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# Public–private partnerships (PPPs) in smart infrastructure projects: the role of stakeholders

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## ABSTRACT


The relationship between urban sustainability of new smart cities and infrastructure projects has become integrated, and reflects the country's progress and prosperity, smart infrastructure projects classified in two main categories, the first is upgrading or retrofitting the built-up infrastructure and provide it with smart solutions, the second is establishing a new infrastructure for new urban sprawl or replace the built-up infrastructure with new one to cope with the global population increase. The concept of smart infrastructure is derived from the idea of the smart city which is described as a comprehensive system with different elements such as stakeholders, environment, economy, mobility, and living conditions of a given geographical space with efficient information communication technology (ICTs). Therefore, Stakeholders is one of the main success factors of Public–Private Partnerships (PPPs) in smart infrastructure projects, Hence, studying and analyzing stakeholders role in smart infrastructure projects through PPPs concept will decrease opposition leading to a non or ineffective implementation of the project as a result of the gap between the expectations of different stakeholders involved in PPPs on the desired process or outcome of the project. The presented study aims to establish a successful PPPs for smart infrastructure project phases with presenting a clear image of stakeholder's roles, and highlights PPPs challenges, characteristics, state's models, and agreements methods, especially with the high cost of these projects, to reach a set of recommendations aid to improve efficiency, quality, and affordable costs to achieve a sustainability whether in retrofitting or in the new urban sprawl.

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**KEYWORDS** Stakeholders; public-private partnerships (PPPs); smart infrastructure projects; (PPPs) project's life cycle phases; smart cities; sustainable development

## Introduction

The recommendations of the 2015 United Nations (UN) Summit entitled (Transforming Our World: Sustainable Development Plan 2030), which had 17 main goals, with focuses on the following two goals: A- Goal 9: Building resilient infrastructure, promoting inclusive and sustainable industrialization

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and encouraging innovation, B- Goal 17: To strengthen the means of implementation and revitalize the global partnership for sustainable development, through this vision, the two goals can be combined to search for how to establish and retrofit the infrastructure projects with the system of public-private partnerships.

'Smart infrastructure is linked to resources and assets that manage risks and weaknesses in order to create flexible and smart cities that provide good governance tools through smart conditions.' [1]. Therefore, Smart PPPs should not be regarded as a strict type of partnership, but rather as flexible institutional arrangements between the public and private entities based on the introduction of technological innovations in the provision of services PPPs.

Thus, the importance of identification of stakeholder's role as to their power, legitimacy, and urgency, and also as a reflection of their knowledge, experience, and culture is a very important topic to ensure the success of these types of projects.

### **Research objectives and methodology:**

The study presents the research objective as a main objective and the research methodology as follows:

#### ***Research objectives:***

The main objective of this research is identifying a role to internal and external stakeholders to establish a successful PPPs for smart infrastructure project phases by: 1- Identifying the smart infrastructure layers and components. 2- Determine the main challenges that face the smart infrastructure projects. 3- Explaining the PPPs characteristics and models as a suggested method for funding the smart infrastructure projects. 4- Studying the PPPs lifecycle phases with determination of its main tasks. 5- Describe the PPPs contracts agreement types.

#### ***Research methodology***

There are three methods used to achieve the research objectives: 1- Descriptive method: There will be an introduction to explaining smart infrastructure projects components and challenges in accordance with being digital, intelligent and smart. 2- Analytical method: There will be an analysis of the PPPs concept, characteristics, models, lifecycle phases and contracts agreement patterns of smart infrastructure projects, 3- Conductive method: Applying the PPPs concepts to determine the stakeholder roles as to their power, legitimacy, and urgency for establish a successful PPPs in smart infrastructure projects lifecycle phases.

## Smart infrastructure projects

Infrastructure is the basis for smart sustainable city (SSC) development, which has a six conceptually distinct characteristics: 1- Smart economy. 2- Smart governance. 3- Smart environment. 4- Smart people. 5- Smart mobility. 6- Smart living [2]. Therefore, (SSC) is defined by the International Telecommunication Union (ITU) as an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects [3]. Smart infrastructure can be divided into two actual parts which are ‘the physical smart infrastructure’ and ‘the digital smart infrastructure’ [4].

- (A) Physical Smart Infrastructure: it’s components can be described according to the following [Table 1](#).
- (B) Digital Smart Infrastructure: A smart city makes optimal use of all the interconnected information to better understand and control its operations and optimize the use of limited resources. ICTs or Information and communication technologies play a vital role in improving the physical smart infrastructure, as they provide a digital platform from which to create an information and knowledge network. If the information is provided in real-time and accurately, cities are likely to take action before the problem begins to escalate. Thus, a Smart City can be described as a ‘predictive city’. One way to look at the smart infrastructure is in the form of various digital supporting layers. Its layers can be described according to the following [Table 2](#).

**Table 1.** Physical smart infrastructure components, Author based on [4].

The Physical Smart Infrastructure Components	
1 <b>Smart Buildings</b>	The smart building integrates the various physical systems in a building in a smart way to ensure all the different systems in a building work together efficiency.
2 <b>Smart Mobility &amp; Transport</b>	Smart Mobility and transport is an approach that reduces congestion and promotes faster, green, cheaper transportation options, aims to improve the trips of these cities, save energy and reduce carbon emissions
3 <b>Smart Energy/ Smart Grid</b>	Smart energy/Smart Grid management systems are a potential solution to energy issues, using advanced sensors, smart meters, renewables resources, digital controls and analytical tools to automate, use, monitor, and improve energy distribution.
4 <b>Smart Water Management</b>	Smart digital technology system is used to help save water, reduce cost and increase transparency in water distribution.
5 <b>Smart Waste Management</b>	The smart system will enable to better monitor the movement of different types of waste and manage its flow from source to disposal.
6 <b>Smart Healthcare</b>	Providing health care by using smart and networked technologies that help monitor citizens’ health conditions with a broader view of holistic care, healthy living and wellness management.

## Challenges of smart infrastructure

When applying and implementing smart infrastructure technologies, governments are expected to face many challenges. The first challenge is to adapt smart city requirements to current regulations, the second challenge is financial constraint and project funding, the third challenge is multi-stakeholder perspectives, and the fourth challenge is generating smart governance that makes city applications more comprehensive. Through the thesis of research focusing on studying the second and third challenges in an integrated way, it may help achieve the sustainability and inclusiveness of smart cities to overcome these challenges.

## PPPs for funding smart infrastructure projects:

In today's economic climate, infrastructure developers have a challenge to achieve the required level of performance within a specific budget without risk. In addition to the complexity and high investment cost of Smart Infrastructure Projects [5]. PPP is one of the suggested and promising methods that can be used to face the funding challenges of smart infrastructure projects, and it is one of the sustainable development goals (SDGs) according to the (UN) goals. The PPPs established between a groups of stakeholders

**Table 2.** Digital smart infrastructure layers, Author based on [4].

The Digital Smart Infrastructure Layers	
1 <b>Urban layer</b>	This is where the integration between the physical infrastructures components and the digital infrastructures layers. For example, the integration between Smart Buildings with Smart Grid, Smart Waste and Smart Mobility.
2 <b>Sensor layer</b>	This layer is involved in smart devices that measure and monitor the comfort requirements and environment quality such as humidity, water, energy, air quality, temperature, solar flux, and occupancy and equipment condition.
3 <b>Data Analytics layer</b>	Data Analytics solutions are of three main methods: (1) Descriptive methods, which uses business intelligence and data extraction to ask: 'What happened?' (2) Predictive methods, using models and statistical forecasts to ask: 'What could happen?' and (3) Mandatory methods (includes Cognitive), which uses optimization and simulation to ask: 'What should we do?'
4 <b>Connectivity layer</b>	It is responsible for transferring data and information through the full range from low-bandwidth sensor networks all the way to broadband networks and everything in between.
5 <b>Automation layer</b>	It is an enabling digital interface that enables automation and scalability for a large number of devices to enable the city and its ecosystem partners to develop smart services and initiatives.
6 <b>Broadband Connectivity</b>	The application of smart city technologies often requires a robust, affordable broadband network to take advantage of smart applications.
7 <b>The Internet of Things</b>	Or (IOT) defined as connect all things and equipment in this world via the Internet and allow computers know many things about people.
8 <b>Big Data</b>	(IOT) with all sensors and connected devices will result in massive amounts of data 'Big Data' that enable cities to improve the maintenance ability and sustainability of the urban environment.

represented in the government (public sector) and companies (private sectors) where they agree to share funding, part of the risks, and expected gains in the infrastructure projects [6].

Infrastructure projects are considered an effective partnership between the state and the private sector in medium and long-term projects through the implementation of the BOT system with various applications.

The BOT concept: UNCITRAL defines the BOT system as, contractual arrangement between a public-sector agency and a private sector concerns whereby resources and risks are shared for the delivery of a public service or development of public infrastructure.

Several PPP models are illustrated in [Table 3](#).

### ***Advantages of PPPs and its Characteristics***

During the past 25 years, over 5,000 infrastructure projects in 121 low and middle-income economies have been delivered through PPPs, representing investment commitments of 1.5 USD trillion to develop infrastructure such as roads, railways, airports, power plants and power and water distribution networks [8]., PPP projects have the following common advantages and characteristics; 1- Cooperation between public and private sectors rise the efficiency of operation and maintenance. 2- The combination of public and private financing to addressing the lack of government funding. 3- Sharing of resources and tasks. 4- Distributing the risks allocated between the public and private sectors [9].

**Table 3.** PPP models, Author based on [7].

Model	Description of Model
BOT	Build, Operate and Transfer
BOT	Build, Own and Transfer
BOO	Build, Own and Operate
BOOT	Build, Own, Operate and Transfer
BLT	Build, Lease and Transfer
BRT	Build, Rent and Transfer
BT	Build and Transfer
BTO	Build, Transfer and Operate
BOR	Build, Operate and Renewal of concession
DBO	Design, Build, Operate
DBOM	Design, Build, Operate and Maintain
DBMF	Design, Build, Manage and Finance
DBFO/M	Design, Build, Finance and Operate/Maintain
MOT	Modernize, Own or Operate and Transfer
ROO	Rehabilitate, Own and Operate
ROT	Rehabilitate, Own and Transfer
O&M	Operate and Maintain

### ***Models of PPPs applications in smart infrastructure projects***

PPPs can be applied in infrastructure projects as:(reviewer# 2comment no:10)

1- Pan City Model: provide a smart solutions to the existing city by integrating design with IT. 2- City Retrofitting Model: Retrofitting the existing build up area and improving the existing infrastructure in a smart way to achieve the smart city objective. 3- City Redevelopment Model: replace the buildup infrastructure with new one considering the sustainable requirements. 4- City Extension Model: determine the potential urban extension trends of the city, therefore support the current infrastructure in these directions to accommodate this potential future extension, which will have a significant impact on reducing the total cost of potential urban extension phases, starting from the planning, implementation, and maintenance phase [10].

### ***Life cycle phases of PPPs infrastructure projects***

As PPP infrastructure projects include six main phases: 1- Identifying projects and screening as a PPPs phase, 2- Appraising and preparing the project contract phase, 3- Structuring and drafting tender and contract phase, 4- Tender and award phase, 5- Managing contract development and commissioning phase and Managing contract operating, 6- maintaining and handing back phase, as illustrated in the following Table 4.

The standard PPPs process phases involves an initial analysis of the project economics and (PPPs) screening in the first Phase, followed by detailed appraisal of the project both as a technical solution and as a PPP during the second Phase. This sequence is well suited to PPP programs as an alternative to public finance, thus allowing for the acceleration of infrastructure development. By screening the project for PPPs potential at an early stage, the government can avoid wasting money on appraisal if the project is not suitable to be a PPP.

### ***Contractual relations in partnership projects (PPP<sub>s</sub>)***

The project agreement is the basic contractual document of the partnership projects. The organizational framework deals with all the contracts of the project from the negotiation stage until transfer from the donor. Owing to the great complexity in the contractual relations in the partnership projects, it is necessary to identify the patterns of these contracts as in Table 5.

Despite the PPP projects are increasingly being used to provide public infrastructure, there somewhat being ineffective, because of the stakeholder opposition [13]. Stakeholder opposition stems mainly from the differing expectations of stakeholders involved in PPP projects regarding the project's intended outcome [14]. Therefore, addressing stakeholder concerns, and

**Table 4.** Main objectives and tasks within PPPs life cycle process and phases, Author based on [11].

	Phase	1- Identifying projects and screening as a PPP	2- Appraising and preparing the project contract	3- Structuring and drafting tender and contract
	<b>Objective</b>	Select the best technical solution for the need, and to pre-assess the suitability of the project.	Assess PPP project contract is feasible in order to the risk of project failure during tender or contract life of the project	Define and develop a PPP contract solution and tender process that best fits with the specific features of the project contract
	<b>Tasks</b>	1-Identify project. 2-Economic assessment. 3-Scoping PPPs project. 4-Screening project as a PPP and pre-assessing financially.	1-Refine project scope. 2-Test technical feasibility. 3-Assess environmental impact. 4-Assess PPP commercial feasibility and affordability. 5-Assess risks. 6-Define procurement paths.	1-Finalizing designs, technical requirements and output specifications. 2-Define final contract structure draft. 3-Confirm previous assessments. 4-Implementing contract management strategy Define qualification and evaluation criteria.
	<b>Phase</b>	<b>4- Tender and award</b>	<b>5- Managing contract development and commissioning</b>	<b>6- Maintaining contract operating, maintaining and handing back</b>
	<b>Objective</b>	Manage the process to select the best value proposal in a competitive and regulated environment, and execute the contract with the most suitable and reliable bidder.	Manage the contract to minimize the impact of risks during the Construction Phase associated with changes and claims. It is important to monitor compliance with construction requirements.	Manage the contract to minimize the impact of risks and threats during the Operations Phase associated with changes, and claims. It is true of monitoring the performance, and controlling the hand-back of the asset at the contract expiration date
PPPs project phases	<b>Tasks</b>	1-Qualify bidders. 2-Negotiate contract. 3-Evaluating and negotiate proposals. 4-Awarding contract. 5-Contract signature. 6-Closing finance.	1-Contract management. 2-Designs approvals. 3-Monitoring construction. 4-Managing changes Start operation.	1-Monitoring performance. 2-Managing claims. 3-Preparing to hand-back. 4-Hand-back.



**Table 5.** PPPs agreement contracts, Author based on [12].

Symbol.	Contract	Description of contract
Ct 1	<b>Financing contract</b>	The contract is signed by the project company with external sources, for instance, banks and international financial institutions to complete the remaining funding for the implementation of the project.
Ct 2	<b>Construction contract</b>	The contract is signed by the project company with the contractor who responsible for the construction process. This type of contract is characterized by a small period if compared to the duration of other contracts, where it ranges duration from one to five years.
Ct 3	<b>Operation and maintenance contract</b>	The contract is signed by the project company with one or more specialized operations and maintenance (O&M) companies responsible for the operation and maintenance of the project during the concession period.
Ct 4	<b>Supply contract</b>	The contract is signed by the project company in order to purchase the necessary energy and raw materials for the long-term operation and maintenance of the project.
Ct 5	<b>Service purchase contract</b>	The contract is signed by the project company with the contracting authority to purchase the service or between the project company and the users directly.
Ct 6	<b>Insurance contract</b>	The contract is signed between the project company and one of the institutions specialized in the commercial insurance markets, such as investment guarantee agencies. This contract is signed against the risks of the project in the construction and operation phase, as well as political, commercial and natural risks.
Ct 7	<b>Consultancy contract</b>	Divided into two types, the first is signed between the state and the consultants who are specialized (technically, financially, legally) to monitor and follow up the various stages of project implementation. The second type is between the project company and consultants who have the same specialization and tasks of the first contract but for the project company.

identifying appropriate stakeholder claims for decision-making is critical to the success of public-private partnerships in the early preparation stage.

## Stakeholders role in smart infrastructure projects

The project stakeholders are defined as an individual or a multidisciplinary team involved in the project with an aspect of rights or ownership in the project, which provides recommendations throughout the project phases to improve the quality of the project at the lowest total cost and time required to complete the project [15], to achieve suitable returns, and allowing the public partner to achieve social and production goals that maintain environmental and health standards [16].

### *Classifications of stakeholders*

Stakeholders are identified according to the nature of the projects. In smart infrastructure projects, stakeholders can be classified as illustrated

in the following [Table 6](#) into two main categories, the first are ‘Internal Stakeholders’ who are formal members of the project and controlling resources and directly affected by a project. The second are ‘External Stakeholders’ who are informal members (do not have a direct affiliation with the projects) of the project and have no direct control over a resource, these stakeholders have an interest in the success of a business. However, they have the ability to influence the project positively or negatively.

**Stakeholders salience in the PPP project:**

Stakeholder salience is: The degree to which competing stakeholder claims are prioritized. The importance of stakeholders is divided into three features: ‘Power, Urgency, and Legitimacy’ [19].

1. The first feature, ‘Power (P)’, **it** has a three dimensions:
  - Coercive – based on the physical resources of force.
  - Utilitarian – based on material or financial resource.
  - Normative – based on symbolic resources, such as prestige and esteem.
2. The second feature, ‘Legitimacy (L)’, **it** can have its base at the individual, organizational or societal level and implies a desirable social good. Examples relevant to choosing stakeholders in research are:
  - An individual stakeholder who clearly works for the good of others.
  - A community group that has transparent governance and clear mechanisms for representing the community’s views.
  - A societal stakeholder such as a democratically elected government.
3. The last feature, ‘Urgency (U)’, is the ‘degree to which stakeholder claims call for immediate attention.’ By identifying stakeholders that look for understanding and acting on the problem is urgent [20].

**Table 6.** Stakeholders classifications, Author based on [17,18].

Stakeholders classifications			
Sym.	Internal stakeholder:	Sym.	External stakeholder:
In 1	Government (public sector)	<b>Ex 1</b>	Non Gov.-Environmental institutes
In 2	Lender & suppliers	<b>Ex 2</b>	Non Gov.-social institutes
In 3	Developer (private sector)	<b>Ex 3</b>	Non Gov.-political institutes
In 4	Contractor & ICT sectors	<b>Ex 4</b>	Citizens & Neighbors
In 5	Planners & Experts	<b>Ex 5</b>	Human rights organizations
In 6	legalistic & Policy makers	<b>Ex 6</b>	Academia and research institutes
In 7	Financial consultant	<b>Ex 7</b>	Media

## **Stakeholders role for establishing a successful PPP for smart infrastructure projects:**

According to the previous study, it's able to develop and determine an internal and external stakeholder's vital roles in clear way to identify and establish a successful PPP can apply to any smart infrastructure project during the PPP project lifecycle phases anywhere in the world, based on needs assessment according to the project city features, priorities based on the city's scope to develop an organized action plan, value proposals, requirements for the success of the project and Creation of the reference project.

The previous [Table 7](#), illustrates a matrix to assess and identify the stockholders' roles in Smart Infrastructure Projects (Physical-Digital) include internal and external stakeholder's salience (P, L, and U) according to tasks and objectives of PPPs life cycle phases illustrated in [Table 4](#), agreement's contracts form is described in [Table 5](#), and the stakeholders description according to rate zone to each stakeholders salient is illustrated in [Table 7](#), and Venn diagram illustrate stakeholders' map in [Figure 1](#).

Reviewer #1 (reviewer# 1comment no:3)

3. How do PPP Stakeholders perceive the project success?

### ***Stakeholders role in initiation phases (Identifying and appraising the project)***

The internal and external stakeholders prepare the economic, social and environmental feasibility study for the project by its consultants, as illustrated in [Table 8](#), these steps must be done as; determine the actual needs of the target group of the project, Study the available resources in project site to be used, determine how the project will effect and affect in the surrounding areas whether positive or negative, identify the expected risks of the project and study the mechanism to prevent or mitigate them, determine the acceptable quality level (AQL) for the project and expect the completion time for the construction.

### ***Stakeholders role in design and tender phases***

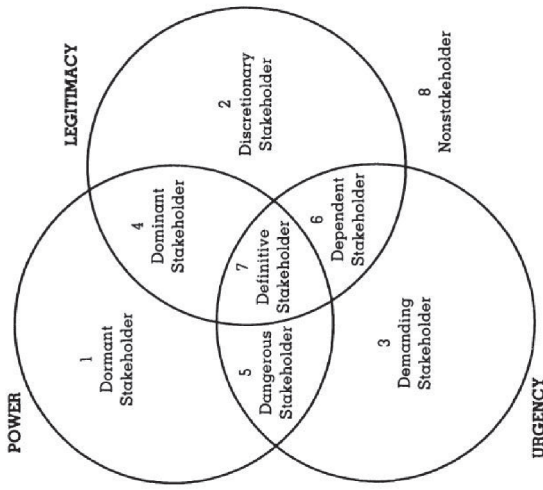
The state (public sector) or Private Sector prepare the project's design and specification according to PPP concession model as illustrated in [Table 9](#), these steps must be done as; explore effective alternative Innovation and intelligent solutions within, Science, Technology, and Innovation (STI) concept, prepare specifications for each design, link the specifications with the available resources in the suggested site and explore cost, time, quality for each design, determining the optimum design which achieving sustainable development objectives.

**Table 7.** Stakeholders salience matrix in PPPs life cycle phases according to phase’s tasks/ objectives and agreement contracts form, Author.

Smart Infrastructure Projects (Physical-Digital)																						
Pan city – City Retrofitting – City Redevelopment – City Extension																						
Agreement's Contracts							(PPPs) life cycle phases															
Ct 7	Ct 6	Ct 5	Ct 4	Ct 3	Ct 2	Ct 1	Internal Stakeholder			External Stakeholder												
Consultancy contract	Insurance contract	Service purchase contract	Supply contract	Operation and maintenance contract	Construction contract	Financing contract	Stakeholder's Salience (P,L,U)	In 1	In 2	In 3	In 4	In 5	In 6	In 7	Ex 1	Ex 2	Ex 3	Ex 4	Ex 5	Ex 6	Ex 7	
							Government (public sector)								Non Gov.-environmental institutes	Non Gov.-social institutes	Non Gov.-political institutes	Citizens & Neighbors	Human rights organizations	Academia and research institutes	Media	
S							Identifying projects and screening as a PPP	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								L	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								U	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								Z	7	2	6	8	7	2	7	5	7	6	2	2	5	2
						S	Appraising and preparing the project contract	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								L	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								U	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								Z	7	2	6	8	7	7	7	4	2	2	2	2	6	5
							Structuring and drafting tender and contract	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								L	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								U	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								Z	7	2	6	2	7	7	7	2	2	2	2	2	1	2
	S	S	S			S	Tender and award	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								L	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								U	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								Z	7	1	5	7	7	4	7	2	2	2	8	2	7	3
							Managing contract development and commissioning	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								L	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								U	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								Z	7	6	6	7	7	5	5	5	2	2	2	2	7	4
		F	F		F		Operating, maintaining and handing back	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								L	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								U	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	F			F		F		Z	7	2	4	2	7	7	7	7	4	4	2	2	7	

**Where:** P = Power & L = Legitimacy & U = Urgency  
 S= Starting contract & F = Finishing contract  
 - Stakeholders role Z Zone in stakeholders map □ No relation

Where: P = Power & L = Legitimacy & U = Urgency  
 S = Starting contract & F = Finishing contract  
 -Stakeholders role Z Zone in stakeholders map □ No relation



<b>Zone 1</b>	Dormant	Power only (P).	Zone 5	Dependent	legitimacy and urgency (L,U)
<b>Zone 2</b>	discretionary	Legitimacy only (L).	<b>Zone 6</b>	dependent	power and urgency (P,U)
<b>Zone 3</b>	demanding	Urgency only (U).	<b>Zone 7</b>	Definitive	power, legitimacy and urgency (P,L,U)
<b>Zone 4</b>	Dominant	power and legitimacy (P,L)	<b>Zone 8</b>	Non-stakeholder	None

Figure 1. Venn diagram illustrates stakeholders map according to how they rate on each salient [20].

**Table 8.** Stakeholders role in initiation phase, Author.

Responsible Authority	Role		Outcome
Internal& External Stakeholders	<b>Determine:</b> 1- Priorities & actual need 2- Available resources 3- Alternative Technologies 4- Schedule time 5- Funding method 6- Excepted project risks 7- (AQL) for the project 8-Starting operation time	<b>Initiation phase</b>	1- Local society satisfaction 2- Non Gov.- institutes Acceptance 3- Identify gaps 4- Alternatives Funding Resources 5- Suggesting New Technologies 6- Prevent and mitigate risks plan 7- Define indicators to access project phases 8- Concession models 9- Clear cost analyzes (cost/ revenue)

**Table 9.** Stakeholders’ role in design and tender phase, Author.

Responsible Authority	Role		Outcome
<b>State (public sector) and Private Sector</b>	Determine: 1- Project constrains 2- Cost, Time and Performance for each design 3- Environmental impact assessment for each design 4- potential Project contractors	<b>Design&amp; tender phase</b>	1- Optimum design 2- Final tender documents 3- Announcement for the project 4- Assigning project contractor 5- Assigning lender 6- Signing Concession models 7- Allocate resources

***Stakeholders Role in managing contract development and monitoring Construction phase***

This phase is done by the private sector through the (project company), and therefore, to ensure the successful implementation of the proposed design and to continue the application of determining the stakeholder’s role, the stakeholders must:

- Monitor material and equipment costs.
- Minimize the project defects to achieve (AQL).
- Improve communication between stakeholders.
- Assess the risks and mitigate them according to the risk plan.

### ***Stakeholders role in operating, maintaining and handing back phase***

This phase is the last phase in PPP projects, and if stakeholders role applied correctly through the different project phases, that will achieve public–private (win-win) solution. This phase starts after the completion date for construction, operation and maintenance is considered the critical and the longest phase in PPP projects, consequently defining the stakeholders role in this phase is too important because it ensures the success and safe transfer for the project to the government (public sector), the stakeholders must concentrate on:

- Customer satisfaction for the product/service.
- Improve the performance of the operation (performance/cost).
- Improve operation and maintenance technology.
- Achieve safety procedures.
- Assess the risks and mitigate them according to the risk plan.
- Training the government team.

### **Conclusion**

According to the recommendation of 2015 UN submit, which calls to build resilient infrastructure and strengthen the (PPP<sub>s</sub>) concept, and through smart infrastructure challenges, this paper presents that stakeholders are the main pillar of (PPPs) for smart physical and digital infrastructure projects during its lifecycle phases through an accurate understanding of the objectives and tasks of each project's phases and the nature of the agreement's contracts to complete the project and safe transfer the project to the government (public sector) to achieve a (win-win) public-private solution, the most important results and recommendations of presented study as the following:

### **Results**

- Stakeholders are the main pillar for the PPP projects, and implementation of these roles will minimize high risk of Stakeholders opposition which mainly emerges from the gap between the expectations of different stakeholders involved in PPP projects by Introduce a mechanism to assess, identify and present a clear distribution stakeholder's salience (P, L, and U) during the Agreement's Contracts and PPP project phases.
- The stakeholder's salience (P, L, and U) varies according to different projects models of PPP applications in smart infrastructure projects.
- Enhancing the communication between stakeholders will minimize the gap between the expectations of the various stakeholders involved in PPP regarding the process or desired outcome of the project.

- Identifying projects, appraising, preparing contract, design, and tender project phases considered the most critical roles and the main reason for success this type of projects.
- The integration between agreement's contracts through PPP lifecycle phases and stakeholders roles generating a smart governance and adapt projects requirements to regulations will ensure a high-quality services and low-cost technology through competition between private sector companies in the framework of transparency.

### ***Recommendations:***

- Establishing a mechanism, that defines the role of stakeholders, as a separate chapter in the project contracts, to be a commitment for all the contracting parties, that will help to accelerate the project life cycle and mitigate potential risks as a result of conflicts of interest and thus achieve sustainable development.
- Division of the long-term contracts, which may continue more than two phases, such as consultations and funding contracts, to a set of contracts, that will ensure more flexibility for negotiations in case of any potential changes in the political and financial condition which may occur in the project country especially in the developing countries, instead of termination the project.
- As a most of infrastructure projects are considered nonprofit projects despite the huge investment in them, which makes investors reluctant to invest in them, so countries must create mechanisms to attract this type of investment, such as providing credit facilities and assigning a group of projects that achieve profits to the investors as complementary contracts to this type of projects.
- Non-governmental institutions and the media must be supported by governments, whether through legislation or funding, because these stakeholders have a great influence on societies in accepting these types of projects as well as pushing them to invest in it.
- Further research is needed to compare different governance structures that enable a dual stakeholder management analysis. As such, potential benefits and costs of different governance structures should be mapped to appoint the optimal structure for each type of PPP project.

### **Disclosure statement**

No potential conflict of interest was reported by the authors.



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