



RESEARCH ARTICLE

A Comparative Analysis of BOT and BO Systems in Infrastructure Development: Case Studies from Egypt and Saudi Arabia

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This study aims to conduct a comprehensive comparison and analysis of the Build-Operate-Transfer (BOT) and Build-Own (BO) systems in infrastructure development, focusing on case studies from Egypt and Saudi Arabia. The research employs a mixed-method approach, combining an extensive literature review with in-depth case study analysis. Eight case studies, four from each country, were examined to provide practical insights into the implementation of these systems. The study revealed that BOT systems offer more flexibility in risk allocation and financing, while BO systems provide greater control to private entities. In Egypt, BOT projects such as the Nile City Hotel and Sidi Krir Power Station demonstrated successful risk allocation and financing strategies. Saudi Arabia's Yanbu III Power Project and Rabigh Independent Power Project highlighted effective risk management through multiple supply and service contracts. The BO system, exemplified by the SCADA Project in Egypt and the Marafiq IWPP in Saudi Arabia, faced challenges in legal documentation and government intervention but offered greater operational control. This research contributes to the understanding of PPP models in the Middle Eastern context, providing valuable insights for policymakers, investors, and project managers involved in large-scale infrastructure initiatives.

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1. INTRODUCTION

Building infrastructure is crucial, for boosting the economy and improving society is well being in times; numerous nations have adopted approaches, like Build Operate Transfer (BOT) and Build Own (BO) to benefit from private sector knowledge and funds through Public Private Partnerships (PPPs). These strategies have become popular for their ability to speed up project completion and maximize resource usage effectively.

The research on partnership (PPP) models for infrastructure growth is vast and covers different angles of build operate transfer (BOT) and build operate (BO) setups according to Xiong *et al.* (2020) [1]. They explored how the concept of Public-Private Partnerships affects the growth of urban cities while highlighting the importance of one-size-fits-all approaches for cities in the developing world. Further Liu *et al.* [2] in the year 2020 upon analyzing several e-government projects including PPP structures, noted the fluidity of these structures over time. Delmon (2021) [3] presented an analysis of how private companies invest in infrastructure projects by examining the financial structures of public private partnership initiatives, in various nations.

Nevertheless, with the increasing amount of research there is still a notable lack, in the comparison of BOT and BO systems especially within the Middle Eastern setting. While there are instances and

analyses specific to countries there is a shortage of thorough research that directly contrasts these two systems across various national contexts in the region. This gap is particularly striking considering the rising use of PPP models in nations such, as Egypt and Saudi Arabia which have economic and regulatory landscapes.

Moreover, the body of work frequently lacks a comprehension of the performance of these systems, in different infrastructure sectors within a single nation. There is a necessity for studies that do not contrast BOT and BO systems across nations but also assess their execution in sectors, within each country.

In order to fill in these pieces of information and provide clarity on the subject, at hand. This research endeavors to tackle the inquiries.

Q1-What are the variations, in frameworks, financing methods, risk distribution strategies and project ownership setups between BOT and BO systems, in Egypt and Saudi Arabia?

Q2-What factors play a role in determining the outcomes of BOT and BO projects across infrastructure sectors in these nations?

Q3-How do the results of BOT and BO projects differ in terms of project completion effectiveness productivity and lasting viability?

By raising these queries and providing insights to policy makers and players in surface infrastructure constructions, who are the main focus of this study in the Middle East region and beyond, it is expected that this research will contribute to the existing body of knowledge on methods of infrastructure development.

2. METHODOLOGY

This study employs a combination of approaches through literature review and case studies to study the adoption of BOT and BO models of integration in the context of infrastructure development, Egypt, and Saudi Arabia in particular.

A number of studies have been conducted in this area with respect to BOT and BO systems applications in developing countries such as Egypt and Saudi Arabia. Osei Kyei, and Chan (2019) ^[4] in their research on the success factors of public-private partnerships (PPP) in developing countries successfully elaborated on the need to have an appropriate allocation of risks, a well-organized private sector, and support from the government. Their findings help in understanding the problems that arise in the process of executing BOT and BO projects in the case of Egypt and Saudi Arabia.

As far as Egypt is concerned, El Sayah (2022) ^[5] looked into the making of BOT contracts. He focused on the changes, if any, in legal regimes available in investment. The research pointed out the consequences of the new Investment Law on people working on BOT projects. This appraisal discusses the current situation and future prospects for infrastructure development, in Egypt.

In 2020 Almarri ^[6] conducted a study focusing the factors that lead to the success of PPP projects, in Saudi Arabia including the significance of government backing project goals and strong financial backing This research sheds light specifically onto the triumph of BOT projects such as the Yanbu III Power Project., in Saudi Arabia.

In research conducted by Ozorhon and colleagues in 2021^[7] they examined the use of PPP models, in Turkey and Saudi Arabia to uncover approaches taken by each country in their implementation strategies for such models. Their study emphasized the significance of customizing PPP models to fit the circumstances – a crucial insight that aligns closely with our evaluation of BOT and BO systems, in Egypt and Saudi Arabia.

In the realm of water management— an aspect of infrastructure advancement, in both nations— Barakat *et. al.* (2020) ^[8] delved into the obstacles and prospects linked to employing private partnership (PPP) frameworks for desalination initiatives in Egypt. Their research sheds light on concerns within the sector that influence the execution of Build–Operate–Transfer (BOT). Build–Own (BO) ventures, in water related infrastructure projects.

The study done by Albishri *et. al.* (2023) ^[9] in Saudi Arabia was concentrated on the investigation of the usage of PPP models as per the requirements of nation’s Vision 2030 program.

Yescombe and Farquharson (2021) ^[10] focused on the particular characteristics of BOT and BO projects, while analyzing the public private partnership projects in the developing countries, exposing for example the difficulties involved in fundraising for infrastructure projects in Egypt and Saudi Arabia.

The combined research helps establish the groundwork, for comprehending how BOT and BO systems are put into practice in Egypt and Saudi Arabia but uncovers deficiencies in literature regarding direct comparisons between these systems in various sectors within the countries mentioned. This gap emphasizes the significance of this study in enhancing our insight into BOT and BO systems within the framework of infrastructure development, in the Middle East.

In conducting the case study analysis, for this research studies investigation phase review was carried out for eight projects—four from Egypt and four from Saudi Arabia—with selection based on criteria like projects executed under BOT or BO setups with completion or substantial advancement in the past five years and having comprehensive details regarding project framework and results available, for examination. The chosen case studies are as follows.

- A. Egypt is a country, in North Africa. Its ancient civilization is well known for its pyramids and rich history.
 - I. The hotel situated by the Nile River (BOT) ^[11]
 - II. The power plant, at Sidi Krir (BOT) ^[12]
 - III. SCADA Project for water management (BO) ^[13]
 - IV. The National Bridge Project (BO) ^[14]
- B. Saudi Arabia is known for its culture and historical significance.
 - V. Yanbu III Power Project (BOT) ^[15]
 - VI. The Rabigh Independent Power Project (BOT) ^[16]
 - VII. Project, for Independent Water Production (IWPP) (BO) ^[17]
 - VIII. Marafiq Independent Water and Power Plant (BO) ^[18]

In every instance researched was thoroughly examined through a framework that looked into the regulatory environment as well, as the financing structure and risk allocation mechanisms involved in the projects ownership and transfer agreements along with the main challenges and results encountered. This method enabled an analysis of BOT and BO systems comparison within and, across both countries.

The purpose of the comparative study was to extract as much information as possible concerning the application of BOT and BO systems in Egypt and Saudi Arabia such as their similarities and differences. This concerned the various methods of transportation, and how they are financed and regulated, the dispersion of risks, modes of ownership and licensing, transfer of technology issues, as well as problems and success factors in implementing such projects.

Through an examination of existing research and, in depth exploration of real-life examples in the field of infrastructure development implementation strategy, BOT and BO systems aim to offer theoretical knowledge and useful practical guidance.

3. RESULTS AND DISCUSSION

3.1 Legal framework

Upon examining the structures, in Egypt and Saudi Arabia regarding BOT and BO initiatives it became evident that there are variations in the regulatory landscapes. In Egypt the Build Operate Transfer Law No. 67 of 2010 governs the BOT model. Offers a framework for executing projects. This legislation delineates the responsibilities and entitlements of all parties participating in BOT ventures encompassing aspects such, as concession durations, revenue distribution mechanisms and conflict resolution protocols. With respect to the Nile City Hotel project and the Sidi Krir Power Station project in Egypt, such outcomes resulted from the coherent legal environment that provided normative conditions for performance and risks management.

Saudi Arabia lacks a legislature specifically addressing BOT projects, resorting instead to various decrees and sectoral laws on the PPP approach. The Saudi Arabian General Investment Authority (SAGIA) plays a vital role in promoting investments for the BOT projects by offering incentives and

streamlining the process of obtaining approvals. Such approach was noted, for example, in the case of Yanbu III Power Project and the Rabigh Independent Power Project, where project-specific governance was established.

For projects related to build operate (BO) both nations typically adhere to investment regulations rather than having detailed regulatory frameworks, like those for build operate transfer (BOT) projects do. In Egypt and Saudi Arabia, the SCADA Project in Egypt and the National Bridge Project faced obstacles due to this gap leading to more extensive negotiations, between private entities and government bodies. In this respect, just as in Saudi Arabia, the IWP Project and the Marafiq IWPP had to contend with the absence of dedicated BO legislation.

It was also established in the course of the research that the new regulations that govern BOT projects in Egypt have restored a measure of confidence in investors and significantly improved risk management. In contrast the potential of Saudi Arabia's regulatory framework has allowed for the flourishing of unique project designs particularly in the energy and water sectors. This proved valuable for instance in projects such as Yanbu III and Rabigh permitting the effective implementation of financing and operational strategies.

3.2 Financing mechanisms

Significant disparities were uncovered in the examination of funding methods between BOT and BO initiatives. Also, across Egypt and Saudi Arabia regions. BOT initiatives primarily relied on project finance arrangements involving a combination of debt and equity financing. For instance, the Nile City Hotel project in Egypt managed to secure 70% of its funding through loans from entities highlighting the effectiveness of BOT models, in attracting international investments. The Sidi Krir Power Plant also made use of both global funding options by taking advantage of government backing to secure loan conditions.

In Saudi Arabia's energy sector, the Yanbu III Power Project and the Rabigh Independent Power Project featured funding arrangements that tapped into global financial markets. The Yanbu III initiative secured \$2 billion through a mix of loans, from banks backing from export credit agencies and Islamic financing tools. Similarly, the Rabigh project employed a strategy drawing on the country's financial landscapes and government backing, for public private partnership ventures.

Unlike government projects that often depend on public funding sources, for financing support business-oriented projects frequently utilize frameworks where private entities undertake a larger portion of the financial liabilities. For instance, the SCADA Project in Egypt primarily relied on the operators' funds along with loans from banks, for financial backing. Similarly, the National Bridge Project encountered funding obstacles requiring the entity to shoulder a substantial portion of the financial responsibilities. In Saudi Arabia, the Independent Water Producer (IWPP) along, with the Marafiq IWPP project highlighted funding methods, for BO projects that integrated aspects of project financing. Took advantage of the country's robust capital markets.

The research revealed that BOT initiatives typically had access, to funding choices and proved to be more appealing to global investors compared to other projects in Saudi Arabia due to the emphasis on public private partnerships under Vision 2030 initiative for infrastructure growth leading to better financing terms for BOT schemes; meanwhile BO projects provided investors with a higher level of flexibility in ownership and operational management especially in sectors, like telecommunications and water treatment known for stable revenue generation.

3.3 Risk allocation

The research findings showed distinctions, in how risks are assigned in Build Operate Transfer (BOT) and Build Own (BO) projects^[19] with differing approaches observed between Egypt and Saudi Arabia as well. In BOT projects the allocation of risks was more organized and well defined, with risks spread out among project sponsors, lenders, contractors, and government bodies based on their capacities to manage and alleviate risks.

The Nile City Hotel development, in Egypt displayed a security setup, with risks spread out across contract agreements. However, the lingering worry of government counterparty risk highlighted the political instabilities in the nation. On the hand The Sidi Krir Power Station project adopted a risk

distribution plan by drawing from past BOT projects experiences and including government assurances to manage specific risks.

The Yanbu III Power Project and the Rabigh Independent Power Project, in Saudi Arabia demonstrated methods for managing risks by spreading them across stakeholders through numerous supply and service agreements. The support of the government and the stable economic conditions in the country enabled the implementation of efficient risk reduction strategies.

Projects involving build operate agreements often entail risk for entities due to market and operational uncertainties involved in the process. For instance, the SCADA Project in Egypt mandated the operator to shoulder a majority of risks related to technology deployment and sustaining efficiency, over the term. Similarly, the National Bridge Project encountered obstacles as the private entity took on responsibilities concerning construction and ongoing operations. The Independent Water Producer (IPR)x Project and Marafiq Integrated Water and Power Plant (IWPP)x in Saudi Arabia adopted features commonly found in BOT projects, like extended procurement contracts to display a blend of risk sharing techniques, within business arrangements.

The research revealed that BOT initiatives typically had access, to an array of funding possibilities and demonstrated appeal to global investors compared to other projects in the field of business development and construction work in Saudi Arabia as observed under the Vision 2030 plan initiated by the government that has emphasized PPP partnerships as a vital strategy for enhancing infrastructure growth and providing better financial support for BOT schemes. In the case of BO projects, the degree of control and management offered was further appealing to the investors especially in the sectors such as telecommunications and water treatment which have inherent monopolistic nature characteristic of high return projects. ^[20]

3.4 Project ownership

The examination of project ownership setups showed disparities between BOT and BO systems that have effects on project management control, operational adaptability, and the handling of assets eventually. In BOT initiatives ownership is usually held by an entity known as a purpose vehicle (SPV) for the duration of the concession agreement with a prearranged process for transferring it back to the government at the agreement's conclusion ^[21].

The development of the Nile City Hotel project, in Egypt highlighted this structure by having the Special Purpose Vehicle (SPV) retain ownership rights for a 30-year concession period. This setup facilitated an assignment of responsibilities throughout the phase and established a framework for the eventual transition, to public ownership. The Sidi Krir Power Station adopted an approach. Additionally, there is the challenging task of managing the transfer of technology alongside ensuring smooth operational functions during the period of transition.

Saudi Arabia's Yanbu III Power Project and Rabigh Independent Power Project ownership configurations engaged financing and local partnerships requirements convincingly adapted to the local laws and social practices with the main objective of transferring operations to government control in the near future.

On the other hand, Build Own Operate projects retained ownership from the inception up to the end of each task such as the SCADA Project as well as the National Bridge Project in Egypt. This long-lasting private ownership structure gave its possessor both dominion and an ability to expand the value of the possessor's assets. This, however, made the party anxious about ensuring the protection of the party's interests, and management particularly with regard to critical infrastructural assets.

In Saudi Arabia's projects, like the Independent Water Producer (IWP) Project and the Marafiq IWPP they implemented ownership models that combined BOT and BO elements. These initiatives upheld ownership while involving government supervision and extended service contracts aiming to blend sector efficiency with public sector strategic goals.

How this ownership is accomplished is a factor which also found to influence project management practices and stakeholder behavior towards the project during its entire lifecycle. It appears that in BOT projects, provisions for governance structures and withdrawal plans for the private investors

are often included. On the other hand, BO projects give freedom to operate but need more intricate rules to make sure they meet public interests effectively [22].

The research also mentioned a development towards increased flexibility in ownership arrangements in both nations. This includes opportunities for transfer of ownership rights and lease back agreements well, as extensions based on performance metrics being integrated into recent initiatives. Overall, there is an increasing recognition that ownership structure needs to be designed for change over time with societal and market forces, or rather, trends, increasing over time [23].

4. CONCLUSION

The thorough analysis of 'Build Operate Transfer' and 'Build Own' strategies in the case studies of Egypt and Saudi Arabia, has revealed how these project delivery systems are employed in the construction of infrastructure works. The discussion highlights [24] the benefits and challenges related to both systems. How factors unique to each country can influence project results.

Research findings show that although both BOT and BO systems can be options, for infrastructure development in Egypt and Saudi Arabia their success depends on the legal, financial, and regulatory landscapes. It has been observed that in the case of BOT projects, there are more successful ways to obtain the necessary project financing and to organize risk mitigations, thus enabling the successful execution of large-scale infrastructural projects such as the Yanbu III Power Project in Saudi Arabia and Sidi Krir Power Station in Egypt. These initiatives demonstrated how BOT frameworks could harness knowledge and funding, in line, with development objectives.

BO initiatives such, as the SCADA Project in Egypt and the Marafiq IWPP in Saudi Arabia provided increased flexibility. Involved long term participation from the private sector.[25] Nevertheless they encountered difficulties with standardization and risk management requiring more intricate regulatory structures to safeguard public interests the mixed models implemented in Saudi Arabia's water and power industries illustrate a developing strategy to harmonize effectiveness, with strategic objectives.

As a result of the research, it contributes towards the enrichment of the knowledge on the PPP, in the Middle East region by stressing on the application differences of the models in various countries and industries. In revealing that the success of projects is determined by more than just choosing between BOT and BO, including the legal regimes, investment mechanisms and risk management strategies in place.

The limitations of this study include the focus on a limited number of case studies; the rapid emergence of PPP networks in the two countries which may affect the timelessness of the findings. As for future research expansion of the current scope could include conducting a review of projects within various sectors of infrastructure development elucidating the lingering effects in the economy and society caused by implementation of BOT and BO strategies and these advanced innovative solutions on effective project management.

In light of infrastructure investments, by Egypt and Saudi Arabia it is crucial for policymakers and project leaders to craft legal structures, for BO projects blend the best aspects of different systems through hybrid models improve risk management tactics and nurture stronger local financial markets. By focusing on these aspects both nations can enhance the effectiveness and sustainability of their BOT and BO setups result in infrastructure development in the years to come.

This study adds to the expanding pool of information concerning infrastructure development approaches, in developing nations. Lays the groundwork for comparative research in the realm of public private collaborations. The findings obtained from this examination can guide decision making in policies and project planning not in Egypt and Saudi Arabia but in other nations aiming to utilize private sector involvement, in infrastructure development.

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