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Presenting the Model of Factors Affecting the Environmental Complexity of Public-Private Partnership Projects in the Urban Rings of West Mazandaran Using a Qualitative-Quantitative Method

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Abstract

The cities in the western region of Mazandaran province face persistent traffic congestion due to rapid tourism growth and the lack of efficient urban ring roads, emphasizing the need for Public-Private Partnership (PPP) infrastructure projects. This study aims to identify and model the factors affecting the environmental complexity of PPP projects in urban ring roads of West Mazandaran using a combined qualitative-quantitative approach. In the qualitative phase, key complexity factors were identified through a comprehensive literature review and expert interviews. In the quantitative phase, these factors were analyzed and structured using systematic analytical methods to develop a conceptual model of environmental complexity in PPP projects. The results reveal that environmental complexity is mainly influenced by managerial, economic, institutional, and operational factors, including risk allocation, stakeholder coordination, regulatory frameworks, and project execution systems. The findings indicate that appropriately designed PPP models can reduce uncertainties, improve time and cost performance, and enhance the sustainability of urban infrastructure projects. This study provides a practical framework to support policymakers and project managers in effectively managing environmental complexity in urban ring PPP projects, particularly in tourism-oriented regions.

Keywords: Public participation, Public infrastructure, The complexity of urban rings, Economic infrastructure, Urban traffic.

1 | Introduction

The effort of today's societies to implement large projects in a limited period and at a certain cost depends on several factors and processes, and project implementation systems are considered one of the important factors in achieving these goals [1]. Currently, the selection of the implementation system in the projects is done according to the specific conditions of each project and the specifications of the plan, as well as its financing method and the project implementation systems meet the needs of employers to an acceptable extent to speed up the implementation of the project and minimize Costs, and environmental provision is suitable for project implementation [2]. But the noteworthy point is considering the excellence and evolution

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of the project implementation systems, even with their comprehensiveness and proportionality with the structure of large and complex construction projects, the construction industry faces lawsuits, judicial increases in construction costs over the defined budget and the imposition of costs, In addition to prolonging the implementation of projects beyond the approved time, which has become more and more common in the last few decades [3]. In the meantime, the tendency of employers to unilaterally transfer contractual risks to contractors has significantly increased with the size and importance of plans and projects [4].

The participation of the public and private sector has emerged in the last decade as a new approach to solving this problem in project implementation systems and has been proposed as a solution to save the construction industry from falling into technical, financial and legal disputes [5]. Public and private sector participation in many projects such as complexes, towers, stores, shopping centres, factories, industrial units, warehouses, schools, hospitals, highways, bridges, tunnels, airports, water structures, docks, water supply facilities, Electrification, waste disposal of defence industries, etc. has been implemented in different countries [6].

With a strategic approach, it has acted effectively in reducing lawsuits and controlling time and cost, as well as improving relations between project stakeholders, and has found a special place and popularity among the agents and parties of project implementation in advanced societies [7].

2 | Participation

Partnership is a relationship-oriented management strategy and concept that guarantees the success of the project in the form of an agreement by setting up a partnership charter and by aggregating and assigning the commitment of trust, respect and equality with a competent executive guarantee to realize the benefits and interests of all parties at all levels. In other words, a partnership is a set of operations and strategic activities that, through creating a clear understanding of common and mutual goals, group decision-making by a number of companies that focus on using feedback to improve their joint performance continuously, make a huge improvement in performance.

In other words, it is a long-term commitment between two or more organizations that ensures the achievement of special commercial goals and objectives by maximizing the impact of the resources of each partner. This issue requires a change in the structure of traditional relationships and turning it into a partnership culture without paying attention to organizational boundaries. Communication is based on trust, dedication to common goals and understanding each other's expectations and personal values. The provision of public services is broader than the state in which the government is responsible for the design, construction, financing and operation of capital assets and services that these Assets can provide. In fact, many government services are performed with assets that governments provide through the private sector or contracts, according to which the private sector pays for the construction of assets in accordance with the government's specifications.

This issue may include things such as the construction of buildings, computers, dams, roads, hospitals and military equipment. Also, governments may conclude contracts with the private sector in the field of providing specific services, including maintenance and consulting services. But none of them may be considered as examples of Public-Private Partnerships (PPPs) but all of these cases may be considered as traditional public procurement.

3 | Public Infrastructure and Private Sector

Public infrastructure can be defined as facilities that are essential to the proper functioning of the economy. Therefore, such facilities are not goals but rather tools to support the economic and social activities of a nation and include facilities that contribute to economic and social goals. In general, public infrastructure can be divided into two categories:

- *Economic infrastructure, such as highways, transportation facilities, and public utilities (water, sewer, power grids, etc.), i.e., infrastructure that is essential for daily economic activity.*
- *Social infrastructure such as schools, hospitals, libraries, prisons, etc., i.e., infrastructure necessary for the social life of people.*

It is also possible to distinguish between hardware infrastructure, whether economic or social, including buildings and other physical facilities, and software infrastructure, including services to improve economic infrastructure (e.g., street cleaning) or to promote social infrastructure (e.g., education, social services). Therefore, it can be argued that infrastructure should be provided by the public sector where competitive market pricing disrupts the way things work or leads to a loss of socio-economic benefits. However, experience has shown that the government can do this in two ways: either by intervening directly or by supporting the private sector by providing facilities through legislation, tax subsidies, or similar factors, or by contracting.

4 | Contracts for Construction, Ownership, Exploitation and Transfer

This type of contract was first designed in Türkiye. Its purpose was to produce electricity, but with the main difference that the consumer (buyer) of electricity will be the public sector or the country's electricity facilities and that at the end of the power plant ownership contract, it can be transferred from its investor to the consumer, usually at no cost or at a low cost. And as a result, be transferred to the public sector. It was only a small step from a build-operate-transfer model to a build-operate-transfer contract, in which ownership of construction completion is transferred to the public sector under a design-build-operate-finance contract. According to that, the legal ownership of the project remains with the public authority based on the contract, while the profit of the private sector in the project is based only on the contractual rights to operate the project, and it receives budget revenues for its implementation from the consumer instead of the ownership of physical property.

4.1 | Project Finance for Concessions

The new application of project finance techniques for concessions under the Build Operate Transfer Financing model was first successfully applied to the Channel Tunnel project between the UK and France in 1987, although this project was a financial disaster, and shortly afterwards to the Dartford Bridge in London across the Thames Estuary. It is worth noting that these were not typical projects, but the lessons learned from them were largely useful for subsequent concessions, mostly in toll road projects. The electricity project is very similar to the spider diagram below, but the main difference is the toll revenue. The key elements in this structure are

- I. Private sector investors own the project company.
- II. An operation contract under which an operating company provides services such as operating the toll booths, minor repairs, accident management, etc.
- III. A maintenance contract under which a maintenance company provides road maintenance services.
- IV. A concession agreement (a standard name for this type of PPP contract) with the public authority grants permission to collect tolls from road users, which usually does not provide the payment portion.
- V. The cash flow after operating costs, which is mainly based on operation and maintenance service contracts, is first used to repay loans and debts and then distributed to the investors.

4.2 | The Private Finance Initiative Model

In 1992, the British government established the Private Finance Initiative with the aim of leveraging private finance to provide public infrastructure. This phenomenon actually began with the rediscovery of concessions in the 1980s, as mentioned earlier, and the first wave of projects began in 1994, involving the construction

and operation of new roads. However, since the capacity of road tolls in the UK was limited, the Private Finance Initiative model introduced the concept of payment by a public authority instead of the principle of concessions on a user-pay basis. The initial payments made by a public authority were still based on driver usage and were made through so-called "shadow payments", i.e., a schedule of installment payments by the public authority per driver/kilometre. The next step in the full design of the Private Finance Initiative model was the use of Private Finance Initiative contracts for the provision of public facilities (such as schools and hospitals) where the operating risk could not be transferred to the private sector. In these cases, the contract structure was still based on a power purchase agreement, under which the private sector investor received a fee from the public authority for the availability of the project; that is, building the project to the required specifications and preparing it for the contract period. The private finance initiative also provided services such as maintenance, cleaning, and catering. The similarity to the power purchase agreement is evident. Here, the main elements of the structure are:

- I. The project company, whose ownership is held by the private sector investors.
- II. Financing the project capital through equity and project finance borrowing.
- III. A design and build contract, under which the contractor agrees to build the school with the required features at a fixed price and schedule.
- IV. A software facilities maintenance contract, under which the company provides services such as safety, cleaning, and catering to the school.
- V. A hardware facilities maintenance contract, under which the maintenance company or the main design and build contractor provides the building maintenance services.
- VI. Project agreement with the public authority.
- VII. Cash flows after operating costs are mainly in the form of installments based on maintenance contracts; facilities are first used to pay off loans and debts and then distributed to investors.

Today, PPPs are based on the rediscovery of the concession and the development of the private financing initiative model. It should be noted that in some countries, only the private financing initiative model is called a PPP to distinguish it from a concession. However, in this study, PPP will be used for general concepts that include both models, and the PPP contract is used to refer to both the concession agreement and the project agreement [4].

5 | Types of Public-Private Partnerships

PPP mainly reflects the point at which the legal ownership of the facilities is transferred from the project company to the public authority, or if the project company is never the legal owner of those facilities, the nature of its legal interest, possibilities such as renting the property or simply the right to use it. Transferred to the company. Such distinctions are legal techniques and do not affect the fact that PPP projects are public-sector properties that usually cannot be completely sold to the private sector. It is better to classify PPPs based on the nature of services and risk transfer. Let's classify PPP contracts.

Based on this, PPPs can be divided into two main groups.

5.1 | Based on Efficiency

As mentioned earlier, the concession model, with tolls paid by the consumer, fares with a user charge for facilities such as roads, bridges and tunnels, and other transport facilities such as ports, airports, tram networks and light rail, is a prototype of a PPP in which the efficiency risk is transferred to the private sector and is probably still the most widely used type of PPP. However, the efficiency risk can also be transferred using the Private Financing Initiative model, for example, through the payment of shadow tolls as mentioned above, where the public authority pays the cost but based on the amount of use of the facility by drivers. A

combination of these two methods is also possible, where tolls or fares are paid by consumers but with financial support (subsidies) from the public sector.

5.2 | Based on Usability

5.2.1 | Housing (Buildings)

Residential projects, such as hospitals, schools and prisons, are those for which the public authority pays for their preparation, usually in the field of social infrastructure. They are the main type of projects using the private finance initiative model. They provide long-term services such as cleaning, reception, maintenance, or even security services in prison, as well as the construction of a building, but for the authority, the public construction of the building and its accessibility is more important than the provision of these services.

5.2.2 | Systems or network equipment

Systems or network equipment based on PPPs are less common and are all based on the private financing initiative model. In such cases, payment by the public authority is based on some form of accessibility, for example, road projects built under the design-build-operate financing model; payments are based on the usability of the road, not the efficiency of the road. Accessibility is judged by measures such as traffic flow, the speed at which traffic moves, the speed at which accidents and litter are collected on the road, etc. Similarly, payments for rail projects are not based on the number of passengers but on how well the system works. Projects also include systems such as street lighting, Information Technology (IT), and another important part is defense equipment.

5.2.3 | Process Plant

The basic "build-operate-transfer" model for power generation falls into this category, but (except in some parts of the Middle East) this model is not at all common due to the widespread privatization of power generation and distribution as PPPs. The most important types of process plants associated with public partnerships are those that are all involved in a fully measurable process. As discussed earlier, water projects are financed through concessions with a private finance initiative model, but in both cases, payments are not based on the actual amount of water produced or treated but on the ability to produce the end product of treated water or wastewater. Similarly, in a waste incineration project, the public authority pays a fee for the ability to use the waste processing capacity, and if the facility fails to meet this requirement, no payment is made. The principles of such projects are similar to those outlined for a power purchase agreement, but in comparison, payments based on performance are less important; therefore, usability is still the main indicator [8].

6 | Project Execution Systems and Public-Private Partnerships

The greatest popularity of PPPs stems from the position that they are applicable to all execution systems. This indicates that PPPs can be used independently of the project contract and, therefore, independently of the type of project execution system. The important question always arises in the minds of whether partnership is an appropriate strategy for any project execution system?

Project execution systems that involve the greatest volume of intra-organizational exchanges and transactions during execution (such as exchanges between the employer and the contractor, the project manager and subcontractors, etc.) have the potential to be more affected by the partnership process. This is more likely to occur in complex, fast-paced, and uncertain projects. In such projects, PPPs will bring several benefits, including [9]:

- I. The partnership approach requires intra-organizational exchanges and transactions to guide the pursuit of agreed-upon common goals rather than the personal and unilateral interests of each party.
- II. The open and unconstrained organizational structure under the partnership process reduces costs, and the impact of each interaction with active, direct and unfettered communication increases.

Therefore, participation derives the greatest benefits and benefits from the connection and linkage with the implementation systems such as construction, operation, transfer, design and construction, and management contracts. It does not mean that participation does not have effective benefits in simpler contracts with fewer interactions or that it will not play an important role in these types of contracts, but only that, in comparison, more benefits will be obtained in more complex contracts.

6.1 | Advantages and Disadvantages of Public-Private Partnerships

One of the main advantages of the above method is that it can save resources in many ways. The government can focus on its core competencies and does not need to rely on its own resources for unfamiliar projects. Due to private sector participation, government capital, data and intellectual property can also be used more effectively, which leads to a fundamental improvement in the quality of public services and facilities. On the other hand, the proper use of skills, experiences, technology and innovation in the private sector can be transferred more satisfactorily. Another advantage is that the public and private sectors can share risks at different stages. Since the private sector introduces commercial rules into public projects, the risk of costs is exceeded, and project delays can be greatly reduced [10].

The private sector can help create a learning structure with a more effective ranking of responsibilities for service delivery by completing the design, construction, and operation phases through PPPs [11]. In addition to the benefits of saving resources and using them more effectively, the economic aspect can also be improved by using this method. For example, PPPs have been shown to reduce life-cycle costs because these projects retain government capital for the life of the project, which ensures the expected rate of return on public investment. Although this approach is a way to build public infrastructure with little or no cost to public funds, the axiom that "nothing is free" still holds true [12].

Kumaraswamy and Zhang [12] have shown several cases of outsourcing risks that have become problematic due to unrealistic price and revenue estimates and legal disputes between private actors and the government. In virtually all of these cases, the government and the public, not the private actors, ultimately bear the cost of failure. Their research focused on the public sector's perspective on the failure of PPPs. This research has shown that political barriers stand in the way of the use of PPPs. This view is not surprising since these projects always require specific legislation.

In most cases, the state parliament and the municipality discuss this issue in detail before approving that a PPP approach should be used. Also, some government agencies may resist the change in the context of adopting a new funding method. This method may not be well understood in the development of a project and sometimes not even well received by the government agencies that manage that project [13].

6.2 | The Importance of Public-Private Partnerships

According to Grimsey and Lewis, in 2004, the history of PPP projects dates back to the 1600s and the construction of the railway in England. PPP is a modern term for actions that have been used as a public method in the past decade. In the past, other actions have also been taken, including private financing initiatives, which have become a more common term for the public due to their general development in England during the early nineteenth century. Therefore, it is not wrong to say that it was the actions taken in the field of private financing initiatives that drew global attention to PPPs in the field of infrastructure projects. With the growing popularity of the PPP method in the world, the importance of project implementation in this field has increased for both researchers and practitioners [14].

Ke et al., in 2008, conducted a detailed review of studies conducted in the field of PPPs. [3] They studied more than 148 articles published in renowned international journals. The findings indicate that the majority of articles presented in this field are from the United Kingdom, the United States, America, Singapore, Hong Kong, China, Australia, and Germany, respectively. In the academic field, the Nanyang Technological University of Singapore, the University of Hong Kong, the National University of Singapore, and the University of Glasgow Caledonian have been among the leading universities in research on the subject of

PPPs. Studies have shown that in most countries in the world, various methods of PPPs are known and accepted by countries, and countries have not limited themselves to the build-operate-transfer method. The topics that have received the most attention from researchers in this field include procurement, procurement, and financing.

The theoretical basis of the concept of PPP is related to the efficiency theory of X. This theory was presented by Lieberstein in 1966. According to this theory, public institutions will not fail as long as they are provided with formal financial and broad-based policies that prevent their failure and ensure their survival. Inefficiencies in public institutions are often due to abnormal interference and organizational structure with high-level government bureaucracy. Therefore, according to this theory, PPPs should reduce the sources of inefficiency, increase their responsiveness to market forces and increase their competitiveness.

This type of inefficiency in public organizations led to the creation of a new approach to public sector management in countries around the world in the early 1980s. The main goal of this innovation was to implicitly introduce the functional principles of private companies in the public sector. The new management was trying to renew the organizational structure, modernize the government, and improve the management of public companies. The emergence of this issue was accompanied by the need to reduce cost inefficiency and overcome the lack of management skills in government organizations. Looking back, we realize that this innovation was one of the key reforms that promoted and generalized the use of PPPs. In recent years, governments have realized that PPPs are considered one of the solutions for financing and managing complex projects. Given the challenges and budget constraints, governments emphasize the use of creative methods of financing and asset management to maintain and improve the infrastructure of countries, and in this regard, PPPs are considered one of the ways to utilize capital resources. In fact, PPP is considered a long-term contractual agreement in which the competent public sector authority transfers its traditional responsibility, including operations or financing, to the participating party in the hope of achieving mutual benefits. One of the early examples of this type of partnership occurred in the 1980s in California and Virginia.

PPPs, as defined here, have the following elements.

- I. A long-term contract is a PPP agreement between a public sector and a private sector.
- II. They are applied for the design, construction, financing and operation of public infrastructure (facilities) by the private sector.
- III. Payments are made to the private sector for the use of the facilities over the life of the PPP agreement. These payments are provided by the public sector or the public as the user of the facilities.
- IV. The facilities remain in the ownership of the public sector, or ownership is transferred to the public sector at the end of the agreement [15].

While there are many definitions of PPPs, few have come up with a true definition of PPPs, this is because there are many uses for the concept of PPPs. In 2006, Pessoa defined PPPs as a sustainable alliance between the public and private sectors (including a non-profit organization) to achieve a common goal in which each party pursues its own interests. Hogg and Graves In 2007, it was defined as a long-term infrastructure project contract. Others consider this partnership within the framework of public management literature as a type of organized procedure for private organizations to participate in the economy in order to provide public services. Linder [16] considers PPPs as a new way to launch infrastructure projects, such as tunnel construction, port construction, transportation, etc. The aforementioned partnership can be considered as arrangements and agreements in which the public sector and the private sector, as an independent entity, commit to fulfilling obligations in the form of long-term contracts in the fields related to the construction or management of infrastructure or the provision of services [17].

6.3 | Different Models of Public-Private Partnerships

Although PPPs are a new phenomenon, the concept of using private capital to build public facilities is very old. In 18th-century Britain, a group of noblemen built a road monopoly by borrowing money from private

investors to repair the roads and repaying this debt through tolls. By the mid-19th century, most of London's bridges were financed by tolls, and in the late 19th century, the Brooklyn Bridge in New York, USA, was built with private capital. In France, canals were built with private capital in the 17th century. This type of PPP is known as a concession, which is a user-pays model in which the private sector is allowed to recover its costs through tolls for the use of public services; for example, paying tolls for the use of a bridge, tunnel, or road. These tolls return the cost of construction and operation of the project to the concessionaire, which is usually controlled by the public sector at the end of the concession period. Apart from roads and related facilities, concessions were used in many countries in the nineteenth and early twentieth centuries to provide facilities such as railways, water supply, and sewage treatment networks. The role of the public sector in granting concessions is to create a framework within which a concessionaire is selected and provides all the construction and operation needs of the project, and this is usually done through the signing of a concession agreement between the public authority and the concessionaire. Another version of granting a concession is a "franchise". Franchise is the right to exploit a project It is already built. That is, it is similar to granting a concession but without the initial construction phase. The franchisee may instead pay the concession fee in a lump sum to the public authority. A franchise is not considered a PPP because it only involves the operation of the infrastructure and does not involve its provision or improvement. However, their contractual basis and financing are similar in several aspects [16].

6 | Conclusion

In this research, I reach the following conclusions: one of the main advantages of the private method is that it can save resources in many ways, the government can focus on its main competencies and does not need to rely on its resources for unfamiliar projects. Due to the participation of the private sector, the data and rational features of the government can be used more effectively, which leads to a fundamental improvement in the quality of services and public facilities. On the other hand, the correct use of the skills and experiences of technology and innovation of the private sector can be transferred more satisfactorily. Another advantage is that the public and private sectors can share risks at different stages. Since the private sector introduces business rules into public projects, the cost risk is increased, and project delays can be reduced to a great extent.

Authors' Contributions

S. S.: Research Design, Data Curation, Investigation Writing-Original Draft, Methodology, Conceptualization, and Formal Analysis M. G.: Software, Formal Analysis, Visualization, Writing-Review & Editing, and Validation. The authors have read and agreed to the published version of the manuscript.

Data Availability

All data are included in the text.

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Conflict of Interest

The authors declare no conflict of interest.

Consent for Publication

The authors confirm consent for the publication of this work

Ethics Approval and Consent to Participate

This work is purely theoretical and does not involve studies on humans or animals.

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