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Is Public–Private Partnership (PPP) a Preferred Strategy for Procuring Smart Infrastructure in Developed Countries: An Empirical Study of the Perceived Benefits, Barriers and Recommended Strategies

Nimesha Sahani Jayasena [1,*], Daniel W. M. Chan [1] and Mohan M. Kumaraswamy [2]

[1] Department of Building and Real Estate, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China; daniel.w.m.chan@polyu.edu.hk

[2] Department of Civil Engineering, The University of Hong Kong, Pokfulam Road, Hong Kong, China; mohan@hku.hk

* Correspondence: nimesha-sahani.jayasena@connect.polyu.hk

Abstract: Attention to Smart Infrastructure (SI) has risen due to its advantages, including better access, increased quality of life, and simplified maintenance management. To develop SI, Public–Private Partnerships (PPPs) are identified as potentially beneficial procurement strategies, which boost capacities to manage risks by pooling diverse resources. However, the applicability of PPP in SI developments in developed countries is scarcely researched. This may be due to underestimating the other potential benefits from PPP, although developed countries may have their own funding to develop SI. Hence, this research aims to evaluate the significant factors influencing the success of PPP in SI projects in developed countries based on public-sector satisfaction (S1), private-sector satisfaction (S2), and end-user satisfaction (S3). A comprehensive literature review was followed by expert interviews and an international survey, focusing on developed countries. The Partial Least Squares Structural Equation Modeling (PLS-SEM) technique was applied to map the connections amongst the influencing factors and S1, S2, and S3. The results reveal that legal and political-related factors significantly impact on S2 and S3, while social barriers significantly impact on S1. The effect of the constructs and factors on S1, S2, and S3 along with their rankings are unveiled in this research paper, providing a sound basis to increase success levels and minimize shortfalls in PPP to boost SI developments in developed countries.

Keywords: Public–Private Partnership (PPP); Smart Infrastructure (SI); developed countries; benefits and enablers; barriers; recommended strategies; Partial Least Squares Structural Equation Modelling (PLS-SEM)

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1. Introduction

Infrastructure plays a major role in our day-to-day lives. A prerequisite for rapid economic development is the provision of appropriate and usually 'advanced' infrastructure services. The use of electricity and water, the disposal of solid waste and wastewater, and travel are all supported by built infrastructure in the urban environment. As a result, many governments have placed a high priority on the expansion and development of infrastructure sectors such as telecommunications, power, trains, highways, ports, and airports [1]. Given the importance of even such basic built infrastructure, rapid urbanization, environmental challenges, health and safety challenges, and heightened demands for a higher quality of life all contribute to the imperative for Smart Infrastructure (SI). Apart from more recent demands as above, according to [2], many cities are struggling to keep up with the rapid expansion of urban areas due to outdated infrastructure and limited funds. As a result, there is more traffic, a lower quality of life, a loss of economic potential, and significant health implications in developed countries as well.

SI provides benefits such as establishing livable surroundings, energy savings, better access, increased quality and value of service, improved public health and safety, and simplified maintenance management, all of which improve inhabitants' quality of life [3–7]; the concept of smart cities and SI has become a popular topic in scientific literature and international policy over recent decades because of these reasons. SI enables greater control and monitoring of operational functionalities than in conventional infrastructure [8,9], and such provisions for connectivity and control of the assets, services, and infrastructure usually constitute the main advantage of SI over conventional infrastructure, increasing the reliability and efficiency of the total asset/facilities management process. Smith [10] also mentioned that SI enables more effective and efficient management, whereby citizens could enjoy a better quality of life with enhanced safety, health, security, and resource and data management. Even though it is evident that SI brings a bundle of benefits improving the quality of life of the citizens, it can be seen that many governments cannot develop SI as a result of the high cost, advanced technologies needed, and management issues. Hence, pooling their resources with the private sector in delivering SI is seen as a smarter solution. Therefore, application of Public–Private Partnership (PPP) in SI developments is a fruitful research area. As there can be many factors affecting the success of PPP in delivering SI, it is essential to identify those factors and investigate how exactly they could influence success.

Hence, conducting a research study on developing a basis to explore the success of PPP in SI development projects in developed countries was identified as a crucial need; further, it was clearly identified upfront that these needs in 'developed' countries may well differ from corresponding needs in 'developing countries' since the former focus more on 'value for money' and 'quality of services to end-users' while the latter may be constrained to focus on a more basic sourcing of project finance itself.

Therefore, this research aims to evaluate the factors affecting the success of PPP in SI developments in developed countries in particular. The research question that the study explores and reports on in this paper is formulated as follows:

What are the principal factors underpinning success in SI developments in developed countries and how are they affecting success?

In construction project management studies, the most widely used types of factors for evaluating project success and potential success were identified as benefits and enablers, barriers, and recommended strategies and enhancing factors (e.g., [11]); hence, the same model was applied to evaluate the success of PPP in SI developments in developed countries. The next step was to identify a basket of suitable measurement criteria to measure the success of PPP in SI projects. Stakeholder satisfaction was identified by Liu et al. [12] as a highly important factor for performance measurement in PPP projects and suggested that it is important to have public-sector satisfaction (S1), private-sector satisfaction (S2), and end-user satisfaction (S3) for the success of a PPP project. Yuan et al., Liu et al., and Mladenovic et al. [13–15] also explained a similar perspective on the importance of satisfaction of the stakeholders for the success of PPP project. Moreover, it was concluded that S1, S2, and S3 would capture the many other diverse subfactors that lead to satisfaction, making them key to assessing the success of a PPP project; hence, they were used in this research to measure the success of PPP in SI developments in developed countries. Therefore, this research aims to evaluate the factors affecting the success of PPP in SI developments in developed countries, where success is measured in terms of S1, S2, and S3. The findings of the study deliver a solid basis for developed countries to target and achieve success through PPP in delivering SI projects.

2. Literature Review: Significance and Use of Public–Private Partnership (PPP) in Smart Infrastructure Developments in Developed Countries

SI is becoming more important in both developed and developing countries to enable people to live better lives in a sustainable and safe manner [16]. It can be seen that developed countries focus more on upgrading the existing infrastructure to be smart rather than developing SI as a whole new project [17] as they already have the required basic infrastructure facilities. This is a major difference between developed and developing countries, as many developing countries do not have the basic infrastructure facilities. However, development of SI is a challenging, complex process, whether in a developed country or a developing country. The reasons behind this range from different discourses deployed by technologists and legislators and lack of capability to relate urban sustainability concerns, to pressures on social and territorial cohesion necessitating distinct governance solutions [18]. Further, the need of interdisciplinary Research and Development exercises in developing SI can be seen as a major barrier. As explained by Tan and Taeihagh [19], even though there is an emerging requirement of delivering SI, high financial costs incurred in infrastructure development and maintenance, as well as various governance challenges act as barriers to development. According to [3], challenges in developing SI in both developed and developing countries include inadequacy of financial resources, lack of knowledge and competencies, lack of citizen participation, political uncertainties, and the diversity of stakeholders. To overcome these various challenges generated when developing SI, PPP in SI developments was identified as a potential solution by Jayasena et al. [3] and Selim et al. [20].

It can be determined that many governments in both developed and developing countries are in dire need of long-term planning to meet rapid population growth, urbanization, and environmental degradation, thereby increasing the significance of SCs and SI [21,22]. SI requires special systems and features compared to conventional infrastructure [23], e.g., with more advanced software, technologies, components, and applications, usually also involving digitalization, robotics and Artificial Intelligence (AI), and multiple stakeholders, thereby incurring higher costs in development. Further, SI developments are liable to higher risks than conventional infrastructure, also reinforcing the need for private sector inputs [16]. However, since governments and related administrative bodies are in desperate need of deploying SI to enhance the quality of life of citizens, the ways forward are increasingly sought through PPPs. In pandemic situations, it was seen that many governments have inadequate funding or resources to even protect public health. This strengthens the case for PPP as a good strategy for developing SI. However, as in the COVID-19 pandemic situation worldwide, it is seen that the 'private sector' also sometimes needs government support and financial relief in lockdown situations; hence, mutual benefits do accrue in such partnerships.

Governments in developed countries such as the United States, the United Kingdom, and Australia have also used PPPs to leverage private money and upgrade, rehabilitate, and maintain infrastructure [24]. For example, in Australia, the Wodonga Wastewater Treatment Plant Project and the Ballarat North Water Reclamation Project are two examples of successful PPP infrastructure delivery projects. The Chicago skyway project and the Indiana toll road are two examples of the deployment of PPP in infrastructure development projects in the United States. As a result, PPPs are becoming increasingly popular in several developed countries as a means of acquiring and delivering public services and infrastructure. PPP has been used in developing smart cities in developed countries as Japan [25], and according to Manville et al. [26], there are many smart city initiatives that span across multiple countries in Europe and are funded by the European Union through the Competitiveness and Innovation Programme (CIP) and PPPs.

However, there have been unsuccessful PPPs in infrastructure developments as well. By looking at these examples and the significance of PPP in Smart Infrastructure developments, which were summarized in the literature review section, it is evident that there is an imperative for researching the factors affecting the success of PPP in SI developments in developed countries. There are a limited number of research studies, which have discussed the application of PPP in delivering SI. Through these published literatures, the following factors, which are presented in Table 1, were identified as the factors affecting the success of PPP in SI projects.

Table 1. Factors affecting the success of PPP in delivering SI.

Factors Affecting the Success of PPP in Delivering SI	Literature Source
Statutory/Regulatory provisions to supplement government resources in PPP	[20]
Supportive legal framework	[3,16,20]
'PPP-friendly' (favorable) policies	[3,16]
Political influences and instability of collaboration commitments to the private sector	[27]
Unstable governments or frequent political shifts	[27]
High cost of development of SI	[3,20,27]
Restrictive and/or complex financial infrastructure	[28]
Uneven and inefficient risk allocation of PPP projects	[3,16,29]
Lack of local and foreign investors in delivering SI	[3]
Need of advanced technological capacities and/or adaptability for SI	[3,16,20]
Higher construction risk if using smart technologies and PPP approaches	[3]
Public/community support	[30,31]
Understanding and acceptability of PPP delivery modalities by the general public	[3,20]
Lack of knowledge and competencies of both the public and private parties	[3,20,32,33]
Multistakeholder coordination complexities	[3,20]

3. Development of the Research Framework and Hypotheses

A three-step procedure was followed to identify the factors affecting the success of PPP in SI development projects. In the first step, a comprehensive literature review was conducted in order to identify the factors affecting PPP in delivering SI. These identified factors from the published literature are presented in Table 1. In the second step, 10 expert interviews in developed countries helped to identify currently perceived (in practice) benefits and enablers, barriers, and recommended strategies and enhancing factors. These were grouped by distilling the perceptions of the experts, which were obtained through expert interviews using the content analysis technique. Finally, in the third step, the identified factors from the literature review and the expert interviews were compared and the final factors were derived, categorized, and validated based on the expert opinions obtained through interviews. This final set of factors is presented in Table 2.

Table 2. Constructs and measurement items.

	Constructs for Benefits and Enablers	Code	Measurement Items
1.	'Political and Legal' (PLBE)	PLBE 1	Clear government objectives
		PLBE 2	Favorable investment climate
		PLBE 3	Supportive legal framework
		PLBE 4	Flexible existing regulations and procurement guidelines
		PLBE 5	'PPP-friendly'(favorable) policies
		PLBE 6	Statutory/Regulatory provisions to supplement Government resources in PPP in delivering SI development projects
		PLBE 7	Clear and proactive PPP guidelines
		PLBE 8	Desire to have public sector administration cost reductions
2.	'Financial and Economic' (FEBE)	FEBE 1	Sound economic policies
		FEBE 2	High cost of SI development
		FEBE 3	Tax benefits
		FEBE 4	Independent competitive tendering
		FEBE 5	High potential for financial investments

Table 2. *Cont.*

	Constructs for Benefits and Enablers	Code	Measurement Items
3.	'Technical' (TBE)	TBE 1	Efficient PPP project management
		TBE 2	Private sector innovativeness in smart technologies
		TBE 3	Drivers to upgrade and/or adapt technological capacities
		TBE 4	Previously used PPP frameworks/management models
		TBE 5	Drivers to increase "value for money" from SI services through more-efficient, lower-cost, and/or reliable services
4.	'Social' (SBE)	SBE 1	Societal needs/'demand' for Smart Infrastructure
		SBE 2	Public/community support
		SBE 3	General public's understanding and acceptability of PPP delivery methods
		SBE 4	Ensuring proper knowledge transfer from the private partner to the public partner
		SBE 5	Drivers to create more local job opportunities
	Constructs for Barriers	Code	**Measurement Items**
1.	'Financial and Economic' (FB)	FB 1	Restrictive and/or complex financial structure
		FB 2	Currency rate fluctuations
		FB 3	Unavailability of investor-friendly tax conditions
		FB 4	Tariff changes
		FB 5	Uneven and inefficient risk allocation of PPP projects
		FB 6	Lack of adequate local and foreign investors with financial capacities to fund SI
2.	'Legal and Sociopolitical' (LSPB)	LSPB 1	Weak/inconsistent legal PPP framework
		LSPB 2	Unavailability/lack of relevant policies
		LSPB 3	Political influences and instability in selecting and administering private sector collaborations
		LSPB 4	Lack of government support for private sector collaboration
		LSPB 5	Inconsistent administrative systems
		LSPB 6	Dishonest/unethical practices and corruption
		LSPB 7	Barriers to transferring ownership/management control of the assets and/or repatriating funds
		LSPB 8	Lack of confidence of the government in private sector collaborators
		LSPB 9	Frequent political/policy shifts affecting SI development and operations
		LSPB 10	Lack of accountability in governance
		LSPB 11	Lack of mechanisms to attract long-term finance from private sources
		LSPB 12	Less competition due to high tendering costs
3.	'Social' (SB)	SB 1	Lack of related knowledge and competencies of the various stakeholders
		SB 2	Citizens' general reluctance to accept private sector involvement
		SB 3	Public opposition due to perceptions of risks of involving private sector in using PPP (rather than only Government) in SI development
		SB 4	Inconsistency between the interests of citizens and private investors
		SB 5	Privacy concerns (e.g., the need to maintain confidentiality of personal information)
		SB 6	Unawareness due to absence of well-defined benefits in SI that would improve citizens' quality of life
		SB 7	Multi-stakeholder coordination complexities
		SB 8	Lack of a PPP-conducive national culture
		SB 9	Lack of private sectors' consideration on sustainable construction and development

Table 2. *Cont.*

	Constructs for Benefits and Enablers	Code	Measurement Items
4.	'Technical' (TB)	TB 1	Unclear scope of work
		TB 2	Higher construction risk of using smart technologies
		TB 3	Difficulties in evaluating dissimilar PPP Proposals/Tenders and their potential impacts
		TB 4	Complex decision making process due to excessive variables and scenarios involved in smart-infrastructure projects
		TB 5	Lack of 'intellectual property rights' protection
		TB 6	Lack of critical resources available to the private parties
		TB 7	Security shortfalls (against 'hacking'/sabotage) and resilience of some smart systems
		TB 8	Inefficient provisions in facility operation and maintenance
		TB 9	Lack of reliable support-infrastructure
	Constructs for Recommended Strategies and Enhancing Factors	Code	**Measurement Items**
1.	'Stakeholder' Related (SREF)	SREF 1	Appropriate equitable risk allocation and sharing
		SREF 2	Clarity of roles, responsibilities, and potential rewards among contracting parties
		SREF 3	Effective stakeholder management
		SREF 4	Strong support from local banks and other relevant bodies
2.	'Legal and Sociopolitical' Related (LREF)	LREF 1	Stable and consistent laws, regulations, and policies
		LREF 2	Proactive national policy for PPP in SI development
		LREF 3	Proactive 'PPP and SI'-friendly laws and regulations
		LREF 4	Protection mechanisms against political volatility
		LREF 5	High transparency of the procurement process
		LREF 6	Extensive vendor and end-user engagement in designing the appropriate PPP structure
		LREF 7	Encouraging competitive bidding from private participants with innovative alternative smart solutions
		LREF 8	Ensuring project continuity and end-user benefits through a long-term commitment
		LREF 9	Enabling public and/or private sectors' equity stakes in innovative PPP SI projects
3.	'Technical' Related (TREF)	TREF 1	Defining minimum functional needs with requisite technical specifications
		TREF 2	Well-structured, equitable, and enforceable contracts
		TREF 3	Highly transparent contracting process
		TREF 4	Periodic high-level reviews and remedial actions throughout the whole project delivery process
		TREF 5	Mechanisms for faster project implementations
		TREF 6	Moving from silo-based to collaborative team working
4.	'Social' Related (SRF)	SRF 1	Effective frequent engagement with end-users and the general public
		SRF 2	Community capacity building
		SRF 3	Citizen centric decision making process
		SRF 4	Ensuring more tangible benefits for the general public
5.	'Financial' Related (FREF)	FREF 1	Proactive facilitation of capital and finance
		FREF 2	Proactive addressing of the private sector's financial priorities and concerns

The factors presented in Table 2 are used as the basis for deriving the quantitative findings of this study.

The research framework for this study is based on both theoretical and logical foundations. Partial Least Squares Structural Equation Modelling (PLS-SEM) method was used to develop the models, which was conducted in two phases.

Phase 1: Validating the quality of the gathered data and quantifying the relationships between the latent variables and their manifest variables in a measurement model. Latent variables are hidden variables, which cannot be seen or directly measured, and manifest variables are observed variables that indicate the presence of a latent variable [34,35].

Phase 2: Specifying the relationships between the latent variables in the structural model.

Figure 1 presents the hypotheses testing framework of the research study. The hypothesis was that the categories of factors (i.e., (1) benefits and enablers, (2) barriers, and (3) recommended strategies and enhancing factors) collectively influence the success of PPP in SI development projects. Therefore, these factors should be simultaneously analyzed. The success of PPP in SI developments was measured using three factors, which are S1, S2, and S3.

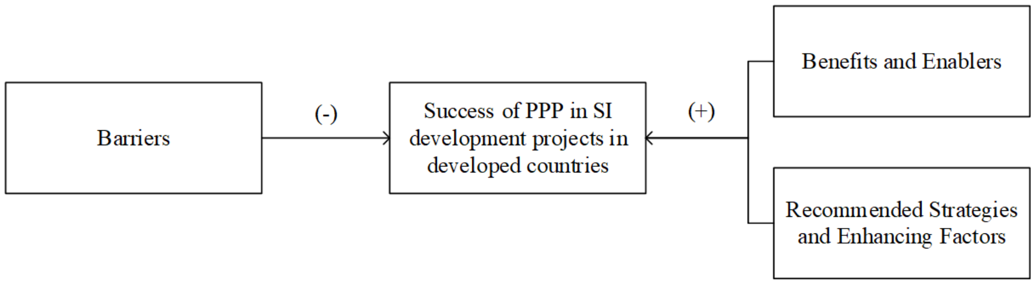


Figure 1. Hypotheses testing framework of the research study.

To evaluate the effect of the factors using PLS-SEM, a conceptual model was developed presenting the connections among latent variables and the relative manifest variables. The conceptual model was developed based on the three categories, benefits and enablers, barriers, and recommended strategies and enhancing factors, affecting the success of PPP in SI projects in developed countries. As per Table 2, 23 benefits and enablers were identified and categorized into four constructs as 'Political and Legal', 'Financial and Economic', 'Technical', and 'Social'. Barriers were also identified and categorized under the four constructs of 'Financial and Economic', 'Legal and Socio-Political', 'Social', and 'Technical', totaling 36 barriers. Furthermore, 25 recommended strategies and enhancing factors were identified and also categorized into five constructs as 'Stakeholder' Related, 'Legal and Sociopolitical' Related, 'Technical' Related, 'Social' Related, and 'Financial' Related, as presented in Table 2.

Findings derived through the literature and the expert interviews generally confirm that barriers can hinder, if not obstruct success in PPP in SI development projects—that is, barriers have a potentially negative influence on S1, S2, and S3. Meanwhile, it was confirmed that enablers and enhancing factors help to achieve success in PPPs in SI projects and have a positive influence on the success of PPP in SI development projects (S1, S2, and S3). In light of these insights and in the context of the above research framework, the following research hypotheses are proposed:

HE1a, HE1b, HE1c: PLBE have positive influence on S1, S2, S3, respectively
HE2a, HE2b, HE2c: FEBE have positive influence on S1, S2, S3, respectively
HE3a, HE3b, HE3c: TBE have positive influence on S1, S2, S3, respectively
HE4a, HE4b, HE4c: SBE have positive influence on S1, S2, S3, respectively
HB1a, HB1b, HB1c: FB have negative influence on S1, S2, S3, respectively
HB2a, HB2b, HB2c: LSPB have negative influence on S1, S2, S3, respectively
HB3a, HB3b, HB3c: SB have negative influence on S1, S2, S3, respectively
HB4a, HB4b, HB4c: TB have negative influence on S1, S2, S3, respectively
HR1a, HR1b, HR1c: SREF have positive influence on S1, S2, S3, respectively

HR2a, HR2b, HR2c: LREF have positive influence on S1, S2, S3, respectively
HR3a, HR3b, HR3c: TREF have positive influence on S1, S2, S3, respectively
HR4a, HR4b, HR4c: SRF have positive influence on S1, S2, S3, respectively
HR5a, HR5b, HR5c: FREF have positive influence on S1, S2, S3, respectively

4. Research Methodology

4.1. Research Approach

A mixed method research approach was adopted in order to achieve the aim of this study, which is to evaluate the factors affecting the success of PPP in SI developments in developing countries, where the success is measured in terms of public-sector satisfaction (S1), private-sector satisfaction (S2), and end-users satisfaction (S3). The mixed approach of a dual qualitative and quantitative strategy is used to counteract the weaknesses of each individual approach [36]; hence, it was adopted in this research study.

4.2. Data Collection

Data collection for the research was conducted in 4 phases.

- **Phase 1:** A comprehensive literature review was carried out to review the concepts of SI, importance of SI for developed countries, and to review the importance of PPP in SI developments in developed countries. Further, factors affecting PPP in SI projects were identified through the published literature.
- **Phase 2:** Ten expert interviews were conducted to identify the factors affecting the success of PPP in SI development projects in developed countries and to categorize the identified factors into the constructs. Then, the factors identified through the literature review were combined with the factors identified from the expert interviews and the final set of factors was validated based on the expert opinions obtained through interviews.
- **Phase 3:** A pilot survey of the questionnaire was conducted to test the research tools such as questions, survey structure, and distribution channels. The target population of the pilot survey included both academic and industry practitioners (five experts from academia and five experts from the industry), who have expertise, knowledge, and experience in PPP and SI developments. As per the received feedback, the questionnaire was revised to improve the clarity and to be more user-friendly and understandable.
- **Phase 4:** Subsequent to phase 3, the international questionnaire survey in the developed countries was conducted to evaluate the factors affecting the success of PPP in SI development projects in developed countries. The structure of the questionnaire and target population are explained below.

The questionnaire consisted of six sections. The first section explained the aim of the research. The second section was to gather background information of the respondents, including their designation, work sector, profession, country of practice, and experience in SI developments and/or PPP projects. In the third, fourth, fifth, and sixth sections, the respondents were asked to assess the measurement items of benefits and enablers, barriers, and recommended strategies and enhancing factors, respectively, and to assess the importance of public-sector satisfaction (S1), private-sector satisfaction (S2), and end-user satisfaction (S3). The respondents assessed the measurement items on a five-point Likert scale. The Five-point Likert scale has been widely recommended and used in construction management research [11,37] because of its advantage to yield unambiguous results. Initially, a pilot study was also conducted before finalizing the questionnaire.

The population of the survey comprised all the industry practitioners and academics with knowledge and understanding of PPP and/or SI development projects in developed countries. As in [11], there was no sampling frame for this study; thus, the sample was based on nonprobability sampling. Convenience and snowball sampling techniques under nonprobability sampling were used in this survey to have a valid and effective sample size, similar to previous construction management researches such as [11,37–39]. When it is difficult to obtain a response from sample elements chosen at random, snowball sampling is preferred [40]. Müller and Turner [41] investigated the impact of project managers on project success using a similar sample strategy, and this sampling strategy was utilized by Liu et al. [42] to investigate risk routes in building projects.

Using this approach, 220 questionnaires were distributed to potential respondents. Eventually, 101 completed questionnaires from 10 developed countries were returned, corresponding to a 45.9% response rate, and 100 questionnaires were used for analysis after removing the incomplete questionnaire. The central limit theorem was satisfied by this sample size as the sample size was above 30 [11,43]. Further, because SI developments are yet limited within the developed countries, the number of experienced professionals is limited in this research area. According to Hair et al. [44], "PLS-SEM minimum sample size should be equal to the larger of the following: (1) ten times the largest number of formative indicators used to measure one construct or (2) ten times the largest number of structural paths directed at a particular latent construct in the structural model" (p. 144). However, as mentioned in Kock and Hadaya [45] and Goodhue et al. [46], this method can result in erroneous estimates of the minimum sample size. Hence, the minimum R-squared method was used in this study in order to validate the sample size of this study. There are several studies that have used SEM with a smaller sample size than required such as those of Ahmadabadi and Heravi [38], Ozorhon et al. [47], and Yuan et al. [13] to validate their own structures. According to Kock and Hadaya [45], if a researcher is aware that all of the path coefficients of a model will be strong before gathering empirical data, leading to large effect sizes, the researcher can use a smaller sample size in a PLS-SEM analysis. The respondent profiles and the developed countries from which responses were received are shown in Table 3.

Table 3. Respondent profiles.

Demographics	Category	Number of Responses	Percentage
Profession	Engineer	42	42%
	Surveyor	16	16%
	Researcher	18	18%
	Project Manager	12	12%
	Architect	12	12%
Sector type	Public Sector	35	35%
	Private Sector	58	58%
	Both Sectors	7	7%
Years of professional experience	Above 15 years	19	19%
	10–15 years	42	42%
	5–10 years	33	33%
	Less than 5 years	6	6%
Country/Region	Hong Kong	29	29%
	Switzerland	11	11%
	Australia	13	13%
	United Kingdom	9	9%
	Canada	4	4%
	Netherlands	2	2%
	New Zealand	7	7%
	United States	9	9%
	Singapore	7	7%
	Oman	9	9%

Through the analysis of Table 2, it is evident that the respondents for the questionnaire are experienced professionals in developed countries, which strengthens the reliability and validity of the study.

4.3. Data Analysis

In this research, Structural equation modelling (SEM), was used in analyzing the data collected through the questionnaire survey. Since its introduction in the 1980s, SEM) has grown in popularity as a powerful multivariate statistical tool [48]. SEM is a technique that can be used for examining relationships between dependent and independent variables and is based on the general linear model. SEM can be considered as a combination of factor analysis, multiple regression analysis, and path analysis to simultaneously examine the structure of the relationships among constructs [44,49]. The variables (independent and dependent) can be either unobserved or observed variables. SEM has four distinctive features, in the comparison of SEM with traditional correlation analysis. SEM estimates numerous and interrelated dependencies. Moreover, SEM denotes unobserved concepts in these relationships and measurement errors are also being considered in the estimation. Further, the SEM model explains a whole set of relationships [50,51]; as a result of the abovementioned advantages, SEM has been used in an increasing number of studies in the field of construction project management [11,52–55]. As a result, SEM was chosen as the best appropriate data analysis technique for this study.

Two types of SEM techniques were identified as the covariance-based SEM (CB-SEM) and the partial least squares SEM (PLS-SEM). The two models are different and are appropriate for different use in research. The CB-SEM is appropriate for confirmation of established theory while the PLS-SEM is prediction-oriented and appropriate for exploratory and confirmatory research [56]. Furthermore, PLS-SEM is recommended if there is a smaller sample size [44]. Therefore, in this research, PLS-SEM will be utilized for modeling in this study.

5. Research Findings and Discussion

In this section, the findings of the Partial Least Squares Structural Equation Modelling (PLS-SEM) analysis are presented. Three models have been developed based on the benefits and enablers, barriers, and recommended strategies and enhancing factors.

5.1. Benefits and Enablers for Adopting PPPs in SI Developments in Developed Countries

5.1.1. Measurement Model Evaluation

Tables 4 and 5 illustrate the evaluation of the results of the measurement models in the model of benefits and enablers influencing the adoption and success of PPP in SI development projects in developed countries. The model developed through PLS-SEM analysis is presented in Figure 2. Table 4 presents the factor loading, Cronbach's alpha coefficients, Rho_A, composite reliability scores and AVE of the collected data. Factor loadings are standardized regression weights or the correlation coefficient for the variable and factor [57]. Factor loading as an indicator illustrates the variance explained by the variable on that particular factor. Reliability and convergent validity were analyzed by assessing composite reliability and Average Variance Extracted (AVE). These values were obtained using the smartPLS software.

Table 4. Constructs' reliability and validity measures of the benefits and enablers model.

Construct	Measurement Item Code	Factor Loading	Cronbach's Alpha	Rho_A	Composite Reliability	AVE
FEBE	FEBE 1	0.885	0.779	0.808	0.858	0.604
	FEBE 2	0.727	-	-	-	-
	FEBE 4	0.653	-	-	-	-
	FEBE 5	0.824	-	-	-	-
PLBE	PLBE 1	0.879	0.950	0.951	0.958	0.740
	PLBE 2	0.892	-	-	-	-
	PLBE 3	0.824	-	-	-	-
	PLBE 4	0.885	-	-	-	-
	PLBE 5	0.851	-	-	-	-
	PLBE 6	0.863	-	-	-	-
	PLBE 7	0.901	-	-	-	-
	PLBE 8	0.783	-	-	-	-

Table 4. *Cont.*

Construct	Measurement Item Code	Factor Loading	Cronbach's Alpha	Rho_A	Composite Reliability	AVE
SBE	SBE 1	0.892	0.831	0.837	0.887	0.664
	SBE 2	0.802	-	-	-	-
	SBE 3	0.784	-	-	-	-
	SBE 4	0.775	-	-	-	-
TBE	TBE 1	0.882	0.808	0.827	0.869	0.573
	TBE 2	0.617	-	-	-	-
	TBE 3	0.789	-	-	-	-
	TBE 4	0.697	-	-	-	-
	TBE 5	0.773	-	-	-	-

Table 5. Discriminant validity of the constructs of the benefits and enablers model.

Measurement Item Code	FEBE	PLBE	S1	S2	S3	SBE	TBE
FEBE	0.777	-	-	-	-	-	-
PLBE	0.723	0.860	-	-	-	-	-
S1	0.640	0.686	1.000	-	-	-	-
S2	0.540	0.807	0.561	1.000	-	-	-
S3	−0.628	−0.749	−0.569	−0.522	1.000	-	-
SBE	0.738	0.751	0.701	0.576	−0.569	0.815	-
TBE	0.734	0.784	0.770	0.557	−0.643	0.870	0.757

The factor loadings of the measurement items FEBE 3 and SBE 5 were removed from the model as their factor loadings were below 0.50. Subsequent to the deletion of those 2 factors, the analysis was rerun to obtain a reliable and valid model. As illustrated in Figure 2, this study involves only reflective measurement. Therefore, some measurement items can be deleted without affecting the meaning of the construct, as reflective measurement items are highly correlated and substitutable [56]. As the measurement items with a low factor loading contribute insignificantly to the explanatory power of the model and could cause biasing of the estimations of other measurement items, they can be dropped [58].

According to Table 4, Cronbach's alpha coefficients, Rho A, and composite reliability scores of the collected data are above 0.70. This indicates a satisfactory level of reliability and consistency of the measurement items. Convergent validity of the constructs is also satisfactory as all factor loadings and AVEs are above 0.50. An AVE of 0.50 indicates a satisfactory level as the construct explains 50% of the variance in its measurement items. Table 5 presents discriminant validity of the constructs.

As illustrated in Table 5, the Fornell–Larcker criterion was fulfilled as each latent construct's AVE value is greater than the respective construct's highest squared correlation with another construct. The discriminant validity of the constructs was justified as the factor loading of each measurement item on the related construct was higher than the other cross-loadings. Hence, the reliability and validity of this measurement model can be confirmed.

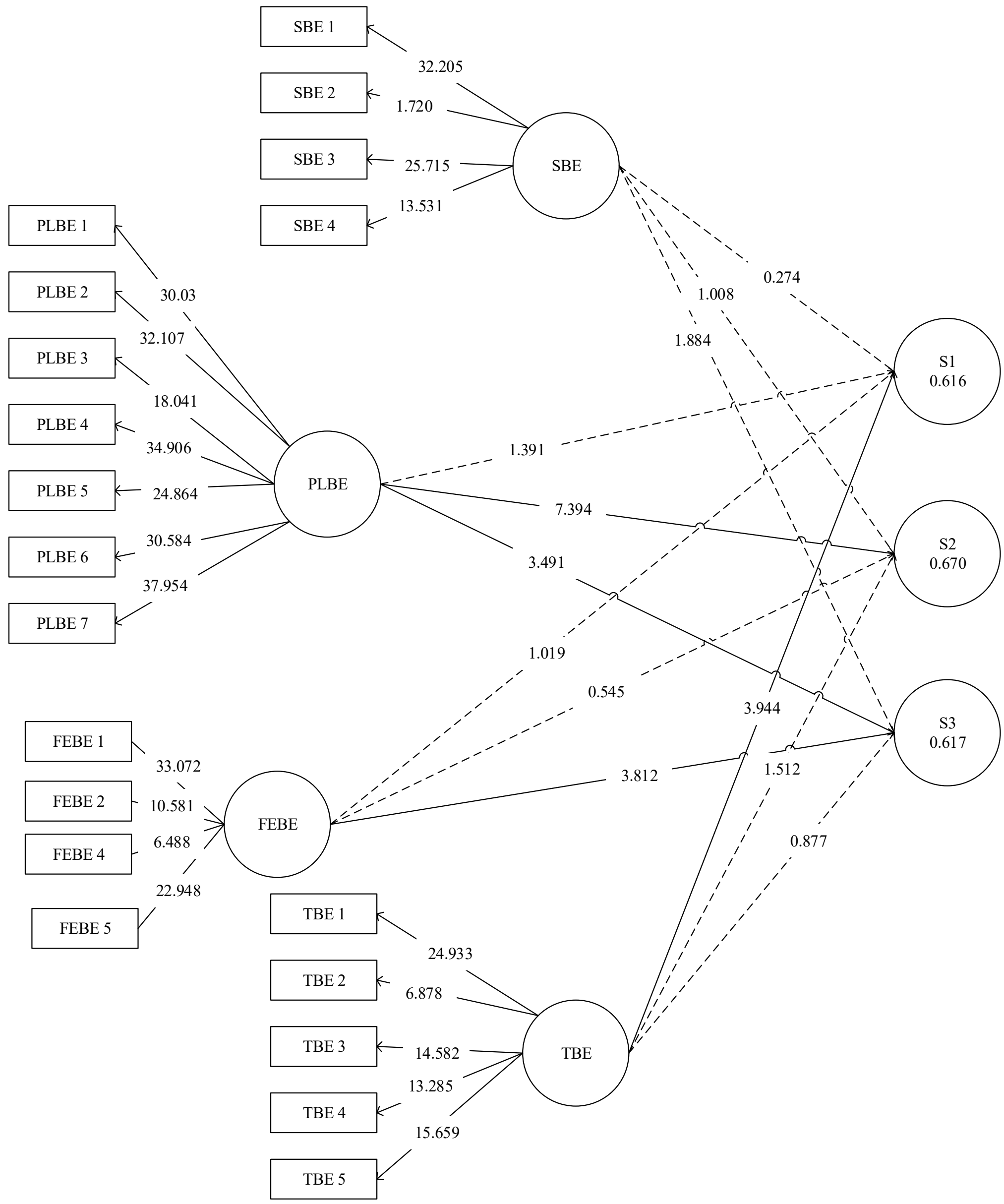


Figure 2. PLS-SEM-based structural model for benefits and enablers.

5.1.2. Structural Model Evaluation

Table 6 illustrates the bootstrapping results for the benefits and enablers PLS-SEM structural model.

According to the presented *t*-values in Table 6, paths linking FEBE—S3, PLBE—S2, PLBE—S3, and TBE—S1 have a *t*-value greater than 2.56. This indicates that these paths are statistically significant at the 0.01 level. Therefore, HE2c, HE1b, HE1c, and HE3a were appropriately supported. According to Ekanayake et al. [52], Darko et al. [11], and Aibunu and Al-Lawati [59], higher path coefficients indicate a greater impact on the variables. Therefore, it can be seen that the strongest path is between PLBE and S2. The dotted lines in Figure 3 illustrate the insignificant paths. The arrows in the structural model indicate the relationship between one construct and another (hypothesized relationship) and the relationship between the measurement items and the construct. The coefficients of determination (R2) value of the dependent variables were greater than 0.3; this further confirmed the model's quality and predictive accuracy [56].

Table 6. Bootstrapping results for the benefits and enablers model.

Paths	Standard Deviation	*t*-Value	*p*-Value
FEBE—S1	0.097	1.019	0.308
FEBE—S2	0.091	0.545	0.586
FEBE—S3	0.087	3.812	*0.000*
PLBE—S1	0.122	1.391	0.164
PLBE—S2	0.130	7.394	*0.000*
PLBE—S3	0.159	3.491	*0.000*
SBE—S1	0.137	0.274	0.784
SBE—S2	0.122	1.008	0.313
SBE—S3	0.135	1.884	0.060
TBE—S1	0.135	3.944	*0.000*
TBE—S2	0.175	1.512	0.131
TBE—S3	0.212	0.877	0.380

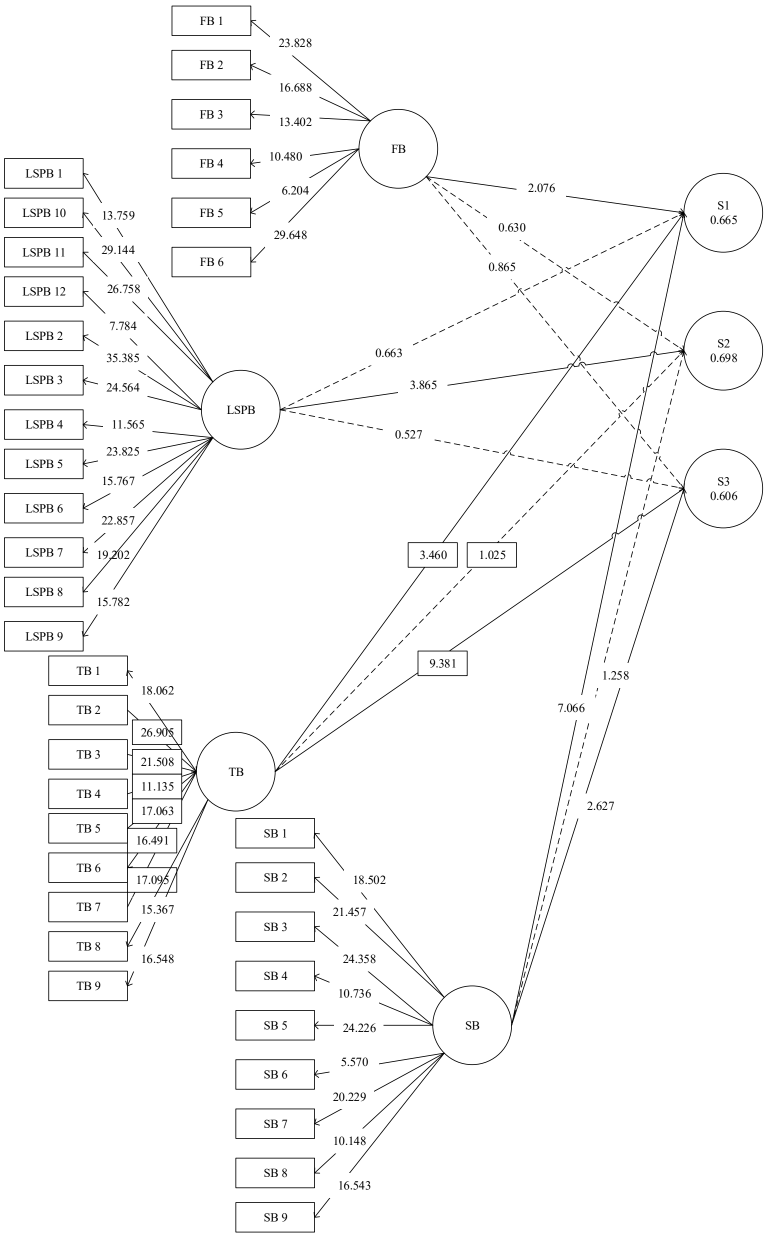


Figure 3. PLS-SEM-based structural model for barriers.

5.2. Barriers to Adopting PPPs in SI Development Projects in Developed Countries

5.2.1. Measurement Model Evaluation

Tables 7 and 8 illustrate the evaluation of the results of the measurement models in the model of barriers influencing the adoption and success of PPP in SI development projects in developed countries. The model developed through PLS-SEM analysis is presented in Figure 3. Similar to the benefits and enablers model, Table 6 presents the factor loading, Cronbach's alpha coefficients, Rho_A, and composite reliability scores and AVE of the collected data regarding the barriers influencing the adoption and success of PPP in SI developments in developed countries.

Table 7. Constructs' reliability and validity measures of the barriers model.

Construct	Measurement Item Code	Factor Loading	Cronbach's Alpha	Rho_A	Composite Reliability	AVE
FB	FB 1	0.747	0.821	0.849	0.870	0.530
	FB 2	0.775	-	-	-	-
	FB 3	0.728	-	-	-	-
	FB 4	0.691	-	-	-	-
	FB 5	0.572	-	-	-	-
	FB 6	0.828	-	-	-	-
LSPB	LSPB 1	0.765	0.940	0.945	0.949	0.611
	LSPB 2	0.862	-	-	-	-
	LSPB 3	0.832	-	-	-	-
	LSPB 4	0.680	-	-	-	-
	LSPB 5	0.820	-	-	-	-
	LSPB 6	0.731	-	-	-	-
	LSPB 7	0.811	-	-	-	-
	LSPB 8	0.810	-	-	-	-
	LSPB 9	0.772	-	-	-	-
	LSPB 10	0.841	-	-	-	-
	LSPB 11	0.856	-	-	-	-
	LSPB 12	0.538	-	-	-	-
SB	SB 1	0.765	0.899	0.905	0.919	0.561
	SB 2	0.829	-	-	-	-
	SB 3	0.858	-	-	-	-
	SB 4	0.686	-	-	-	-
	SB 5	0.807	-	-	-	-
	SB 6	0.535	-	-	-	-
	SB 7	0.805	-	-	-	-
	SB 8	0.707	-	-	-	-
	SB 9	0.694	-	-	-	-
TB	TB 1	0.796	0.916	0.917	0.930	0.599
	TB 2	0.831	-	-	-	-
	TB 3	0.824	-	-	-	-
	TB 4	0.643	-	-	-	-
	TB 5	0.766	-	-	-	-
	TB 6	0.778	-	-	-	-
	TB 7	0.774	-	-	-	-
	TB 8	0.767	-	-	-	-
	TB 9	0.771	-	-	-	-

Table 8. Discriminant validity of the constructs of the barriers model.

Measurement Item Code	FB	LSPB	S1	S2	S3	SB	TB
FB	0.728	-	-	-	-	-	-
LSPB	0.616	0.782	-	-	-	-	-
S1	0.542	0.628	1.000	-	-	-	-
S2	0.599	0.819	0.583	1.000	-	-	-
S3	−0.224	−0.581	−0.345	−0.468	1.000	-	-
SB	0.803	0.653	0.761	0.647	−0.194	0.749	-
TB	0.506	0.883	0.643	0.752	−0.728	0.570	0.774

Similar to the benefits and enablers model, measurement items with a factor loading below 0.50 were searched to be removed from the structural model as the model in this study is only a reflective model. However, in the barriers model, there were no measurement items with a factor loading less than 0.50. According to the Table 7, Cronbach's alpha coefficients, Rho_A, and composite reliability scores of the collected data are above 0.70. This indicates a satisfactory level of reliability and consistency of the measurement items. Convergent validity of the constructs is also satisfactory as all factor loadings and AVEs are above 0.50. An AVE of 0.50 indicates a satisfactory level as the construct explains 50% of the variance in its measurement items.

Table 8 presents discriminant validity of the constructs.

As illustrated in Table 8, the Fornell–Larcker criterion was fulfilled as each latent construct's AVE value is greater than the respective construct's highest squared correlation with another construct. The discriminant validity of the constructs was justified as the factor loading of each measurement item on the related construct was higher than the other cross-loadings. Hence, the reliability and validity of this measurement model can be confirmed.

5.2.2. Structural Model Evaluation

Table 9 illustrates the bootstrapping results for the barriers PLS-SEM-based structural model.

Table 9. Bootstrapping results for the barriers model.

Paths	Standard Deviation	*t*-Value	*p*-Value
FB—S1	0.110	2.076	*0.038*
FB—S2	0.098	0.630	0.528
FB—S3	0.097	0.865	0.387
LSPB—S1	0.119	0.663	0.507
LSPB—S2	0.143	3.865	*0.000*
LSPB—S3	0.184	0.527	0.599
SB—S1	0.110	7.066	*0.000*
SB—S2	0.122	1.258	0.208
SB—S3	0.141	2.627	*0.009*
TB—S1	0.111	3.460	*0.001*
TB—S2	0.142	1.025	0.305
TB—S3	0.105	9.381	*0.000*

According to the presented *t*-values in Table 9, paths linking LSPB—S2, SB—S1, SB—S3, TB—S1, and TB—S3 have a *t*-value greater than 2.56. This indicates that these paths are statistically significant at the 0.01 level. Therefore, HB2b, HB3a, HB3c, HB4a, and HB4a were appropriately supported. The path linking FB—S1 has a *t*-value greater than 1.96, indicating that this path is statistically significant at the level of 0.05. Therefore, HB1a was also appropriately supported. According to Ekanayake et al. [52], Darko et al. [11], and Aibunu and Al-Lawati [59], higher path coefficients point to a greater impact on the variables. Therefore, it can be seen that the strongest path is between TB and S3. The dotted lines in Figure 3 illustrate the insignificant paths. The coefficients of determination (R-square) value of the dependent variables were greater than 0.3; this further confirmed the model's quality and predictive accuracy [56].

5.3. Recommended Strategies and Enhancing Factors for Improving PPPs in Delivering SI Development Projects in Developed Countries

5.3.1. Measurement Model Evaluation

Tables 10 and 11 illustrate the evaluation of the results of the model of recommended strategies and enhancing factors influencing the adoption and success of PPP in SI development projects in developed countries. The model developed through PLS-SEM analysis is presented in Figure 4. Similar to the benefits and enablers model, Table 10 presents the factor loading, Cronbach's alpha coefficients, Rho_A, and composite reliability scores and AVE of the collected data regarding the recommended strategies and enhancing factors influencing the adoption and success of PPP in SI developments in developed countries.

Table 10. Constructs' reliability and validity measures of the recommended strategies and enhancing factors model.

Construct	Measurement Item Code	Factor Loading	Cronbach's Alpha	Rho_A	Composite Reliability	AVE
FREF	FREF 1	0.933	0.869	0.877	0.938	0.884
	FREF 2	0.947	-	-	-	-
LREF	LREF 1	0.716	0.867	0.875	0.895	0.489
	LREF 2	0.816	-	-	-	-
	LREF 3	0.791	-	-	-	-
	LREF 4	0.620	-	-	-	-
	LREF 5	0.578	-	-	-	-
	LREF 6	0.665	-	-	-	-
	LREF 7	0.758	-	-	-	-
	LREF 8	0.705	-	-	-	-
	LREF 9	0.606	-	-	-	-
SREF	SREF 1	0.866	0.836	0.842	0.891	0.672
	SREF 2	0.862	-	-	-	-
	SREF 3	0.750	-	-	-	-
	SREF 4	0.796	-	-	-	-
SRF	SRF 1	0.842	0.877	0.884	0.916	0.731
	SRF 2	0.829				
	SRF 3	0.919	-	-	-	-
	SRF 4	0.826	-	-	-	-
TREF	TREF 1	0.672	0.838	0.842	0.881	0.554
	TREF 2	0.755	-	-	-	-
	TREF 3	0.825	-	-	-	-
	TREF 4	0.723	-	-	-	-
	TREF 5	0.722	-	-	-	-
	TREF 6	0.760	-	-	-	-

Table 11. Discriminant validity of the constructs of the recommended strategies and enhancing factors model.

Measurement Item Code	FREF	LREF	S1	S2	S3	SREF	SRF	TREF
FREF	0.940	-	-	-	-	-	-	
LREF	0.641	0.700	-	-	-	-	-	
S1	0.546	0.643	1.000	-	-	-	-	
S2	0.625	0.811	0.563	1.000	-	-	-	
S3	−0.700	−0.571	−0.497	−0.578	1.000	-	-	
SREF	0.655	0.803	0.577	0.712	−0.757	0.820	-	
SRF	0.507	0.764	0.639	0.638	−0.418	0.684	0.855	
TREF	0.607	0.732	0.745	0.638	−0.546	0.727	0.680	0.744

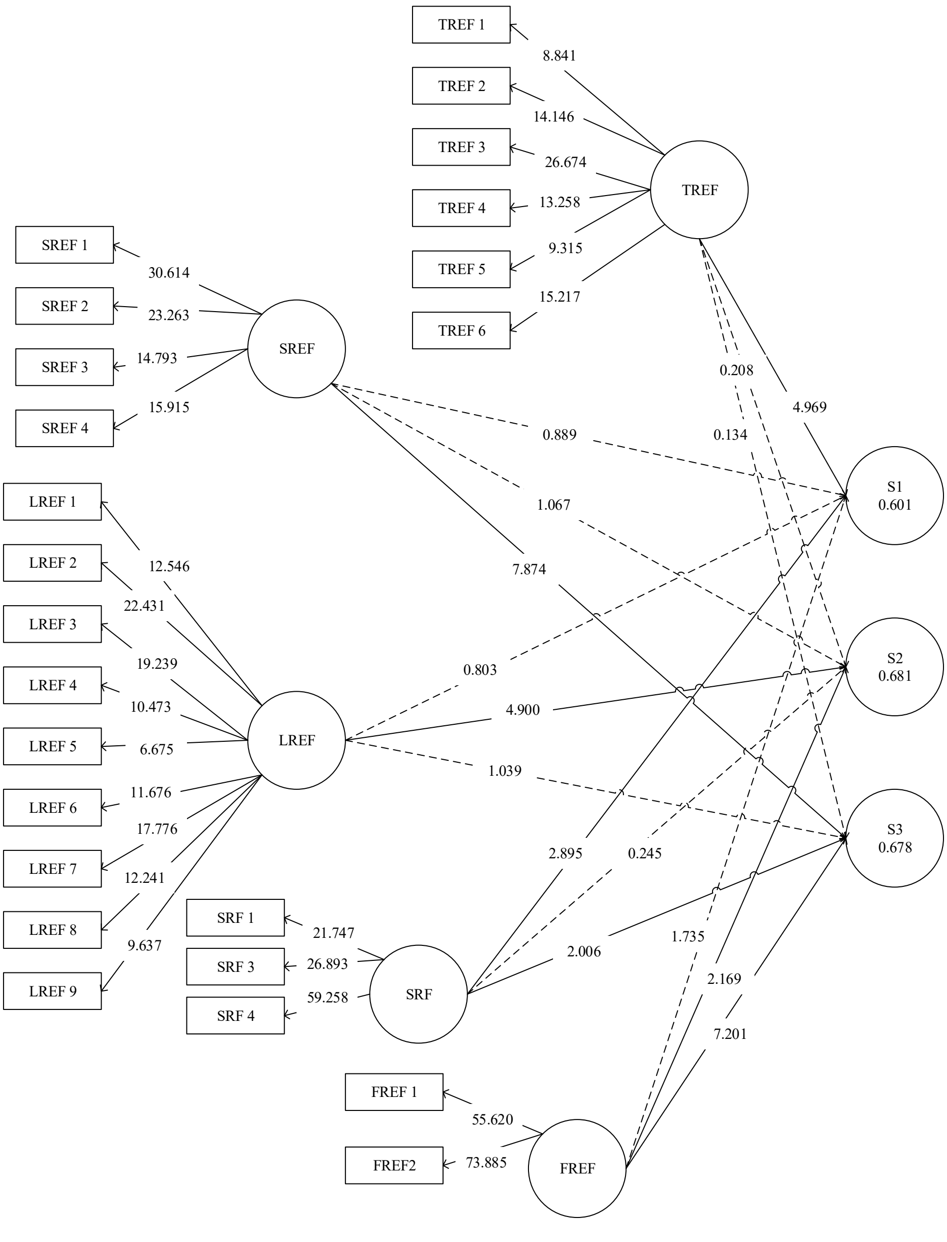


Figure 4. PLS-SEM-based structural model for recommended strategies and enhancing factors.

Similar to the other models, measurement items with a factor loading below 0.50 were searched to be removed from the structural model as the model in this study is only a reflective model. However, in the recommended strategies and enhancing factors model, there were no measurement items with a factor loading less than 0.50. According to Table 10, Cronbach's alpha coefficients, Rho_A, and composite reliability scores of the collected data are above 0.70. This indicates a satisfactory level of reliability and consistency of the measurement items. Convergent validity of the constructs is also satisfactory as all factor loadings and AVEs are above 0.50. An AVE of 0.50 indicates a satisfactory level as the construct explains 50% of the variance in its measurement items.

Table 11 presents discriminant validity of the constructs.

As illustrated in Table 11, the Fornell–Larcker criterion was fulfilled as each latent construct's AVE value is greater than the respective construct's highest squared correlation with another construct. The discriminant validity of the constructs was justified as the factor loading of each measurement item on the related construct was higher than the other cross-loadings. Hence, reliability and validity of this measurement model can be confirmed.

5.3.2. Structural Model Evaluation

Table 12 illustrates the bootstrapping results for the recommended strategies and enhancing factors PLS-SEM-based structural model.

Table 12. Bootstrapping results for the recommended strategies and enhancing factors model.

Paths	Standard Deviation	*t*-Value	*p*-Value
FREF—S1	0.073	1.735	0.083
FREF—S2	0.069	2.169	*0.030*
FREF—S3	0.056	7.201	*0.000*
LREF—S1	0.136	0.803	0.422
LREF—S2	0.124	4.900	*0.000*
LREF—S3	0.113	1.039	0.299
SREF—S1	0.148	0.889	0.374
SREF—S2	0.098	1.067	0.286
SREF—S3	0.091	7.874	*0.000*
SRF—S1	0.074	2.895	*0.004*
SRF—S2	0.062	0.245	0.806
SRF—S3	0.089	2.006	*0.045*
TREF—S1	0.108	4.969	*0.000*
TREF—S2	0.075	0.208	0.835
TREF—S3	0.106	0.134	0.894

According to the presented *t*-values in Table 12, paths linking FREF—S3, LREF—S2, LREF—S3, SREF—S3, SRF—S1, and TREF—S1 have a *t*-value greater than 2.56. This indicates that these paths are statistically significant at the 0.01 level. Therefore, HR5c, HR2b, HR2c, HR1c, HR4a, and HR3a were appropriately supported. The paths linking FREF—S2 and SRF—S3 have *t*-values greater than 1.96 and this indicates that this path statistically significant at the level of 0.05. Therefore, HR5b and HR4c were also appropriately supported. According to Ekanayake et al. (2021), Darko et al. (2018), and Aibunu and Al-Lawati (2010), higher path coefficients state a greater impact on the variables. Therefore, it can be seen that the strongest path is between SREF and S3. The dotted lines in Figure 4 illustrate the insignificant paths. The coefficients of determination (R2) value of the dependent variables were greater than 0.3. Therefore, this further confirmed the model's quality and predictive accuracy [56].

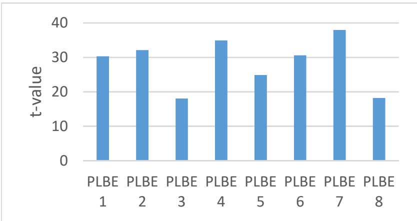
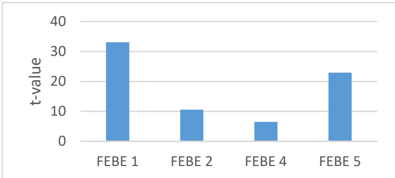
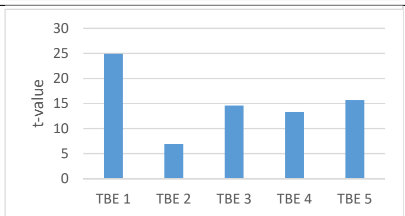
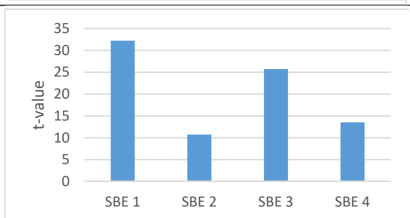
6. Discussion

In this study, a model was proposed to investigate the influences of various benefits and enablers, barriers, and recommended strategies and enhancing factors on the success of PPP in SI development projects in developed countries.

6.1. Benefits and Enablers for Adopting PPPs in SI Development Projects in Developed Countries

Table 13 presents the summary of the findings for benefits and enablers impacting the adoption and success of PPP in SI developments in a developed country. It can be seen that all the measurement items in the model influence significantly on the constructs, which shows the validity of the measurement items identified in this research. The bold ranks in Table 13 present the significant constructs for S1, S2, and S3.

Table 13. Summary of the findings for benefits and enablers.

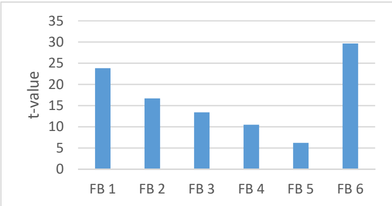
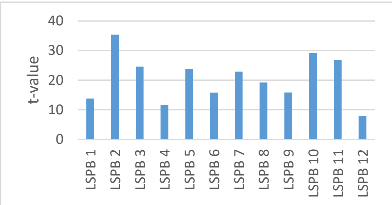
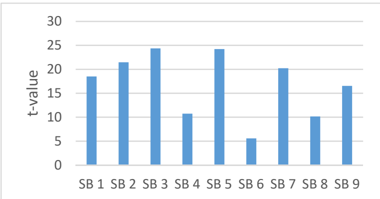
Benefits and Enablers	Construct	Rank for the Impact		
		S1	S2	S3
	PLBE	2 (1.391)	**1 (7.394)**	**2 (3.491)**
	FEBE	3 (1.019)	4 (0.545)	**1 (3.812)**
	TBE	**1 (3.944)**	2 (1.512)	4 (0.877)
	SBE	4 (0.274)	3 (1.008)	3 (1.884)

Technical benefits and enablers (TBE) have been recognized as the most significant influencing construct on public sector satisfaction (S1) in a developed country, which in turn affects the adoption and success of PPP in SI development projects. As the public sector does not have the required technical know-how, it is clear that TBE affects mostly as benefits and enablers for the satisfaction of public sector. Moreover, it has been identified that financial benefits and enablers (FEBE) do not affect S1 significantly in developed countries. The reason for this result is also clear, as the governments of developed countries have the required financial capabilities to finance their infrastructure developments. In consideration of private sector satisfaction (S2), it is clear that the PLBE has the greatest impact, which has a substantial impact on the acceptance and success of PPP in SI development projects in a developed country. This could be due to the private sector's willingness to obtain the PLBE for their projects in exchange for delivering a service to the population. It has also been identified that TBE, SBE, and FEBE do not have a significant impact on S2 in developed countries. This could be because the private sector already has the financial and technological capacity to carry out the developments, but they require PLBE to complete the projects. For the satisfaction of the end users (S3), it can be determined that there is a significant influence from the PLBE and FEBE. Among all the constructs, for the success of PPP in SI projects in developed countries, PLBE affects the most.

6.2. Barriers to Adopting PPPs in SI Development Projects in Developed Countries

Table 14 presents the summary of the findings for barriers impacting on the success of PPP in SI developments in developed countries. It can be seen that all the measurement items in the model influence the constructs significantly, which also shows the validity of the measurement items of the barriers identified in this research. The bold ranks in Table 14 present the significant constructs for S1, S2, and S3.

Table 14. Summary of the findings for barriers.

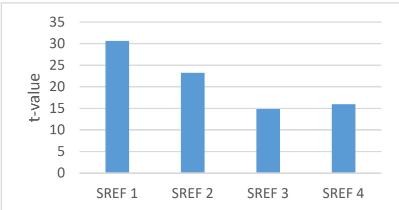
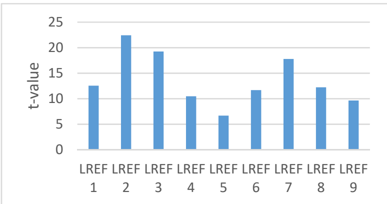
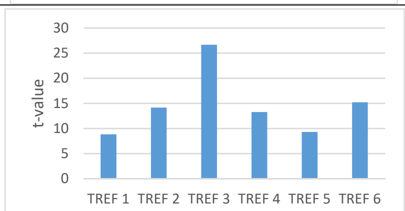
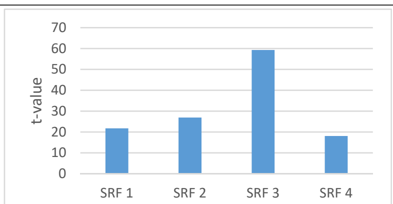
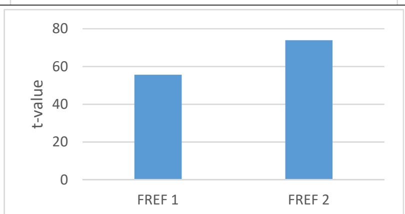
Barriers	Construct	Rank for the Impact		
		S1	S2	S3
	FB	**3 (2.076)**	4 (0.630)	3 (0.865)
	LSPB	4 (0.663)	**1 (3.865)**	4 (0.527)
	SB	**1 (7.066)**	2 (1.258)	**2 (2.627)**
	TB	**2 (3.460)**	3 (1.025)	**1 (9.381)**

In a developed country, social barriers (SB) have been identified as the most significant influences on S1. This is due to the fact that the public sector should always view citizens as vital stakeholders in every endeavor. Technical barriers (TB) can be seen as the second significant influencers. Legal and sociopolitical barriers (LSPB) do not seem to impact significantly on the S1. When it comes to S2, it is clear that LSPB has the most impact. Therefore, it can be seen that the private sector involved in SI projects in developed countries also considers barriers in the legal background such as weak/inconsistent legal PPP framework, barriers to transferring ownership/management control of the assets and/or repatriating funds, frequent political/policy shifts affecting SI development and operations, etc. For S3, it is seen that TB affects the most. This could be due to TB in the utilization of SI; if there are numerous TBs, the project would fail, negatively impacting S3. SBs also have a considerable impact on S3, while it is evident that there is no considerable impact from LSPB and FB to S3, which can be expected as the end-users do not need to consider the LSPB and FB in executing a project, as do the public sector and private sector.

6.3. Recommended Strategies and Enhancing Factors for Improving PPPs in Delivering SI Development Projects in Developed Countries

Table 15 presents the summary of the findings for recommended strategies and enhancing factors impacting on the adoption and success of PPP in SI developments in a developed country. It can be seen that all the measurement items in the model influence the constructs significantly, which shows the validity of the measurement items of the barriers identified in this research. The bold ranks in Table 15 present the significant constructs for S1, S2, and S3.

Table 15. Summary of the findings for recommended strategies and enhancing factors.

Recommended Strategies and Enhancing Factors	Construct	Rank for the Impact		
		S1	S2	S3
	SREF	4 (0.889)	3 (1.067)	**1 (7.874)**
	LREF	5 (0.803)	**1 (4.900)**	4 (1.039)
	TREF	**1 (4.969)**	5 (0.208)	5 (0.134)
	SRF	**2 (2.895)**	4 (0.245)	**3 (2.006)**
	FREF	3 (1.735)	**2 (2.169)**	**2 (7.201)**

Under the recommended strategies and enhancing factors, for S1, it can be seen that TREF and SRF are more significant in helping to achieve success. For example, with the periodic high-level reviews and remedial actions throughout the whole project delivery process, defining minimum functional needs with requisite technical specifications and well-structured, equitable, and enforceable contracts, there is a higher chance for the PPP projects to be successful, which affects S1. SRFs have the second most significant influence on S1, which states the importance of engaging citizens in the projects in developed countries. When it comes to S2, LREF is the most important constructor to consider. This is due to the fact that the private sector places a greater emphasis on legal considerations.

This has been seen in the analysis of barriers and benefits, and enablers as well. Other than LREF, FREF also affects S2. SREF is the most significant construct affecting S3, while FREF and SRF also considerably affect S3.

7. Conclusions

The significance of PPP in SI projects in developed countries was identified and explored with an emphasis on the way forward for mutual benefits. Even though many of the governments of developed countries have their own funding to develop SI, PPP was identified as a suitable procurement strategy to deliver SI for developed countries as well. This is because of pressing needs for specialized technological advancements and complex interdisciplinary Research and Development exercises in developing SI. Moreover, it was evident that many developed countries have identified PPP as a preferred solution for optimum risk management. However, there are unsuccessful PPP projects as well. Therefore, it is important to explore and evaluate the factors affecting the success of PPP in delivering SI. It is clear that the findings of this study are fruitful and important for the construction project management literature, as well as the construction industry at large.

The significant factors, which affect the success of PPP in SI development projects, were determined through PLS-SEM analysis. The 'political and legal' category was identified as the most influencing category of benefits and enablers impacting on the private sector participants. The findings highlight the importance of a suitable independent legal background and infrastructure in the host country, for the satisfaction of the private sector partners. A stable and suitable legal system that encourages PPP in the host country could attract more investors for the developments. While the private sector can be encouraged to involve PPP for developing SI through 'political and legal' benefits and enablers, the public sector would be interested in the technical 'benefits and enablers', as well as the social 'benefits and enablers' since they need to provide a service to society. This is because PPP brings the technological know-how required in developing and managing SI and also enhances services to the public. The final deliverables would then also have a bigger impact on the satisfaction of end-users. Hence, the end-users are also interested in the legal background and the political background of the country, which affect the adoption of PPP in SI projects in developed countries. Social barriers were identified as the most significant barrier for the government and the public sector to involve in PPP projects to deliver SI. However, through the findings, it is clear that the involvement of the private sector is limited or retarded by legal and sociopolitical barriers. There also are technical barriers, which should be overcome for end-user satisfaction, as they are the ones who will use the SI. Therefore, the importance of capacity building of the end-users is identified as crucial.

These insights, which were indicated and explained by the quantitative significance for each measurement item and the constructs in the discussion section, respectively, contribute to the development of the theoretical concepts underlying the application of PPP in SI and also to the existing literature. Moreover, for construction industry policy-makers and the project/construction management subsector, these findings provide a solid basis to avoid complications in PPP procured SI development projects and arm the parties with some useful pointers on how remedial actions may be planned and prioritized according to the ranking results derived through this study. The models for recommended strategies and enhancing factors could be used subsequent to the project initiation. These would help to enhance the outcomes; hence, they would increase the success rate of PPP in delivering SI in developed countries. The findings of this study provide a solid basis for understanding how these diverse factors interact in these projects—in turn, helping to plan and deliver more successful SI projects with PPP inputs in a developed country.

Despite the valuable knowledge derived from the comprehensive literature review and expert interviews, a limitation of this study is that the questionnaire survey data collected were from 100 respondents in 10 developed countries. Further, applicability of the identified factors may differ to some extent based on the financial, legal, technical, and social factors available in the host country and based on the type of developing SI. Hence, further research could be conducted by expanding the number of respondents and the number of data collection countries. Moreover, case studies based on this model can be carried out so as to develop more effective country-specific implementation strategies in this area. Further, case studies based on these developed models could be conducted on specific SI developments, so as to develop a set of Smart-Infrastructure-type-specific-based decision-making platforms.

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