .153 | .848 | 98.687 | | | |
| 17 | .143 | .795 | 99.482 | | | |
| 18 | .093 | .518 | 100.000 | | | |

## Table C.8: UK Critical success factors- Rotated Component Matrix

| | Component | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| *Strong private consortium* | .851 | | | | | |
| *Shared authority between the public and private sector* | .742 | | | | | |
| *Transparent procurement process* | .665 | | | | | |
| *Political support* | .514 | | | | | |
| *Committed and competent public agency* | | .864 | | | | |
| *Commitment of public and private parties* | | .763 | | | | |
| *Appropriate risk allocation* | | .540 | | | | |
| *Social support* | | | | | | |
| *Local financial market* | | | .807 | | | |
| *Government guarantees* | | | .620 | | | .553 |
| *Project technical feasibility* | | | .603 | | | |
| *Macro-economic conditions* | | | .539 | | | |
| *Favourable legal framework* | | | | .847 | | |
| *Good governance* | | | | .808 | | |
| *Sound economic policy* | | | .526 | .527 | | |
| *Detailed cost/ benefits assessment* | | | | | .839 | |
| *Competitive procurement process (specs, shortlist, etc.)* | | | | | .548 | |
| *Multi-benefit objectives of all stakeholders* | | | | | | .807 |

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 11 iterations.

# APPENDIX D RESEARCH REACTOR QUESTIONNAIRE

## Table D.1: Sample Questionnaire for guiding the research reactor interview questions

| Part one: Issues related to research reactors<br>Please tick one box for each statement which best describes your opinion | | | | | | |
|---|---|---|---|---|---|---|
| N. | Statement | Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree |
| 1 | The future prospects of research reactors are very promising. | ( ) | ( ) | ( ) | ( ) | ( ) |
| 2 | Early identification of stakeholders in research reactors projects is a precondition for considering the project. | ( ) | ( ) | ( ) | ( ) | ( ) |
| 3 | There are more potential gains than losses for public and private sectors, and the community for adopting a research reactor program. | ( ) | ( ) | ( ) | ( ) | ( ) |
| 4 | The main difference between research reactor projects and other complex long-term projects is in security and safety issues. | ( ) | ( ) | ( ) | ( ) | ( ) |
| 5 | Research reactors are well justified and mostly don't require feasibility studies to prove their contribution to research and the economy. | ( ) | ( ) | ( ) | ( ) | ( ) |
| 6 | More gains can be expected from research reactors if there is a regional or international cooperation. | ( ) | ( ) | ( ) | ( ) | ( ) |
| 7 | Industrial involvement is the key factor for research reactor project completion. | ( ) | ( ) | ( ) | ( ) | ( ) |
| 8 | Research reactors are strategic projects that are likely to attract foreign investors through generic funding mechanisms. | ( ) | ( ) | ( ) | ( ) | ( ) |
| 9 | Most of research reactors are commercially viable and generate profits. | ( ) | ( ) | ( ) | ( ) | ( ) |
| | | | | | | |
| Part two: What is the rank of the following success factors for RRs in your opinion? Please tick one box for each factor which best describes your opinion | | | | | | |
| N. | Success factor | Essential | Very Important | Important | Moderately Important | Of Little Import. |
| 10 | Stakeholders | ( ) | ( ) | ( ) | ( ) | ( ) |
| 11 | Life-cycle funding and financing | ( ) | ( ) | ( ) | ( ) | ( ) |
| 12 | Waste management | ( ) | ( ) | ( ) | ( ) | ( ) |
| 13 | Site and material security | ( ) | ( ) | ( ) | ( ) | ( ) |
| 14 | Industrial involvement | ( ) | ( ) | ( ) | ( ) | ( ) |
| 15 | Human resources | ( ) | ( ) | ( ) | ( ) | ( ) |
| 16 | Environment | ( ) | ( ) | ( ) | ( ) | ( ) |
| 17 | Radiation protection | ( ) | ( ) | ( ) | ( ) | ( ) |
| 18 | Utilization | ( ) | ( ) | ( ) | ( ) | ( ) |
| 19 | Any other success factors you want to add? | | | | | |
| 20 | Any particular issues for consideration when developing RR in the UAE? | | | | | |

## D.2: Covering letter for the research reactor questionnaire

# QUESTIONNAIRE

**Dear Sir/ Madam,**

This questionnaire gives you the opportunity to express your views on a wide range of issues related to research reactors. This study is the first milestone for considering a research reactor in the UAE, and it is a great opportunity to be part of this ambitious program.

The questionnaire will be used to collect the primary data needed for a research study related to the feasibility of considering a research reactor program in the UAE.

The researcher assures you that no individuals will be identified from their responses and there are no requests for confidential information included in the questionnaire. The results of the analysis will be strictly used by the researcher **for study purposes only.**

***If you feel you wish to contribute more details and wish for your name to be acknowledged in the final report, please inform the researcher and a 30 minute recorded interview will be scheduled accordingly.***

The questionnaire should not take more than 5 minutes

Thank you

**Researcher**

## D.3: Sample invitation letter for participation in research reactors interviews

Dear

I'm conducting a study on the topic of public private partnerships in research reactors for my doctoral requirement at the British university in Dubai, which will be the first step for developing a research reactor program for the UAE.

I need to interview you. The questions will be open-ended to allow your full elaboration on general questions on success factors, where there will be no technical, sensitive, or particular country related information required.

The telephonic interviews will last between 15 and 30 minutes. Unless you request anonymity, which will be guaranteed if requested, your name will be acknowledged in the acknowledgement section of the thesis.

If you are interested in helping in this study, please let me know to work on the best timing for contacting you.

Thank you very much for your consideration.

I look forward to hearing from you soon.

Khalid Al Marri
Senate Member and Representative of Students
PhD Program in Project Management
British University in Dubai
120077@student.buid.ac.ae

## D.4: Grounded theory interview questions

1. Tell me please how you see the future prospects of research reactors.
2. Would you like to elaborate on the justification for building a research reactor? Regional RRs?
3. What are the strengths and weaknesses of research reactors?
4. What are the success factors for RRs in your opinion?
    - Stakeholders, early identification
    - Life-cycle funding and financing
    - Nuclear safety and security, material security
    - Site selection
    - Waste management and Fuel management
    - Industrial involvement
    - Human resources development
    - Environmental and radiation protection
    - Utilization
5. What makes a research reactor commercially viable for investors? Partial commercialization?
6. Any particular issues for consideration when developing RR in the UAE? Size? Multi purpose

# APPENDIX E VALIDATION QUESTIONNAIRE

You role: Practitioner/ Researcher

Years of experience:

| NO | Validation criteria | Poor | Fair | Average | Good | Excellent |
|---|---|---|---|---|---|---|
| 1 | Degree of comprehensiveness | | | | | |
| 2 | Degree of objectivity | | | | | |
| 3 | Degree of reliability | | | | | |
| 4 | Degree of practicality | | | | | |
| 5 | Degree of replicability | | | | | |
| 6 | Degree of adaptability | | | | | |

1. Whether the model is a complete framework for PPP implementation in the UAE.
2. Whether the framework is unbiased.
3. Reliability of the framework to deliver the requirements of the users.
4. The framework is realistic and implementable.
5. Repeated uses.
6. Can guide developing other types of PPPs.

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