The Role of Public-Private Partnerships in Sustainable Smart City Management in Egypt

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Abstract

Egypt is the most densely populated country in the Middle East and has 44.4% of people under the age of 15 years. Egypt faces extensive challenges including the impact of rapid urban growth on social, economic, and environmental conditions.

The effects of overpopulation can be mitigated by utilizing smart solutions to improve customs, infrastructure, and services. A smart city is designed to work on six main parameters: smart economy, smart environment, smart people, smart mobility, smart living, and smart governance. A smart city provides its residents, businesses, and governmental authorities with technology and data to make better decisions and achieve a better quality of life. This is achieved by building a stable infrastructure of electricity, water, gas, telecommunications, transportation, and local resources.

This paper addresses the idea of smart cities by looking at the use of advanced technologies and internet services by government institutions and private individuals to address the challenges of

urbanization and their impact on the environment and natural resources. The paper highlights the role of public-private partnerships to finance and manage such projects, in developing renewable resources, and reducing the amount of electricity consumed in the projects as much as possible. In addition, it reviews and understands the challenges faced by Egypt in developing smart cities according to the lack of legislation on the feasibility of the projects and the financial constraints on government budgets. In conclusion, the paper proposes rapid solutions to increase the number of smart cities in Egypt through the use of private sector capital and monetary resources to finance and operate any project in a short period of time.

Keywords: Public-Private Partnerships, Smart City Development, Investment opportunities, Public Sector, Private Sector.

1. Introduction

Egypt's strategic location, situated between three continents, provides navigational advantages. Cities in Egypt are often established near water resources, such as the Nile River. Additionally, it is important to leverage the use of PPPs to attract new investments. Smart city initiatives in Egypt began with Cairo 2050, but these plans have had to adapt to political and socio-economic changes. People in Egypt are increasingly recognizing the potential of information technology in addressing

issues such as traffic congestion and the high cost of living, as well as creating new job opportunities. Egyptian authorities have proposed the use of PPPs as a solution to these challenges. According to El Kady, "Smart City PPPs" involve the private sector's involvement in the management of public sector infrastructure, including conceptualization, implementation, operation, and the delivery of value-added smart and sustainable services. Over the past twenty years, studies have been conducted on PPPs in various countries (Alsaid, 2021).

The role of public-private partnerships in smart city development in Egypt is significant. Egypt has faced economic challenges that have resulted in a deteriorating economy, making it difficult to allocate resources for infrastructure investments. To address this issue, Egyptian authorities have proposed the use of public-private partnerships (PPPs) as a solution. The aim of this paper is to assess and explain the role of PPPs in smart city development and their impact on current and future smart city projects and infrastructure in Egypt. The paper also aims to highlight the importance of using PPPs in smart city development in the Egyptian context (Selim & ElGohary, 2020).

1. Objectives

However, despite the guidelines that exist and might be considered in the framework of smart cities, it is challenging to shorten infrastructure services and frameworks. There is only a

technology-based or solution-based approach that does not include social, cultural, innovation, economic but public contribution by directly approaching the service provider (Gaievska et al.2023).

This paper will generally discuss how the global smart city program can lead to an Egyptian context and the part of community urban development through public participation. We will then address how the concept of the intelligent guide includes communities, private local areas, in particular by utilizing public-private partnerships (PPPS), with the World Bank's Zoning Development Program. This paper also provides an indirect measurement of the value of the social, economic, and cultural impact of those services that should not only be comprehensive but also effective and ubiquitous. Assuming actual services and emphasis on how they will be generated and how they will change cities and communities with the simple application of infrastructure and services. Data will be taken from the experience of Cairo University's urban lab experience working as the World Bank consultant (Bibri, 2021).

Smart cities are an inevitable solution to address different aspects of urban life at various levels. Throughout the developed world, smart cities are emerging to be common solutions to provide infrastructures and services. In the developing world, the process of providing pre-technology supportive and efficient infrastructure and services to a rapidly growing population in a

few cities or metropolitan development zones concludes that "smart city" solutions are needed. Despite this fact, smart city framework, guidance, and solutions are still being explained and allow some ambiguity (Hollands, 2020).

It is clear that today's smart cities contribute to social and economic development and offer sustainability, quality of life, participation of the local community, innovation, and productivity.

3. Overview of Smart City Development in Egypt

In March 2020, President Abdel Fattah Al Sisi announced the E-Parliament project. He said the New Administrative Capital would have a dedicated business model and would be integrated with modern technology to develop and manage sophisticated urban communities. Achieving wise cities is also the best approach to business improvement, as identified by economic regions and prime business advisors (Kandt & Batty, 2021).

Consequently, all infrastructure sectors can create more effective organizational capacities. Developing new infrastructure that combines smart and urban settlement infrastructure with quality service infrastructure and full public service of technology, while stimulating access for innovative innovators, data, and inventions, are the best human capital and seeking a perfect business (Halegoua, 2020).

Egypt has been applying efforts to achieve its vision of establishing a new smart city despite its considerable developmental issues. Infrastructure is a major challenge impacting Egypt's smart city objectives. The Smart Village, which was founded in 2000, was the first step taken by the Egyptian government to establish a smart city and attract foreign investments. The Smart Villages Development and Management Company (SVD-MC) implemented it and has been one of the most successful technology parks in the Middle East and North Africa (MENA) region. Today, it entails more than 880 companies combined (Jiang, 2020).

Since 2014, the Egyptian government has highlighted the significance of shifting towards smart city infrastructure. This includes establishing centralized management in the country's main areas, which its inhabitants can use in various aspects including but not limited to academic, educational, and research purposes. Unscheduled urbanization and infrastructure development make it difficult for governments to meet citizens' basic living requirements. Surely those issues can be effectively addressed by overcoming some public financial constraints. One potential solution is public-private partnerships (PPP), as influenced by smart cities (Yigitcanlar et al., 2021).

3.1. Current state of cities in Egypt

The concept of "smart city" has been one of the most argued and discussed areas since the introduction of technologies in city affairs. A large number of definitions and ideas about the application and criteria of smart cities in various fields formed the concept of smart cities. Some of these definitions emphasize the use of technology to improve city operations, while others address city functions' overall effectiveness, even without technology (Ramirez Lopez & Grijalba Castro, 2020).

In Egypt, smart cities first shone out in the mega-projects of The New Capital, the first urban city announced by the government that contains the latest ICT features, super infrastructures, and ground-size service facilities. However, the concept of a smart city is not yet widely acknowledged, and people do not consider ICT an essential tool for urban development (Hollands, 2020; Gomaa & Emam, 2023).

Egypt is one of the world's most rapidly urbanizing societies, facing unique challenges. Urban areas in 2021 accounted for 43.4% of the country's total population, yet only about 6% of Egypt's entire land area is inhabited. Since 1996, the average urbanization rate is rapidly increasing, reaching over 2% from 1996 to 2006 and over 2.5% from 2006 to 2017 (Mostafa et al., 2023).

This growth has been accompanied by the expansion of spatial disparity within and across cities. Consequently, the result

is increased vulnerability and extreme pressures on infrastructure, services, land, housing security, and social equity with increased demand for public services and resources. Cities with negligible municipal government support, as well as villages with large numbers of people who live in extreme poverty, are emerging in Egyptian streets, informal settlements, and urban villages (Suartika & Cuthbert, 2020).

3.2. Definition and characteristics of smart cities

SCs are the well-integrated communicative mechanism that gives cities the ability to improve their functioning and innovation; it is the strengthening that will also drive economic growth and the collective need to make them more efficient (Salama et al., 2023).

In turn, urban growth will increase both social and environmental resources with urban intelligence. With the economically competitive environment and growing communication between developing and developed cities, SCs can foster a sustainable impact for the future. Smart Cities are missing the necessary awareness and recognition. It is essential that we recognize the mutual benefits of cities that plan for smart growth and the nation that will see a leveled collaborative competitive advantage (Abdalla et al.2023).

SCs address the challenges of climate change, system complexity, population growth, environmental standards, and

technological innovation. SCs provide cohesive, intelligent, efficient SC services using a holistic combination of trusted ICT solutions and innovative tactics in communications among the city stakeholders. Cities use ICTs to capitalize on their human, economic, and natural well-being. They help smart cities tackle the battle on both climate change and support of urbanization as some of the most significant changes of the 21st century (Kumar et al.2020).

Smart Cities (SCs) enhance lifestyle, make life easier, and provide better service with an improved quality of life, and have a clean and sustainable environment by using digital solutions and intelligent and cognitive urban-based approaches. SCCs ensure the participation of all citizens and accountable and transparent leadership through open governance, holistic and human-centered approaches that will help empower awareness and co-creation by all stakeholders, including the private sector (Al et al.2021).

Communities in general are interested in providing their residents, visitors, and business community with the best possible environment. They further endeavor to meet the social, economic, and environmental concerns of the community in a sound and progressive way. Cities are also concerned with keeping pace with the rapid technological advances of a high-tech society. Cities are complex, having varied neighborhoods and business districts, large and small educational institutions and community organizations, entertainment and shopping areas (Ragheb et al., 2022).

3.3. Importance of smart city development in Egypt

General government investment, citizen participation, and creation of skilled and fit individuals are major enablers for the development of smart cities. Therefore, every country needs to develop a national smart city strategy that includes the roles and responsibilities of state, municipal, private investors, academic institutions, and citizens. As a result, smart city development addresses the limitations mentioned above by improving the quality and effectiveness of key support services and associated infrastructure and enabling local, state, and central governments to practice the principles of good governance. In addition to its ongoing upwards, the timetable will have an additional major local, economic, and environmental impact that will make operations, both public and private, efficient and efficient (Shamsuzzoha et al., 2021; Kim, 2022).

As part of the cabinet's 2030 sustainable development plan, the Egyptian government launched the Egyptian Vision Smart City initiative in 2018, aiming to create eight smart cities across the country. Mitigating climate change, introducing e-governance, and creating job opportunities outside major urban centers will achieve socially inclusive growth in the country (Ali, 2022; Abusaada et al., 2023).

Egypt is witnessing rapid urban development, leading to several problems that cities in Egypt are currently facing, such as

overcrowding, traffic congestion, infrastructure problems, and an increase in flood risks, among others. Urban expansion is largely limited to suburban areas and concentrated in specific regions, often considered the last resort by many people. In general, the informal built environment is more dominant in its character, making it increasingly difficult for the government to upgrade and renew areas for new urban development, which has made several hot spots of socio-informal urban neighborhoods. Support modernization makes the government, investors, and the private sector determine the integration of smart urban technologies and principles in the development process, known as smart city developmen (Faheem et al.2024; Elrefeie, 2023).

4. Public-Private Partnerships in Smart City Development

The effective implementation of private sector participation in smart cities remains, however, an attractive way to distribute competences. However, relying on the private sector in the smart city development in the present living lab is rather necessary. The advantages demonstrated by the involvement of the private sector are the following: creation of knowledge and experience needed by smart cities in the preparation and implementation of ICT-based solutions, creation of growth and wealth, support to entrepreneurs, favoring of investment in a sustainable urban development framework, involvement in partnerships of public and private entities in the promotion of cross-cutting ICT solutions to improve the quality of life of the

citizens, having the necessary business and financial training in the design and implementation of ICT-based solutions, achieving the transfer of urban management from public local authorities to smart cities, where profit sharing becomes the main reason for the promotion of ICT infrastructure development (Konbr and Maher2021; Tan & Taeihagh, 2020).

Public-private partnerships (PPPs) are known as the relations developed between the public and private sectors for producing products or services owned by the private sector or public sector in partnerships, where risks and responsibilities of the public and private sectors are shared. The smart city concept practically requires the collaboration of different stakeholders, such as governments at different territorial levels. Examples of publicly-owned smart projects range from technological services offered to support citizen needs to projects managed by municipalities or other public entities (Ghanem & Ghaley, 2024 ; Mohammed et al., 2023).

4.1. Definition and concept of public-private partnerships

The supplier chosen by the public organization may work solo or form a consortium with other private undertakings. Additionally, PPPs are not limited to national borders, implying that cooperation and investment can happen within one country or across borders. In practice, the increasing internationalization of PPPs is leading to a growing number of PPPs involving international development banks.

This is due to two main reasons: the enhanced involvement of governments in less developed or emerging nations in PPP contracts, and the need for further assistance in providing financial and technical resources and in planning and implementing projects (Gaievska et al.2023 ; Fouad et al., 2022).

While there is no universally accepted definition for the term public-private partnership (PPP), one of the most commonly accepted definitions for the concept of the "public-private partnership" is "a funding, operating, development, or investment agreement between a public and private sector entity governed by a complex contract." Such a definition suggests three criteria to be met: PPP is a contractual relationship; PPP is a cooperation between the public and private sectors; and PPP is also a form of investment. However, despite the mentioned preconditions, they are not always necessarily essential for a contractual relationship to be identified as a PPP. The simplest definition related to the concept, "cooperation between a public and a private actor," does not fully encompass the concept's scope and complexity. It therefore stresses the presence of at least three legally separate entities, one or more from the public sector and one or more from the private sector (Sarmento and Renneboog2021; Carbonara and Pellegrino, 2020).

4.2. Benefits and challenges of public-private partnerships

The overall risk of PPP projects may be very limited indeed, as risk can be adequately and equitably allocated to both

partners during the negotiation phase. Despite the PPP model offering numerous benefits, there is still a considerable gap in its application. However, before adopting a PPP model to upgrade and transform the infrastructure system, stakeholders need to be informed about the responsibility, participation, and consideration of costs and benefits associated with the model in order to find a viable solution that is both legitimate and efficient. Past research reveals several factors influencing successful PPPs, including risk sharing, financial stability, project time, collaboration, and the need for a solid legal framework. The implementation of the PPP model can improve service quality and customer satisfaction, while also promoting the long-term sustainability of public investment. As a result, cost reductions are accompanied by improved service quality levels (Cao & Wang, 2023; Van et al.2022; Mallat et al.2021).

A number of benefits could be anticipated from implementing the PPP model, including facilitating the provision of new infrastructure as well as upgrading and renewing existing infrastructure; reducing costs associated with project development, construction, and operation; providing more and better products with innovative designs and shorter service times; minimizing risk of time lapses; increasing competitive pressure on the need to improve services and implement modern management models; contributing to developing the private sector; improving the availability and flexibility of infrastructure;

increasing economic growth; contributing to improving the development and construction process; solving problems faced by the government in cases of limited resources; and enabling the transfer of technology from the private to the public domain, in which expertise can be transferred from global private enterprises to local private and public sectors and can be shared (Mohammed et al.2023 ; Gaievska et al.2023).

4.3. Examples of successful public-private partnerships in smart city development

The Energy Efficiency Collaborative (EEC) is an example of an initiative of the RTA in the United Arab Emirates (RTA). It is a collaboration between private energy organizations from a variety of verticals and public sector organizations that operate in the field of improving fuel and water efficiency (Leal-Arcas, 2024).

The company's main mission is to reduce fuel consumption by 30% by 2021 by offering energy-efficient initiatives that service a variety of vehicle brands. Another result of this collaboration is the Dubai Clean Energy Strategy 2050, which aims to generate 75% by 2050 through environmentally friendly fields such as technologies and smart cities. Roads and Transport Authorities utilized a PPP development mechanism, owned by RTA, which has shown that through conducive government regulations and attractive investment opportunities, PPP projects can help reduce costs, provide access to innovative solutions, and

explore strategies to enhance city quality and growth. Consider the private sector, Graffiti SO.FIN, and IoT solutions (Riadh, 2022; Elrahmani et al., 2021).

Poznan, Poland is one of the pioneering smart cities in the world. The city embarked on its journey to a smart city eight years ago by cooperating with IT companies in initiating pilots that gave the city much-needed information. The Poznan PCC's unique approach to reducing CO2 emissions and energy savings offers a good example for other cities. Interact smart grid with 270 substations, 150,000 IoT devices, and 15 PetaBytes of sensory data, interoperable ICT architecture, and open datasets inspired developers. The approach directly increased its mobility for citizens. The Poznan PCC initiative illustrates the importance of involving key public and private stakeholders in innovative services to reduce waste emissions and energy savings (Gromek-Broc2023 ; Pancewicz et al., 2023 ; Kinelski et al.2023).

5. Role of Government in Facilitating Public-Private Partnerships

The role of the government is to represent important factors through which it can reduce smart city project risk for the private sector. The government's role is dependent on its ability to address a number of governance installation factors. Often, these factors comprise the government's ability to broker different collision sectoral interests, embracing municipal bodies.

To accomplish sustainable habit integrating smart scaling and occasioning PPP in cities, it is a must for the local government of Egypt to cooperate with various coinage to explore indices for public-curiosity smart city subvening. Moreover, it is very important to involve a user-centered style in the course of smart city theme and implementation. The approach is not technical but rather aims at tackling mainstream inhabitants' chaperon and other stakeholders' impositions (Othman and Mahmoud2022 ; Gomaa & Emam, 2023).

The role of the government in facilitating the collaboration between the public and private sector in financing smart city projects is crucial. The government should make the decision to utilize, embrace, and embed public-private partnerships (PPP), as well as create an enabling environment. This setup should comprise two complementary aspects, namely - physical and legal. The physical aspect comprises sectoral growth programs, specifying the types of PPP, project screening, and preparation. Government physical assistance to potential PPP stakeholders is also required in project performance and monitoring, as well as for the procurement of project clearance (Lam & Yang, 2020 ; Liu et al.2021 ; Clement et al., 2022).

5.1. Government policies and regulations

The government perspectives, goals, visions, and strategies are represented in specific plans, justifications, promises and public

policies implemented and issued by the Government of Egypt, where it is dedicated to accelerating the strategy of establishing smart cities. It also offers an integrated ecosystem between the interrelated objectives of integrated infrastructure, smart government, economy, environment, society, and life for smart cities. This will lead to reshaping an innovative direction in accelerating the licensed quadruple commercial elements. And a new generation of job opportunities is necessary to achieve comprehensive prosperity in the economy. This approach is generally characterized by the leverage of innovative ICT solutions to improve the quality of life for inhabitants by enhancing the quality and efficiency of urban services, positioning cities as sources of economic growth, and as a major contributor to the national economy. Formerly, most countries and cities, including Egypt, and their governments considered sustainability as an afterthought in city development goals (Badran, 2023 ; Embarak, 2022; Torkey & Abdelgawad, 2022).

Contribution to achieving prosperity. It aligns with the United Nations Sustainable Development Goals (SDG) in general and SDG11 "Sustainable city communities" in particular through maximizing the use of ICT to achieve prosperity, through sustainable and inclusive socio-economic development and to simplify the infrastructure and environment for cities as well as the residential environment. in the rural as an essential component of socio-economic development. Besides, the objectives of vision

cannot be achieved without leveraging the accelerants of innovative technology. Technologies converge with integral urban planning, supported by global best practices and high equity enabling a supportive ecosystem, thus contributing to achieving prosperity (Abed et al.2024 ; Nasr et al., 2023).

Egypt embarked on three smart city project implementations. Cairo, as the capital and portal of Egypt, represents the "Gate of the East" project, which is part of the Documentation Project taking place at the Ministry of Communications and Information Technology of Egypt. This project is currently piggybacking to implement another project in Alexandria, in addition to the partnership projects to be implemented in the New Administrative Capital of Egypt. The implementation of the vision projects years is from 2019 to 2030. The intention of the project is to improve and modernize services to be the core of management using technological technology. The new and green technology solutions also transport services, communications, healthcare, infrastructure, bridges, roads, management, smart management, and transportation in major cities. In addition to opening and accessing the initiative (Ali, 2022 ; Alsaid, 2021).

5.2. Financial incentives and support

The new capital is distributed on 25,000 acres, which is sufficient for infrastructure. This is followed by the establishment

of the government's presence in the new capital and attracting the private sector by providing investment opportunities in the implementation of various projects (Ahmed et al.2024 ; Abdelkader, 2023).

Also, the income tax is exempted 100% for earnings generated by economic activities in the new administrative capital. Part of this concession comes within the framework of a mechanism to assist and encourage the private sector to participate and engage in the implementation of the new projects, through the investment of surplus funds. These funds are aimed at developing the required infrastructure for the capital along with the various services. The land will also be provided at a low price and available with a variety of pricing mechanisms that make them easy to market and attractive to all investors (Fuest et al., 2022; Avi-Yonah, 2023).

The authorities responsible for smart cities in Egypt have given great attention to the financial incentive packages and technical support provided for investors within the smart city projects. There are many incentives, the most important of which are the exemption of land and tax payments. In order to encourage foreign and local investors to finance and contribute to the development of the project, the land prices will be exempted and the land will be handed over to the investor by a usufruct system (B.O.T), without any governmental fees and allocations compensations. This is done to encourage the private sector to

participate fully in the implementation of infrastructure projects and provision of services in cooperation with the government (Moustafa & Abdel-Hamid, 2023 ; Allam & Newman, 2023).

It is clear that the main disadvantage for the private sector in the field of smart cities is actually the large capital expenditure and the long payback period for projects and systems related to smart cities, as well as the high level of risk in infrastructure projects. So, the role of the PPP in financing smart city projects comes here as a partnership between the government and the private sector, making it an important part of attracting investments (Bjørner, 2021).

5.3. Collaboration and coordination with private sector

It will also be important to set goals and tasks that are achievable to achieve continuous financial support for smart city development, and to strengthen the role of the private sector and the market. It is important to use comparative evidence-based strategies and research to identify smart city best practices and encourage the private sector's willingness to participate. The government should prioritize the promotion of smart city development in Egypt by allowing greater public-private partnerships, simplifying the process of obtaining construction permits, ensuring that permitting approval procedures operate fairly and reasonably with a focus on smart city models, and by considering giving tax advantages. In order to ensure that

necessary infrastructures are installed in these smart metropolitan areas and to attract the private sector and further investment in the smart city, the government could accelerate legal provisions and acquire technical standards diffusion platforms, support further pilot tests and options to work around bottlenecks, and expand energy restructuring mandates and electric transportation mandates (Gomaa & Emam, 2023).

Collaboration and coordination with the private sector is an effective method to build smart cities. The government should mainly collaborate with the private sector in smart city development. The private sector can assist the government in infrastructure development, provide the government with resources, and propose smart city models which companies are able to successfully achieve because companies are familiar with market demand, have extensive experience, and are professionals in both technology and commerce (Ali, 2022 ; Gomaa & Emam, 2023).

The level of collaboration and cooperation between the government and the private sector will ensure the success of the smart city model. In addition, it will help to encourage private investment in the development of the smart city. For example, the concept of cooperation between both sides in the form of Public-Private Partnerships is encouraged. Coordination between the two parties involves the establishment of contracts for private investment in the development of infrastructure; thus, the private sector's strengths in technological innovation and

commercialization activities are utilized. Promoting smart city development can only be achieved through cooperation and coordination with all partners, especially stakeholders, business owners, visionaries, research institutes, technology actors, policymakers, and the Egyptian Government (Gomaa & Emam, 2023; Magdy et al.2021).

6. Role of Private Sector in Smart City Development

The Smart City PPP evaluation emphasizes that private companies are responsible to invest in the new city, and to operate and maintain it for 25-30 years, as the modus operandi is a profit sharing scheme with a partner that should also provide contractor expertise, such as consultants and project managers. However, as previously mentioned, the Master Plan/Project which is developed by the private sector is subleased from the General Authority for Investment (GAI) with all the facilities, including funds and incentives but all the legal procedures and requests are exclusively carried out by the developer or the coordinator. This means that only planned actions are carried out when needed; public actions are carried out using the required data and evidence for increasingly efficient public services. In addition, to meet environmental, economic, and social criteria, sustainable development would help to provide sustainable solutions for future generational needs on many levels. This can be called the first stage of the development after the executive regulations are established by the public sector, which also

creates a single window for services and a housing unit database. The establishment of the Urban Projects Management Units (UPMU) also monitors and controls the cities (Rustiadi et al.2021 ; Calheiros et al.2022, Jiang and Waley, 2020).

The current role of the private sector in the Smart City projects is based on the simple definition approach of "Smart Cities"; where the private sector is considered a utility partner that commercially supplies goods or services such as telecommunication, broadcasting, electricity, cables, communications networks, internet, and transportation. The process starts with a governmental authority that decides to develop a new area or city. Then, it allows the private sector to undertake it as a public-private partnership (PPP) or using Built-Operate-Transfer (BOT) mechanisms. The private sector, by its own initiative, might decide to develop a city to host a hub project like Smart City Project in Egypt or the Middle East or Africa. The remaining population of Egypt can continue to live in uninhabitable areas that are commercially unfeasible for companies that present a profit/revenue sharing basis like the Smart City companies. This leads to an unsustainable unplanned urban expansion (Alsaid, 2021 ; Ali, 2022).

In Egypt, cities are known to grow without planning and are controlled by the public sector. This leads to unrealistic demands at a rate faster than the development of the structured growth of the urban environment, which can be controlled by the

public sector in cooperation with the private sector. PPP will support the needed fund and the skills transfer mechanisms that are called for by the Smart City concept to be fulfilled (Abdel Wahed Ahmed & Abd El Monem, 2020 ; Toan, 2023).

6.1. Investment opportunities and potential returns

At a higher level, multiple competences form potential ecosystems necessary for smart city policies. Public-private partnerships and public procurement play a role in developing innovative solutions. Partnerships and pilot initiatives have positive effects, but cities need to increase their abilities in promoting smart solutions and attracting private investments. High costs and complexity are barriers to building and maintaining innovative smart cities (Kumi et al., 2020).

Investment in urban areas within smart cities has the potential to create wealth. Private sector providers of goods and services have a financial interest in the livability of a city. Addressing an investment perspective on what makes a city smart is critical in this context of PPPs in the development of smart cities. Argens plans that the demand for goods and services as well as technologies emerging from smart cities, push the investment opportunities for the private sector. The edges of a city become part of the living room of a city's inhabitants, improving the city's image and attracting investments. The need for coordination among different groups of investors is

therefore another aspect of the complex nature of smart city investment (Kamel, 2021).

6.2. Innovations and technological advancements

Enterprises in Egypt perceive the State as being slow filler in respect of even so-called basic utilities with the result that even in these times when the technology of communication is available to all and can be potentially relatively inexpensive, many businesses cater for their own basic utilities. They generate their own electricity to drive some essential machinery on which they cannot afford a lapse in processes. Considering the time and concentration involved in unit cost computations, SMEs are likely to consider previously serviced but increasingly empty and dilapidated industrial parks. It has been argued time and again that the private sector is best placed to plan, design, develop, and deliver all manner of services with perhaps the exception of military and security. In defense of the public sector, one would argue that public intervention via the public sector could and should be harnessed in support of innovation (El-Haddad, 2020).

The role of information-based, knowledge economic opportunities in spurring success - globally and nationally - is fundamental. Internationally, innovation and technological advancements have an undeniable public good dimension in respect of countries which find themselves at advanced levels of intellectual development and economic competitiveness. Yet, one

also hears of their presumed private-sector-led capacity. Other countries possibly bet on large volumes of human input, generally referred to as collective knowledge or collectively obtained knowledge - with a public good dimension. In any event, the recognition of a significant public good dimension of knowledge and innovation and the concomitant acceptance of the need for public intervention in markets aimed at procuring the national interest, growth, and development cannot be overstated (Coman & Cojanu, 2023).

6.3. Collaboration with government and other stakeholders

The difficulties of developing a Smart City require the government to practice collaboration with others. Collaboration is part of a broad spectrum of relationships that range from a traditional transactional approach to one of closer cooperation. Common to all these relationships is the need to communicate openly and honestly, as well as defining roles and responsibilities. Instead of having a few collaboratives working simultaneously, one for each urban service, the parties need to consider collaboration at an aggregate level in a single comprehensive Smart City agreement between city stakeholders and their partners. This study investigates factors enabling the partnership and collaboration among various stakeholders to lead to effective mandating and implementations of a duly comprehensive Smart City in Egypt (Ali, 2022).

Since 2010, Egypt's 2030 Vision has been to be one of the world's most competitive nations. Development of the Smart City is one of the initiatives under the 2030 Vision. The government has its plans to turn Egypt into a Smart City, covering all types of smart solutions spread over multiple sectors. Moreover, promoting the Smart City initiative by engaging private investors is one of the implications of implementing the "participatory" concept in 2030 Vision. Both the government and private investors need to collaborate with each other in order to facilitate the initiative. This chapter shall, therefore, look at the development of Smart City solutions in Egypt in detail. Although the concept of the Smart City may seem promising and potentially revolutionary, it involves many challenges and difficulties (Alsaid, 2021; Selim & ElGohary, 2020).

7. Case Studies of Public-Private Partnerships in Smart City Development in Egypt

Challenges of PPP and smart cities are extensively included, paying special attention to the ICT-related PPP projects that are designed to facilitate the implementation of smart cities, as well as detecting the main factors that impact the success of such particular PPP projects in Egypt. This includes identifying the influence of these PPP key factors along with their consequences on the success dimensions that are required for them. Finally, a model is introduced for managing PPP in ICT aimed at establishing and supporting cities to be up to smart-city

level. Based on the elements that were detected and led to a success of PPP in smart cities, technological transformations which resulted from the introduction of e-government services can be further detected, while the use of ubiquitous and secure available technologies becomes a must that can facilitate economic growth, diminish the governmental limitations on competent service conduct, simplify dialogue between stakeholders, boost the city direction towards empowerment, increase local participation, possibility of cost reduction of the service offered, as well as effectiveness, quality, and safety (Helmy et al.2020 ; Othman & Khallaf, 2023).

The Egyptian market has recently emerged as an attractive destination for Egyptian/Dutch businesses. This was previously demonstrated through the increased number of the twinning agreements that were signed in order to enhance cooperation between different Egyptian and Dutch cities in various sectors, such as technology, security, environment, health, waste and sewage water treatment, renewable energy, and reporting the financial market needs. In addressing these issues, Egypt introduced a smart city project in accordance with national aims. As the Egyptian government sought ways to improve public services, spark economic growth, and connect citizens to ICT, the project was launched. However, it is important to mention that the concept was introduced in Egypt without focusing on its

relationship with PPP, which will definitely constitute a main success factor (Eissa and El-Nahas, 2021).

7.1. Case study 1: [Cairo Metro Line Automatic Fare Collection System

Authorities stated that the Cairo Metro would serve more than 300 million passengers per year, prompting thorough research on the new line by the ATM before the appropriate line's specification. Cairo's journey turned out to be a sophisticated one, with the initial study phase suggesting the decision to improve public transport in the form of a new metro network. The latest strategy has been implemented under the Egyptian government's wide-ranging drives to open up the opportunities available to all Egyptians, which may allow them to take the next stage to rise along upon inclusivity/co-responsibility within the role of the African NCP, the consistent implementation of the African NIS global projects, and the clean transportation strategy. The Sharm El-Sheikh proposal is only a small number of green drivers to influence passenger destinations.

This project concerns the metro line implementing the center line of the fourth phase of the metro. This phase started from the Ataba station in Cairo to Assiut City. This metro is about 1759 km in which Cairo Metro company has started the construction of the sixth largest metro network in the world spanning 78 km across Cairo. For the completion of the fourth stage of the Cairo Metro

Line, the ATM, which is managed by the public sector, selected a bid from a consortium including Arab Organization for Industrialization (AOI), China National Machinery & Equipment Import & Export Corporation (CMC), and Shanghai Fuxing Group, where 48 Chinese security became assured national banks and Chinese companies whose particular names were not singled through a letter of comfort from the Cabinet OBOR Egypt Operation LLC, also established the EGP 13.741 MN A2C for the implementation of the Cairo Light Rail. The Cairo Metro is one of the fastest-growing underground systems in the world. In 1987 the operational section was extended to be about 19 km long due to the addition of 11 new stations. The carriage-km would be increased to be 32 km/h. (Owais et al.2021).

7.2. Case study 2: [New Capital]

The Egyptian government needs to consider utilizing technology to assist in the various stages of planning the National Network of Science. With globalization and increased production activities, there has been a rise in tourist influx towards the greater East. It is crucial to ensure that the initiative is executed efficiently. The government must leverage all available resources to tackle any challenges that could potentially hinder the project. Future research should focus on specific areas of investment in Egypt's smart city project (Ahmed et al., 2022 ; Sharaf et al., 2022).

Thus, the collection of data includes qualitative and quantitative research methods. The foreign investment of the project was the lowest, as the foreign companies relied on their funding. At that time, the economy of Egypt has become affluent and direct investment activities have generally increased, complemented by the development and rehabilitation processes of the infrastructure.

The New Administrative Capital of Egypt serves as the central hub for the national government's administration. In contrast, the religious government of al-Mahalla al-Kubra city is considered the secondary administrative capital of Gharbiya city, aiming to transform the existing city into a technologically advanced smart city. This involves a pilot project that focuses on enhancing city services and adopting clean energy solutions. The research methodology includes collecting data from various sources such as field visits, official documents related to the smart city project, and reports on strategies, development plans, as well as the optimal specifications and requirements for smart cities (Alsheyab, 2022).

7.3. Case study 3: [Nile University Campus]

A new smart city campus (the Nile University campus) has recently been introduced at a public university. Every aspect of the campus was meticulously planned to be energy efficient, with a special interest in aesthetics in order to create a comfortable,

vibrant, and aesthetically pleasing working environment for the students and employees. The campus is thus characterized by its efficiency in terms of energy and cost, while at the same time being innovative, flexible, and sustainable.

The project features a number of educational buildings, a museum, a planetarium, a laser research institute, a student activity center, and a knowledge park. The buildings are designed to achieve a 25% reduction in energy consumption compared to LEED energy modeling. Given the buildings' systems such as air handling units, air terminals, and their controls, when recording power consumption, some zones reuse the energy of offsets where the waste water line falls. The waste heat recovery system includes non-tempered makeup air-dried air for primary heating and cooling, while tenant iced water is distributed from the heat pump unit for primary heating and cooling at PCU loads during mid-season periods.

The integrated design process took into account the effects of on-site and off-site items on Egypt's future embassies, adjacent related sites, and off-site environmental attributes. All buildings sit in the middle of the axis with views of the telemark river and the pyramids, while maintaining a comfortable vertical sun penetration and limiting the degree of disruptions on the University City academic campus and consultants using the AutoDesk Revit integrated design and charitable asset model technology. The energy analysis results showed the impact of the on-site campus on

the overall energy performance of a high patch that provided more than 5X the amount of air/fossil consumption. Proper efficiency and energy allowance for buildings, structured performance planning as part of the energy calculations, careful designs of internal and external reflected and transmitted views, analysis of sunlight beams, focus on the energy performance of buildings, given the emphasis on the top floor of the urban lighting scheme signaled the well-lit and spacious interior. Located in the breeze during the fall, and comfort plays a vital role in providing a comfortable environment for students and employees. The landscape and pavement design also play a decisive role in controlling the micro-climate (Hafez et al.2023).

8. Best Practices and Lessons Learned

Conversely, there have been numerous failures in smart city initiatives. Some of the initiatives failed because of the lack of planning and others because of the lack of thinking of the consequences of risk management plans. These cities were unable to deliver the expected services to the community. At the end of the day, smart city services did not contribute to improving residents' quality of life. This was followed up by creating more vertical data silos among different city services that created an absolute confusion in citizens' minds. Privacy and security issues surfaced as the main risks resulting from multiple data sharing, in addition to creating inequality between residents who had accessibility to the service and those who didn't. Reduction in transparency has been

witnessed in some cities. These cities adapted the seductive technologies that involve unnecessary complexity, cost, and bureaucratic control. Some city officials used these technologies to attract global attention and investments, aiming at masking up their incompetence and annealing the interest of specific political or economic groups (Qabbal et al., 2022).

Smart cities are a new trend in urban development with the ultimate goal of improving the quality of life for their citizens. This is achieved through sustainable urban development and a higher level of infrastructure quality. Moreover, a smart city is an interconnected city. The concept of a "smart city" extends to a broader range of functionalities and applications that rely on the city's connectivity to improve the quality of services provided to its citizens. Strategic smart city initiatives aim at achieving digital inclusion because technology enables deep transformation of services, processes, business models, and institutions. Several best practice cities have been recognized for the success of their smart city initiatives. These cities embraced the digital era and transformed traditional ways into technologically advanced means that created innovative solutions to urban problems. Moreover, smart cities follow a set of rules based on protecting the public interest first because a smart city is for everyone, not only for the few that can afford the service (Zhu et al., 2024).

8.1. Key success factors in public-private partnerships

A general project success factor refers to every factor that contributes directly and/or indirectly to project success. However, as discussed further above, general project success factors vary significantly among different projects because of differences in project goals, contexts, orientations, or nature. A particular project-specific key success factor refers to a success factor that is relevant and important for the success of a specific category or group of projects, possible existing interactions, and presence of potential barriers. Some examples of such categories include water and wastewater infrastructure projects (Bailey et al.2020).

The aim of this study is to investigate the role of public-private partnerships in smart city development in Egypt. The methodology is qualitative and exploratory in nature. The study is based on document analysis of secondary data sources and ten semi-structured interviews. The study reveals the importance of the role of the private sector in smart city development in Egypt and then presents public-private partnership opportunities in this field. Public-private partnership models, in general, and project-specific key success factors, deriving from existing literature, in particular, are discussed. In the absence of previous research on public-private partnerships in smart city development in Egypt, the study discusses public-private partnership opportunities and outlines various types of public-private partnership models and project-specific key success factors based on mediated general project-related success factors.

Follow-up case study-based research is planned to develop a decision-making tool that would enable municipalities in Egypt to select the most relevant public-private partnership model and to operate such a framework (Yu et al.2021).

8.2. Challenges and solutions in implementing public-private partnerships

From the very nature of the public-private partnership, there are many professionals engaged in its implementation. First, construction community involvement can deliver PPP effectiveness in developing countries. Because of that, many European countries have proposed such projects based on their specific status in the partnership practices. Furthermore, independent regulators, from the corporate governance point of view, have an important impact on the companies engaged in the partnership in many countries. To confer an effective form of corporate governance to the PPP, private and social (national, provincial, and municipal) interests of the countries have joined their forces, which lead them to reconcile conflicts of interests of all the stakeholders at various stages of the PPP life. This mechanism represents a specific regulatory environment of the PPP market in the EU, USA, and China. In the mix of the regulatory environment of the countries to enhance the role of PPP in modern market economies, specific legal and regulatory conditions concern key PPP constituents and the main PPP conflicts (Alsheyab, 2022).

After discussing the challenges of implementing PPPs, the following refers to many solutions in dealing with these problems. These solutions are drawn from different approaches and experiences of several countries, in addition to Egypt. However, Egypt's experiences carry the main part of this area. These suggest that a number of approaches are already ongoing, and others are suitable for Egyptian practices. The role of local governments, in general, and PPPs is commencing to be more vital in Egypt, and the overall integration of PPP projects with urban development plans and objectives represents the heart of public policy and governance. Decentralization is becoming recognized as a powerful tool for sustaining PPP implementation. A useful model was proposed concerning a scheme with a self-propelling mechanism, inferring that state-owned companies take the initiative in delivering partnership projects. Also, a new structural framework has been revealed by the scenario approach to handle the triple challenges. Accordingly, cross-national evidence refrains Egypt from public spending controls. There is much room for raising public investment efficiency by improving the strategic decision of PPP achievements (AlMallahi et al.2022).

8.3. Lessons learned from previous projects

The development of the Cairo metro line as a PPP in 1989 did not include the full transfer of risks to the private sector. Not only was the government unable to transfer the risk of variations adopted by the government itself, but it also funded 70% of the

concessions revenue through advertising revenues and fuel taxes. The government also had to support the project with a subsidy for energy to keep the tariff level fixed. The government put off its second experience for a long time until the fast track revealed that the risk of this project affected the operating companies. A rule was adopted by the World Bank PPP Unit to present that the proposed PPP projects would be a supplement to the traditional theory of government procurement guidelines adopted by the OECD, which emphasizes that the government bears the economic risks. The guidelines have the tradition of using PPP agreements to encourage the private sector to adopt rigorous risk management (Mohammed et al., 2023).

There are reasonable explanations for the limited use of PPP in Egypt and the obstacles that limit effective implementation. It was decided to show the characteristics of the selected company, which is in line with Hamilton's definition of PPP as a reason to limit the use of private-public partnerships as a financial subsidiary. These semantic dislocations of the concept not only reflect the expediency and piecemeal manner in which public authorities use such instruments, but also reduce the overall effectiveness of this regulatory technique. Early, before starting Egypt's PPP projects, descriptions of the feasibility phases of public institutions. This required clear help from the government (Helmy et al.2020).

9. Future Prospects and Recommendations

Established PPP frameworks, which could result in accountability and transparency, risk allocation, and fostering innovation, could increase the role of PPPs effectively. The model is yet to be specific for smart city and smart sustainable development. However, the findings could help understand the elements such as reducing technical obstacles in project implementation, knowledge exchange, involvement in financial stability, shared roles and responsibilities in maintenance, guidance from professional areas like technology and information governance and data management, creative technology-independent reuse, access to expertise in technology, governance as well as monitoring and evaluation in Egypt's smart sustainable development. To realize the GPN role, evolving project management competencies as part of smart sustainable development projects could monitor the role of partnership and PPPs. Prediction and future development in a smart and sustainable way and establishing a well-articulated risk management policy, along with an appropriate PPP model for the Egyptian authorities as future prospects, could also enhance the shared value and success of people-centered smart sustainable development initiatives. Synchronization of Egypt's strategic and long-term development vision with shorter-term opportunities for future PPP structuring and climate-informed city line management programs in Egypt could bring funding solutions

along with PPP-based tools that could lead to a green resilient city transformation in the future.

It can be concluded that smart sustainable city development, Egypt's development strategies, and the roadmap of Egypt 2030 and Egypt 2050 would lead to smart sustainable communities, which will enhance the quality of life and opportunities for development, ultimately leading to Egypt's overall development. Like any other developing country, funding has been an ongoing issue for Egypt. Public-private partnerships not only act as an instrument for funding but can also reduce operational and project management risks as authorities take on the services of private sector expertise in managing, planning, and offering the right solutions to the complexity of the problem (Wei et al., 2022).

9.1. Potential areas for future smart city projects in Egypt

A smart city is a city that uses ICTs to solve urban problems and improve living standards. The developing regions can also benefit from these technologies. At the same time, they must answer the specific context and problem-solving needs of the cities as well as the local and national development strategies. Most of the smart city research in the Arab world focuses either on the global overview of the reality or on the analysis of certain initiatives in the cities. The former usually focuses on the concept of smart cities, such as the forecasts, dimensions, and processes of the development of smart cities, and how to better achieve them, and is of a mixed

nature and interest of the customers and partners. Some smart city initiatives have also been examined and performed in the cities. These studies examined the different components of smart cities. Most of these components are common characteristics or indicators of intelligent cities, and they are linked to a great extent to the smart city concepts that are currently important and established worldwide. Turning cities into smart cities is one of the main purposes, and rightly so, the research on cities or urban systems in general (Madessa et al.2024).

The initiatives and collaborations between the government and the private sector in Egypt, particularly in the ICT sector, are many. The smart city projects in Egypt could contain not just the construction of new cities or recent financial investment in real estate, but also ICT innovation, both in hardware and in software, ideas and high-tech solutions for city development services and sustainability. The experience of developed countries with regard to smart cities can be very useful for developing countries, including the components of smart city construction and viable infrastructure. Almost all smart city frameworks, concepts, policies, models, and indicators have been approached and have been written from the perspective of developed countries or are a result of the experience of built smart cities there. Only a few deal with the concept of developing a city. Of course, the development conditions and lifestyles in developing countries are different from Europe or the US, for example. Despite the needs and cultural differences, not

much work has covered the experience and the significance of smart cities in the context of the developing countries' new smart city construction (Ozarisoy & Altan, 2021).

10. Conclusion

This paper aimed to investigate the role of PPPs in smart city development in Egypt in order to meet the research objectives. The first objective was to identify the effective roles of the public and private sectors in ICT city development. Then the promising model of PPP, which enhances the role of both sectors, was described. The effect of applying PPPs on the successful implementation of smart cities and how it is successful in city development was discussed related to the different sectors. In addition to this, the chapter shed light on identified PPP projects in Egypt. Finally, by analyzing international best practices of PPPs, reflections for smart city development in the Egyptian context are determined and some challenges were recognized and how should rethink the approach and involve projects holistically.

Throughout the paper, the focus was placed on best practices and results of applying PPPs in the real-life context, particularly in the development of the smart city concept specifically in Egypt. This was with a focus on identifying the effective roles played by PPPs. Key lessons were learned, and recommendations and reflections were drawn. The stakeholders

who have an active role in achieving digital transformation were identified, roles of both the public and private sectors were discussed, and PPPs were deeply investigated using the knowledge gained from primary research. Besides, problems and challenges were recognized, best practices were reviewed, and PPPs were evaluated. Also, how different sectors were involved in PPPs and an effective implementation of PPP, how to make PPPs successful in city development, were described.

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