The Value for Money Factors and their interrelationships for Smart City Public-Private Partnerships Projects

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Abstract

Purpose: The amount of expenditure required to scale up smart infrastructure projects is often enormous. PPP is one of the proposed and viable solutions for addressing the financial issues of smart infrastructure projects. However, the most important criterion in choosing PPP over other procurement methods is that the project under the PPP method should deliver the best value for money (VFM) while also including defined economic and social objectives, rather than relying exclusively on efficiency factors. While PPP provides a variety of advantages for developing infrastructure, significant challenges may arise as a result of smart infrastructure initiatives. Diverse PPP approaches have been used to build smart infrastructure around the world, with varying degrees of success. The aim of this study is to identify the VFM factors that are suitable for smart infrastructure projects and to examine the impact of their interrelationships.
Design/methodology/approach: The methodology for this study consisted of three stages: identifying VFM factors in PPP for smart cities based on an extensive literature review, analyzing data from a sample of 90 PPP practitioners using a Likert scale questionnaire, and estimating interrelationships among VFM factors using structural equation modelling.
Findings: After performing a SEM analysis on the gathered data, the best fitted measurement model consisted of 11 VFM factors acting as indicators of three latent variables for smart infrastructure projects (clear output specification for measuring performance, efficient dispute resolutions, optimized risk allocation and business models, improved and integrated community services, economic sustainability, appropriate capital structure and collaterals, smart asset management, diffusion of smart technologies, technical innovation, Ince) and three clusters of their interrelations (Economic sustainability, Integration drive, Optimization and smart technology).
Practical implications: This research has resulted in a useful and readily applicable list of factors and clusters of value for money criteria for the implementation of PPP in smart infrastructure projects, assisting public sector management by providing a measure of pre-conditions that can be used as an assessment tool when determining whether a PPP should be used instead of conventional methods.
Originality/value: In addition to the theoretical and methodological contributions, this study produced a usable and readily adaptable list and clusters of value for money factors for the implementation of PPP in smart infrastructure projects.
Keywords: Public procurement, PPP, value for money factors, smart cities

1. Introduction

According to a United Nations report (2019), by 2050, 68 percent of the world's population will live in cities, and city dwellers will outnumber rural dwellers by a factor of two. Rapid urbanization exacerbates a variety of issues, including environmental degradation, resource depletion, unequal spatial development, and traffic congestion. Various governments have emphasized the need of developing a smart infrastructure as a means of improving urban administration and development. The majority of research agree that smart infrastructure projects entail the use of cutting-edge technology to improve the efficiency of municipal processes (Liu et al., 2020; Tan and Taeihagh, 2020).

Additionally, there is growing understanding that smart infrastructure development should prioritize enhancing residents' quality of life by fulfilling local requirements (Huang-Lachmann, 2019). A smart infrastructure is believed to provide novel answers to a variety of social, economic, and environmental challenges confronting expanding cities (Yigitcanlar et al., 2018). By 2025, it is estimated that smart infrastructure development would provide over US$2 trillion in commercial potential (Liu et al., 2020; Lam and Yang, 2020).

There are several obstacles to the establishment of smart cities. Lam and Yang (2020) noted that governments worldwide are confronted with fiscal limitations and aging infrastructure. According to Alim and Polak (2016), public funding restrictions impede the development of smart infrastructure programs. Additionally, smart infrastructure development involves a diverse range of stakeholders, including municipal governments, people, and for-profit and nonprofit organizations with a range of interests and requirements. Additionally, creating a smart infrastructure demands a high degree of innovation, which involves significant commercial and business creativity on the part of service providers (Liu et al., 2020). Cruz and Sarmento (2017) asserted that cities can overcome funding and management challenges associated with smart infrastructure projects by demonstrating new technology's potential for cost reduction, repurposing existing and legacy infrastructure assets, unlocking value, and bringing together key stakeholders. As a result, collaborations with private organizations is required to promote smart infrastructure projects. Public-Private Partnerships (PPPs) provide the platform for the public and private sectors to collaborate on smart infrastructure projects (Liu et al., 2020). Furthermore, PPPs are recommended and proven strategies for overcoming smart infrastructure project funding issues (Selim and ElGohary, 2020).

While PPP has several advantages in the development of built infrastructure, significant obstacles may arise as a result of complicated decision-making, ineffective risk management, a lack of transparency, and a lack of market competition (Jayasena et al., 2020; Kwak et al., 2009). Diverse PPP models have been employed globally to construct smart infrastructures, with varying degrees of success. As Jayasena et al. (2020) cited, a variety of issues have arisen while implementing various PPP models.

In underdeveloped nations, a lack of information and knowledge in the private sector was identified as an obstacle to adopting PPPs (Jayasena et al., 2020; Sharma and Bindal, 2014). According to De Oliveira and Pinhanez (2017), challenges to PPP adoption in smart infrastructure projects include a significant risk associated with investing in new solutions, policy uncertainty, and long lead times to profitability.

According to Jayasena et al. (2020), Lam and Yang (2019), and Nguyen et al. (2019), variations in PPP models are also necessary to account for the unique characteristics of smart infrastructure development projects. As a result, it is argued that there exist barriers to PPP adoption in smart infrastructure developments, and that these barriers might be overcome by identifying the drivers for PPP benefits realization in smart infrastructure development (Jayasena et al., 2020).

The PPP approach has made significant progress in recent years because individuals and organizations believe it provides more value for money (VFM) (Malek and Gundaliya, 2021). However, according to a study that reviews the UK government's PPP schemes, the majority of PPP projects are costly and fail to deliver on their promise of ensuring the best value for money (Meyer, 2012). The current PPP industry's biggest problem is ensuring that all programs will be funded in such a manner that they can provide successful VFM results. Some scholars argue that the weakness of PPPs may be due to a lack of reliable tools for measuring PPP project success. According to studies, there are a variety of value for money factors that can increase the success of PPP programs (Malek and Gundaliya, 2021). In project management literature, VFM variables are viewed as success enablers that may be handled in the environment in which they can be used to maximize a project's chances of success (Lam and Yang, 2020; Jayasena et al., 2020).

Most studies show that VFM is critical to the effective implementation of PPP programs (Malek and Gundaliya, 2021; Lam and Yang, 2020; Jayasena et al., 2020). Liu et al. (2014) cited Yuan and others (2009), who stated that value for money in a project can be described as the ability to accomplish the objectives established by the public client in a PPP project. Liu et al. (2014) further cite the studies of Henjewele et al. (2011) and Akintoye et al. (2003), who describe VFM as a benchmark target for PPP projects. They further stated that the public client's requirements could be used to measure the output standards of PPPs. However, according to Lam and Yang (2020), smart cities are new domains, and more emphasis should be made on developing additional factors for investment decision making beyond the efficiency criterion. It is also critical to improve the social and economic objectives of a PPP project in order to meet the VFM objectives. (Lam and Yang, 2020). The value for money in a long-term project should mean that all relationships are constantly built in order to achieve the necessary monetary and social objectives (Yuan et al., 2012).

The UNECE (2008) report also emphasizes the importance of including clear economic and social objectives, rather than relying solely on efficiency criteria.

The rationale for this study is that in order to scale up smart infrastructure initiatives, PPPs are essential to handle the financial challenges connected with these projects, as well as to ensure that these programs meet economic and social objectives. The VFM factors are always used as criterion to ensure that the PPP is the most feasible choice. By identifying the value for money factors and constructs impacting the selection of PPP procurement options for smart infrastructure projects, stakeholders would be able to make collective and informed decisions relevant to this type of projects prior to project award, increasing the success rates of PPP in smart infrastructure projects.

The aim of this research is to establish the value for money factors in smart cities PPP projects and try to experimentally develop a structural equation model (SEM) of the relationships between the value for money latent variables. This statistical approach evaluates and estimates the strength of causal linkages using a combination of data and qualitative causal assumptions, which are commonly obtained from theories. The model will represent the causal interrelationships among the value for money constructs that can help better evaluate the capability of the procurement method of meeting the public client's economic and social objectives.

This paper is divided into five sections to convey the whole concept. Section 2 provides background information as well as a critical review of existing studies in order to update the existing value for money factors to fit smart infrastructure projects. Section 3 describes the methodological technique used to arrive at the findings. Section 4 offers an analysis of the data, as well as a discussion and implications of the findings of the research and suggestions for future research.

2. Literature review

A smart infrastructure “provides the foundation for all of the key themes related to a smart city, including smart people, smart mobility, smart economy, smart living, smart governance and smart environment" (UNCTAD, 2016). The basic feature that underpins the majority of these components is that they are linked and create data, which can be used intelligently to ensure maximum resource use and performance.

In today's economic situation, infrastructure developers have a difficulty in achieving the desired degree of performance while staying within a given budget, in addition to the complexities and high investment costs of Smart Infrastructure Projects (Selim and ElGohary, 2020). PPP is one of the recommended and potential strategies for addressing the finance issues of smart infrastructure projects, and it is one of the (UN) objectives for sustainable development (Selim and ElGohary, 2020). PPPs are agreements between groups of stakeholders from the government (public sector) and businesses (private sector) to share money, risks, and projected rewards in infrastructure projects (Alfen, 2010).

PPPs may be used in infrastructure projects in the following ways: 1- Pan City Model: providing smart solutions to existing cities by merging design and information technology. 2- City Retrofitting Model: Smartly retrofitting the existing built-up area and strengthening the current infrastructure to reach the smart city goal. 3- City Redevelopment Model: Replace existing infrastructure with new infrastructure that meets the needs of the future. 4- City Extension Model: determine the city's potential urban extension trends, and then support current infrastructure in these directions to accommodate this potential future extension, which will have a significant impact on lowering the total cost of potential urban extension phases, beginning with planning, implementation, and maintenance (Selim and ElGohary, 2020; Vadgama et al., 2015).

PPP projects often aim to leverage the private sector's knowledge and resources to help operate public services and deliver the advantages of creativity, efficiency, and increased quality with better funding (Osei-Kyei and Chan, 2015). One of the most critical factors to choose PPP over the other procurement options is that certain projects through PPP provide the highest value for money under certain circumstances (Malek and Gundaliya, 2021). In a PPP project, value for money can be defined as the capacity to meet the objectives established by the public client and effectively meeting the needs of the broader population, who will eventually use the product (Almarri, 2021). The value for money delivered in a PPP is also contingent on precisely identifying risks in a project and then distributing them to parties most suited to managing them in order to efficiently manage the project (Almarri, 2021). The idea here is to ensure that each risk is assigned to a party who has shown a demonstrated capacity to manage the risk and reduce its effects on a project. The party should therefore be prepared to face the consequences of risky propositions with the least financial effect (Lam and Yang, 2020; WBI, 2012).

Cruz and Sarmento (2017) defined three classifications for PPP development to show how PPPs are employed at different phases of smart projects: typical PPPs, incremental innovation PPPs, and breakthrough innovation PPPs. Build-operate-transfer (BOT) projects or concessions are referred to as typical PPPs. These usually entail long-term contracts of more than 20 years as well as considerable private-sector finance. Incremental innovation PPPs are those that are built for partial subsystems, such as ticketing systems or electric fleet operations. These are technical enhancements to current systems that do not reflect a reorganization of the system's backbone and do not take a disruptive approach. Groundbreaking innovation PPPs bring about significant changes by establishing new business models and completely reorganizing existing structures.

Increasing the usage of PPPs in soft systems, such as ICT systems, has been a rapidly developing area over the previous decade. Some of these systems are inextricably linked to 'hard' infrastructure operations (Cruz and Sarmento, 2017). Many characteristics of PPP projects, such as long durations, numerous stakeholders, complex processes, and high risks, capture the interest of researchers. Many studies have been conducted to examine the PPP model in a systemic way in order to determine how these projects perform. Some scholars have also looked at these studies and discovered that they are experiencing significant changes (Malek and Gundaliya, 2021; Lam and Yang, 2020; Jayasena et al., 2020).

According to Aizawa (2018) , VFM in PPP projects often requires the provision of additional benefits at the lowest possible expense in the realm of public services . VFM is a primary criterion used by the public sector to determine if a particular project will perform better using the PPP model rather than the conventional procurement processes. Yuan et al. (2009) examined the key objective of a PPP, which is to provide the highest value for money, by taking into account the client's overall strategic plan and project priorities, the private sector's long-term development and payoff approach, and the general public's expectations of reliable public facilities and services. According to Henjewele et al. (2011) and Akintoye et al. (2005), improving VFM is one of the benchmark goals of any PPP. According to Henjewele et al. (2011), meeting client's specifications should be regarded as a central criterion of performance measurement of PPPs.

While PPPs are backed by optimistic analyses, they are subject to unexpected obstacles that can impede their efficiency. These impediments involve financial, technical, and coordination issues that may hinder the normal operation of a PPP project (Henjewele et al., 2011). All of these challenges reduce a project's VFM and will alter the project's overall dynamics, since they are often long-term prospects. The emergence of these issues implies that there is still a need to find solutions to these issues. The significant factors will then be defined and utilized by stakeholders to make informed decisions.

This study will take into account the VFM factors mentioned in Li's et al. (2005) analysis. There are several studies that specifically recognize the practices and factors presented in this study (Cheung et al. 2009; Chou and Pramudawardhani, 2015; Hwang et al., 2013; Robert et al., 2014; Ismail, 2013; Osei-Kyei et al., 2015). Li and others (2005) performed an extended literature review in order to find the important value for money factors in the UK. Each factor was chosen only if it was supported by a sufficient number of research studies. These factors were subjected to a thorough literature review of current value for money studies in order to make them reflective of the value for money aspects in smart infrastructure projects (Malek and Gundaliya, 2021; Lam and Yang, 2020; Jayasena et al., 2020; Lomoro et al., 2020). According to Li et al. (2005), the following factors improve project value for money: VM1-Clear output specification, VM2-Competitive bid process, VM3-Early service delivery, VM4-Efficient dispute resolutions, VM5-Reduced negative environmental impact, VM6-Appropriate capital structure, VM7-Improved facilities to the users, VM8-Optimised risk allocation, VM9-Improved services to the community, VM10-Incentives for private party, VM11-Long-term engagement, VM12-Low life-cycle cost, VM13-Low tariffs, VM14-Optimisation of assets efficiency, VM15-Private sector's project management skills, and VM16-Technical innovation.

To check for the suitability of value for money factors established in Li’s et al. (2005) model, Malek and Gundaliya (2020) investigated if the VFM metrics created in Li's study are still applicable to enhancing decision-making between PPPs and the traditional procurement approaches. The study was focused on a group of Indian PPP road construction projects and yielded the following measures: reduction in litigation, claims and conflicts, no cost on Government consideration, extent of substantial and insubstantial advantages of the users, economic tolls, environmental deliberation, variety of financial innovation, private organization’s profitability, economical cost of project life cycle, private sector’s expertise sector, transferring risk, output based specification, quick delivery of project, technological modernization of private organizations, better roads to government, moderate tender, long-term nature contracts, systematic, risk allotment, and optimal utilization of road and effectiveness of project. There is a similarity with Li’s et al. (2005) criteria with some minor rephrased statements of the same content. Therefore, the whole 16 value for money factors seem to be suitable to answer current day value requirement. However, UNECE’s (2008) report stresses on including clear economic and social objectives and not only relying on the efficiency criteria for selecting PPP frameworks to deliver the type of services that satisfy the basic needs for human well-being, such as transparency, equity, accountability, accessibility and inclusiveness.

As for the suitability of these value for money factors for the consideration of selecting PPPs in smart infrastructure projects, in a study titled "Factors influencing the consideration of Public-Private Partnerships (PPP) for smart infrastructure projects: Evidence from Hong Kong" Lam and Yang (2020) on an attempt to identify the factors that influence the selection of PPP in smart cities posited that smart cities are new domains and more emphasis should be put on identifying additional criteria for the procurement decision making. The authors argued that the following measures would improve making such a decision: Availability of finance, availability of expertise, availability of needed data, efficiency drive, need to share risk, rate of technology becoming obsolete, rate of technology diffusion, suitable business models can be devised to share income/saving, asset availability, capability of measuring performance, possibility of procurement by competition, possibility to maintain transparency of procurement and monitoring of operation, complexity of coordination of government departments. This, as well, was further complimented by another comprehensive study on PPP in smart infrastructure projects. In their study "A systematic literature review and analysis towards developing PPP models for delivering smart infrastructure", Jayasena, Chan, and Kumaraswamy (2020) argued that PPP procurement method may alleviate the challenges of inadequate expertise in smart infrastructure and lack of funding for the successful development of such infrastructure. In addition to identifying the needs, barriers, and drivers for overcoming current urban challenges, the authors have highlighted some objectives to be considered as the basis for the selection of PPP over other conventional procurement models. These include growth for impacting on outcomes of sustainability, guarantee the sustainability, enhance the fineness of citizens' lives, competitive and innovative commerce, good maintenance system, and leverage the collective intelligence."

Based on the above, the value for money factors from Li et al. (2005) were modified to suit the type of procurement assessment they should produce in smart infrastructure PPP projects (Malek and Gundaliya, 2021; Lam and Yang, 2020; Jayasena et al., 2020; Lomoro et al., 2020). It is therefore hypothesized that the following value for money factors improve PPP in smart infrastructure projects (Table 1).

Insert Table 1 here

3. Methodology

Survey item scores are a common source of input to the analysis for SEM since they provide a covariance matrix of measurable variables (Manhas et al., 2013). Out of the 326 distributed questionnaires, 90 qualifying questionnaires were returned from PPP specialists with varying exposure to smart infrastructure initiatives in the UAE and the United Kingdom, to ensure a diverse input. For SEM analysis, a minimum sample size of 50 and a maximum sample size of 100 can be adequate to provide reliable results (Hair et al., 2010; Molwus, et al., 2013). Purposive sampling was used were practice groups participated via an online five-point Likert scale questionnaire to measure the significance of the modified 16 value for money factors for smart infrastructure projects. 52.2% of respondents were from the private sector, 29.3 from the public sector, and 18.5% of the respondents identified themselves as researchers. As for the organizational level, 30.4% of the respondents identified themselves as top managers, 47.8 as middle managers, and 21.8 % as general staff. As for the experience, 8.7% had under 6 years of experience, 22.8% had between 6 and 10 years, 48.9% between 11 and 20 years, and 19.6% had above 21 years of experience.

The principal component analysis demonstrated the presence of more than one factor in each group, indicating that data commonality was not an issue (Hair et al., 2010). Cronbach's alpha coefficient for the measured variables was 0.904. Cronbach's alpha is a widely used test that accurately measures the internal consistency of a study's measurement set, showing a high degree of reliability (Hair et al., 2010).

To check the suitability of the data, Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity were used. The value of KMO indicates if the data is suitable for factor analysis. The KMO index should be between 0.5-1.0 to be considered suitable. (Brace et al., 2012). The value for the Kaiser-Meyer-Olkin measure of sampling adequacy was 0.824, which suggested that the sample is factorable (Brace et al., 2012). Bartlett’s Test of Sphericity was large (Chi-Square = 786.1, significance = 0.000), indicating it is unlikely that the correlation is an identity matrix, confirming that there is no need to eliminate any factor (Brace et al., 2012).

Exploratory factor analysis (EFA) is essential for establishing the number of latent variables that can be obtained from the theoretically established measurement items, which should reflect the conceptual model the study is attempting to validate (Hair et al., 2010). To establish the EFA, the data was analyzed by means of principal component analysis, where factor grouping through a Varimax rotation was conducted to establish the total variance explained by each factor. When the Eigenvalue was set to be greater than one, five factors were found sufficient to represent the value for money factors for considering PPP methods in smart infrastructure projects (Brace et al., 2012).

Structural equation modelling (SEM) is a technique that allows researchers to examine the theoretical propositions about the many ways that the study constructs are linked. It also allows for establishing the relationships and the direction of such relationships of any latent variable, which are improved iteratively to arrive at the best fit model through establishing many decision indices (Russell et al., 2011). Confirmatory factor analysis (CFA) is used to assist in developing a measurement model that is based on the theoretical exploratory factor analysis (Matsunaga, 2010). Another criterion is to check if the obtained population covariance is equal to the implied one. This is the Chi-squared (χ 2) test, and the model fit should yield an insignificant value at 0.05 (Moss, 2016). The acceptable ratio for this test when divided by the degree of freedom varies, but generally a value under 3.0 is considered desirable (Ullman, 2001). Root Mean Square Error of Approximation (RMSEA) is another model fit test, where the null hypothesis of the baseline in constantly evaluated under common situations. For the best model, the lower limit value should be close to 0, while the upper limit should not exceed 0.08 in general (McQuitty, 2004).

Comparative fit index (CFI) is another index that can be used to compare the sample covariance matrix with the obtained null model. An acceptable fit model will have a cut-off CFI of 0.90 (Bentler, 2007). Finally, the last index that will be utilized in this study is Tucker-Lewis Index (TLI) this index in a non-normed fit index introduced by Tucker and Lewis in 1973. The value should be between 0 and 1, the lower the value the less acceptable will be the model (Bentler, 2007). The EFA analysis yielded five new latent clusters (Table 2). Two items loaded on the first cluster, VM1-Clear output specification and capability of measuring performance and VM2-Competitive and transparent bid process and operations.

Insert Table 2 here

Two items loaded on cluster two, VM12-Low life-cycle cost and economic sustainability and VM7-Improved facilities to the users. Three items on cluster three, VM3-Early service delivery and efficiency drive, VM4-Efficient dispute resolutions, and VM5-Quality of life and the growth of social, technical, and economic aspects. Two items on cluster four, VM14-Optimisation of assets efficiency and connectivity to smart functions and VM16-Technical innovation.

Insert Fig. 1 here

And finally, two items on cluster five, VM10-Incentives for private party and VM11-Long-term engagement and knowledge management. Items VM6-Appropriate capital structure and the availability of assets and finance, VM8-Optimised risk allocation and business models, VM9-

Improved services to the community and integration with other smart services, VM13-Low tariffs, and VM15-Private sector's expertise and diffusion of smart technologies did not load successfully on any cluster, however they will not be eliminated yet and will be checked again if they have any significance on the model fit through the CFA analysis.

In the new model (Table 3) the minimum was achieved where Chi-square was insignificant at 0.185 with a value of 40.08 (degrees of freedom=33) which indicated that the model has a good fit. The model suggested significant regression paths as shown in Figure 1.

Insert Table 3 here

However, RMSEA is greater than the threshold of 0.08. the model suggested possible improvement regression relationships of VM3-Early service delivery and efficiency drive with VM14-Optimisation of assets efficiency and connectivity to smart functions and VM16-Technical innovation. Furthermore, a regression between VM16 and latent 3 (Growth and efficiency). The model is further modified to improve the indices all the while keeping theoretical sense to achieve the objectives of the study.

Insert Fig. 2 here

A final model was produced with three latent variables (Figure 2) were sufficient to explain the variance by replacing and deleting some of the measures to achieve the best fit model.

Insert Table 4 here

The final model (Table 4) had a TLI =0.969, CFI=0.981, and RMSEA=0.049. At the current state, and to maintain the theoretical objectives of the study, it can be concluded that the model fit of the confirmatory factor analysis for the modified model of PPP value for money factors is acceptable, as it successfully meets the cut-off values.

The modified latent clusters consisted of the following measures: Cluster one (VM1-Clear output specification and capability of measuring performance, VM4-Efficient dispute resolutions, VM8-Optimised risk allocation and business models, VM9-Improved services to the community and integration with other smart services, and VM12-Low life-cycle cost and economic sustainability. Cluster two: (VM6-Appropriate capital structure and the availability of assets and finance, VM14-Optimisation of assets efficiency and connectivity to smart functions, VM15-Private sector's expertise and diffusion of smart technologies, and VM16-Technical innovation. And Cluster three (VM10-Incentives for private party and VM11-Long-term engagement and knowledge management)

4. Results and discussion

The first latent variable established from the SEM analysis for VFM assessment in smart infrastructure projects included 5 factors, clear output specification for measuring performance, efficient dispute resolutions, optimized risk allocation and business models, improved and integrated services to the community, and economic sustainability. This variable was themed economic sustainability for smart infrastructure projects. This cluster established a clear complementarity between the contractual cost theory and the agency theory in determining the value for money assessment for smart infrastructure projects (Gottschalk and SolliSther, 2005). Transaction costs arise because complete contracting is sometimes impossible, and partial contracts need recurrent renegotiations when the power balance between the transacting parties shifts (Gottschalk and SolliSther, 2005). Agency theory is concerned with two difficulties that may emerge during agency interactions. The first is the agency problem, which happens when the principal's and agent's objectives or goals clash. The second problem is risk sharing, which happens when the risk preferences of the principal and agent differ (Eisenhardt, 1989).

Clear output specification for measuring performance. To add to the value for money goals of a PPP project, it is critical for the safe execution of long-term projects, such as PPPs, to provide consistent output specifications for calculating efficiency, rather than only inputs, since inputs are expected to change over the long lifespan of the y project (Lam and Yang, 2020). For the economic sustainability of the project, performance measures need to be undertaken to ensure the long-term viability and to incentivize the contractor for quality services. This is in line with recommendations of Liu et al. (2014). A structured approach to coping with dispute resolutions variations reduces the likelihood of disagreements and lays the groundwork for renegotiations. Renegotiations are the most effective way to cope with input changes for long-term initiatives such as smart infrastructure projects to guarantee their longevity. (Malek and Gundaliya, 2021). Optimized risk allocation is often essential in the private party's commitment. Risk should be assigned to the party most suited to manage it. The public party should not transfer any risks that the private party is not interested in handling. If all risks are assigned to the appropriate party, less unforeseen events from the already complex smart cities and infrastructure projects may be anticipated, and the private party can commit more to the project because they will feel protected from hazards that do not belong to them. This is in line with current studies supporting the importance of optimizing the risk allocation for the economic sustainability of the project (Malek and Gundaliya, 2021; Lomoro et al., 2020). Improved and integrated services to the community will be obtained by giving the private sector a buffer to implement emerging innovations and creative growth concepts that are the underpinning requirements for smart cities, where efficiency in development costs is often expected. As a result, the community would benefit from improved amenities as well as lower tariffs and utility costs for accessing those facilities and services (Almarri, 2021; Jayasena et al., 2020). As for the economic sustainability, the value for money gained by project sustainability is even more realistic due to the low life-cycle cost advantage achieved through PPP models. The convergence of all production processes, including planning, construction, management, maintenance, financing, and so on, helps to reduce waste and best utilize resources, resulting in better value for money. (Jayasena et al., 2020; Lomoro et al., 2020).

The second latent variable that emerged from the SEM analysis was named optimization and smart technologies included 4 factors: appropriate capital structure and collaterals, smart asset management, diffusion of smart technologies, and technical innovation. There was an obvious influence of the innovation diffusion theory in modifying this cluster, which focuses on the study of how, why, and at what rate innovative ideas and technologies spread in a social system (Wani and Ali, 2015).

Appropriate capital structure and collaterals often provide a plethora of public gains, since the most sustainable capital structure leads to the lowest investment expense, which determines the public service charges. There are all advantages that end users see as good value for money when it comes to using PPP models (Lam and Yang, 2020). By giving the private party flexibility in introducing the most viable solutions for structuring the project's finances and offering them access to viable collaterals and financial institutions, the most cost competitive project can be accomplished with the state of art technology for achieving financial equilibrium, resulting in the introduction of new technologies and techniques for the public sector to adopt for future smart infrastructure projects. This is in line with the findings of Weber et al., (2016). The value for money in the form of financial efficiency is expected to be achieved by optimizing asset efficiency, and this would entail leveraging technologies to better manage the assets, where the optimal use of all assets to produce the best value for the project will be a priority. The activities will often involve the asset's alignment with other properties, as well as preventive and corrective maintenance steps to ensure the asset's sustainability (Malek and Gundaliya, 2021). As for the diffusion of smart technologies, the application of new technologies by the contractor to reduce cost, improve quality, and minimize risk, e.g., using robotics and automation and how they influence the sustainability of the project, will become at the disposal of the public sector to use in the future in their efforts for expanding their smart cities (Hoeft et al., 2021). Technical innovation via the use of cutting-edge concepts and goods is projected to greatly add to the project's long-term viability. Such principles and products can be incorporated into the project's processes and operations, optimizing resource utilization and reducing redundancy while improving the end product and providing the highest value for money spent. (Lam and Yang, 2020).

The third latent variable for assessing the viability of the PPP model was named integration drive and consisted of two factors, incentives for private party and long-term knowledge management. The model developed in this study emphasized the interaction and effect of the partnership theory and the relational exchange theory (Lambe, Spekman and Hunt, 2002). Partnership has frequently been cited as an important aspect of project outsourcing. Partnership can reduce the risk of insufficient contractual provisions, which can be reassuring and attractive to parties contemplating outsourcing as a complex and expensive activity (Lambe, Spekman and Hunt, 2002). Relational norms also serve as the foundation for relational exchange theory. According to this viewpoint, the key to evaluating how well contract governance is carried out is in the relational norms between the transactors (Gottschalk and SolliSther, 2005).

As private parties are given incentives to participate in projects, the financial efficiency of the PPP project improves. Incentives may include tying returns to performance, improved risk sharing, subsidies, off-take agreements, guarantees, and so on. Further incentives may be awarded for the integration with other projects and services within the government’s smart cities initiatives. These steps are expected to maximize the private party's performance, the government’s gains, and inching closer to a smarter infrastructure (Hoeft et al., 2021; Lam and Yang, 2020). And the other factor for the integration drive variable was long-term knowledge management. If the private party is able to use their accumulated knowledge and skills in executing the project, where prior insights and exposure to the latest technologies can be used for project completion, value for money can be achieved in the context of time and financial performance. Furthermore, the contractor's digitization process to analyze and enhance the users' experience by employing state of the art sensors and robotics, data mining, expert systems, and connectivity media, will allow unprecedented knowledge transfer to the public sector. It will also allow for the integration of the project with others within the government's portfolio of smart cities and infrastructure, in addition to the adoption of the contractor's new innovations (Lam and Yang, 2020; Jayasena et al., 2020).

5. Conclusion

Despite the fact that VFM factors provided evidence of their benefits in improving the assessment of PPP procurements, previous research did not identify the VFM aspects that are suitable for smart infrastructure procurements, as well as investigate the influence of their interrelationships.

PPPs are important to address the financial issues that come with infrastructure projects, as well as to ensure that these projects achieve their economic and social goals. The purpose of this study was to identify the VFM elements for the success of PPPs in smart infrastructure projects and explore their interrelationships so that decision-makers may assess whether a public-private partnership is the best option for acquiring a project in their endeavor to scale up smart infrastructure projects.

For this endeavor this study followed a three-tiered approach, identifying VFM factors for smart infrastructure projects based on an extensive literature review, data collection using a Likert scale questionnaire, and identifying the most significant factors and estimating interrelationships among them using structural equation modelling. The SEM approach confirms hypothesized relationships on a theoretical level. Eleven VFM factors for smart infrastructure projects were identified (Clear output specification for measuring performance, Efficient dispute resolutions, Optimized risk allocation and business models, Improved and integrated services to the community, Economic sustainability, Appropriate capital structure and collaterals, Smart asset management, Diffusion of smart technologies, Technical innovation, Incentives for private party, Long-term knowledge management) and three interrelated clusters (Economic sustainability, Integration drive, Optimization and smart technologies). The model developed depicted the causal interrelationships among the value for money components, which may assist better assess the procurement method's capacity of satisfying the public client's aims and fulfilling the desires of the greater population. This work fills a research gap and contributes significantly to academic literature, with a focus on PPP in smart cities.

The structure and relationships of the theorized clusters show that numerous theories were evaluated and merged in a creative way to improve the value for money clusters. The theory of core competencies, the resource-based theory, the transaction cost theory, the contractual theory, the partnership and alliance theory, and the agency theory are some of the theories (Gottschalk and SolliSther, 2005; Almarri and Gardiner, 2014). None of the current PPP studies have prioritized the categorization of value for money elements, especially for the types of smart infrastructure projects under consideration. The purpose of the study was to contribute to the theoretical literature through empirical analysis of primary data. The researcher found from a survey of the literature that there is a gap in the literature on the relationship between the PPP value for money elements for smart infrastructure projects, the correlation of such factors, and the relationships between their clusters. This study adds to the theoretical knowledge of the aforementioned theories by increasing their contribution in a novel way through the construction of the underlying clusters and interrelationships. The importance of specific factors and their clusters in boosting PPP outcomes in smart infrastructure programs was emphasized in this study. The study generated updated value for money factors and discovered that some have grown in importance since they not only contribute to greater success, but also have a significant impact on other factors.

This research has resulted in a useful and readily applicable list of factors and clusters of value for money criteria for the implementation of PPP in smart infrastructure projects, assisting public sector management by providing a measure of pre-conditions that can be used as an assessment tool when determining whether a PPP should be used instead of conventional methods. As a result, it assists in overcoming the issues connected with resource allocation and meeting the bare minimum needs prior to committing to the PPP method. When building a PPP in smart infrastructure projects, public sector managers are encouraged to gain more information, particularly if they become aware of how a group of factors may have greater value when weighed collectively.

This study contributes to the body of knowledge about public-sector PPP by opening up new research possibilities for future studies. It provides a clear methodology that is directly drawn from the need to develop new value for money criteria that are highly adaptable for smart infrastructure projects. The updated 16 value for money factors established in this study can be used in any future study dealing with PPP in smart cities.

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Table I: Identification of the value for money factors

Factor	**Sources**

VM 1	Clear output specification for measuring performance	Malek and Gundaliya, 2021 Lam and Yang, 2020 Jayasena et al., 2020 Lomoro et al., 2020 Osei-Kyei et al., 2015 Chou and Pramudawardhani, 2015 Robert et al., 2014 Hwang et al., 2013 Ismail, 2013 Henjewele et al., 2011 Cheung et al. 2009 Akintoye et al., 2005 Li et al., 2005
VM 2	Competitive and transparent bid process and operations	
VM 3	Early service delivery and efficiency drive	
VM 4	Efficient dispute resolutions	
VM 5	Quality of life and the growth of social, technical, and economic aspects	
VM 6	Appropriate capital structure and collaterals	
VM 7	Improved facilities to the users	
VM 8	Optimised risk allocation and business models	
VM 9	Improved and integrated services to the community	
VM 10	Multi-benefit objectives of all stakeholders	
VM 11	Incentives for private party	
VM 12	Economic sustainability	
VM 13	Low tariffs	
VM 14	Smart asset management	
VM 15	Diffusion of smart technologies	
VM 16	Technical innovation	

Table 2. Standardized regression weights of the best fitting measurement model for VFM

Direct path	Estimate	S.E.	C.R.	P
VM2<----- 1	1.000			
VM1<----- 1	1.242	.205	6.063	.000
VM12<----2	1.000			
VM7<----- 2	.783	.159	4.932	.000
VM5<------3	1.000			
VM3<----- 3	1.153	.208	5.541	.000
VM4<----- 3	1.255	.209	6.007	.000
VM16<----4	1.000			
VM14<----4	1.155	.174	6.642	.000
VM10<----5	1.000			
VM11<----5	1.545	.359	4.301	.000

Table 3. VFM fit statistics for CFA

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	33	40.083	33	.185	1.215
Saturated model	66	.000	0		
Independence model	11	437.331	55	.000	7.951

Table 4. Final model indices and adjusted measures

Model	NFI	RFI	IFI	TLI	CFI	RMSEA
Default model	908	.847	982	969	.981	0.098
Saturated model	1.000		1.000		1.000	0.049
Independence model	.000	.000	.000	.000	.000	0.276

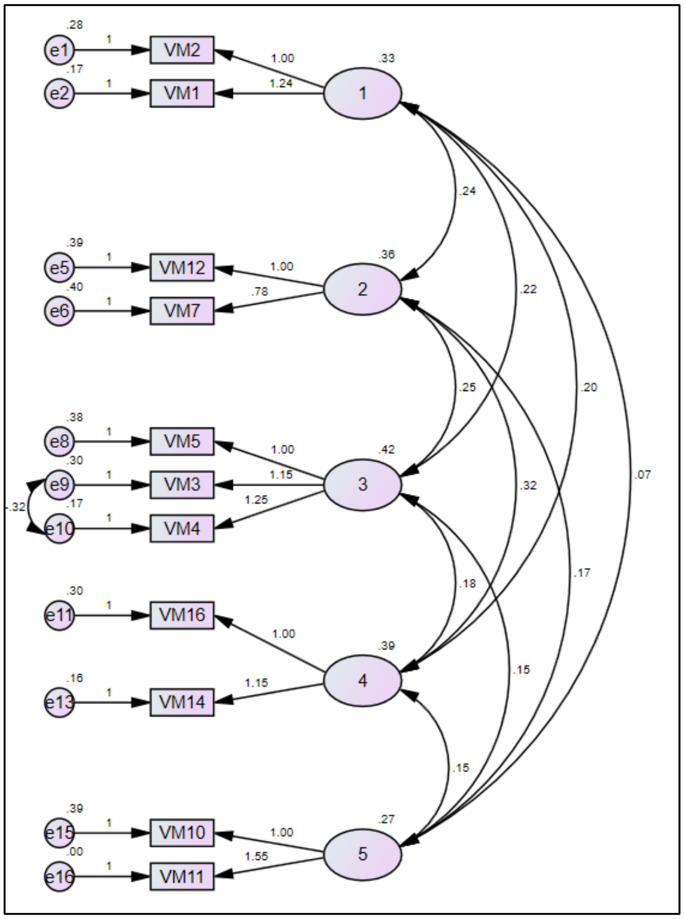

Fig. 1. Conceptual measurement model for value for money factors

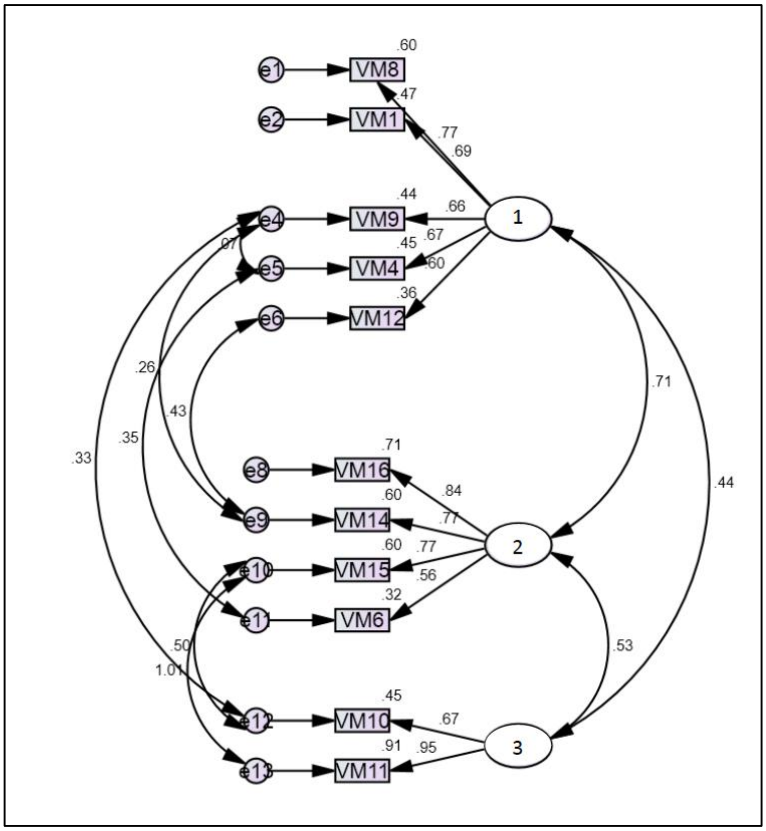

Fig. 2. Improved fit model for the value for money factors