■Ngày nhận bài: 20/6/2024 ■Ngày sửa bài: 10/7/2024 ■Ngày chấp nhận đăng: 29/8/2024

# Identifying factors affecting cost management of investment projects in construction of technical infrastructure under the public-private partnership (PPP) approach

## Xác định các yếu tố ảnh hưởng đến quản lý chi phí dự án đầu tư xây dựng hạ tầng kỹ thuật theo hình thức đối tác công tư (PPP)

**> THUY HIEN THI NGUYEN[1], QUOC TRUONG PHAM[2,*], KHANH VAN THI HOANG[3], LAM PHUONG VU[1], TUAN HUNG HA[1]**
[1]University of Transport Technology, Vietnam
[2]Phan Thiet University, Vietnam
[3]Le Quy Don Technical University, Vietnam
*Corresponding author: Email address: phamquoctruong0495@gmail.com

**ABSTRACT**

The study identified 30 factors affecting the cost management of technical infrastructure construction investment projects under the public-private partnership (PPP). Through the process of collecting and analyzing survey data and applying the mixed method research in which the methods of analyzing the exploratory factor and of analyzing multivariate regression are mainly used in clarifying research issues and achieving the research objectives. From there, propose solutions and recommendations to contribute to improving the effectiveness of cost management of technical infrastructure construction investments under the public-private partnership (PPP). The content of the article focuses on 2 main issues: Research design, data collection procedure theoretical framework of the quantitative model and the results of the application for building effetive cost management model. The reliability and value of the scale are determined by Confirmatory factor analysis (EFA) shown that effitive cost management is influenced by 5 factors: Legal Framewwork (LF); Capacity of the parties involved (CP); Construction solutions (CS); Planning compliance (PC); Organizational Modeling (OM).

**Keywords:** Cost management; effective cost management; influencing factors; technical infrastructure; PPP projects.

**TÓM TẮT**

Nghiên cứu đã xác định 30 nhân tố ảnh hưởng đến công tác quản lý chi phí dự án đầu tư xây dựng hạ tầng kỹ thuật theo hình thức đối tác công tư (PPP). Mục tiêu của nghiên cứu đạt được thông qua quá trình thu thập, phân tích số liệu điều tra, áp dụng phương pháp phân tích nhân tố khám phá và phân tích hồi quy đa biến. Một số giải pháp được đề xuất và kiến nghị góp phần nâng cao hiệu quả công tác quản lý chi phí dự án PPP. Ngoài phần tổng quan, tài liệu tham khảo, nghiên cứu tập trung vào 2 nội dung chính: Thiết kế nghiên cứu, quy trình thu thập dữ liệu, khung lý thuyết của mô hình định lượng và kết quả mô hình quản lý chi phí dựa án PPP hiệu quả. Độ tin cậy và giá trị của thang đo được xác định thông qua việc phân tích nhân tố khẳng định (EFA) cho thấy công tác quản lý chi phí hiệu quả chịu tác động của 5 nhân tố chính là: Khung pháp lý (LF); Năng lực của các bên liên quan (CP); Giải pháp kỹ thuật, tổ chức thi công (CS); Tuân thủ quy hoạch (PC); Mô hình tổ chức (OM).

**Từ khóa:** Quản lý chi phí; quản lý chi phí hiệu quả; nhân tố ảnh hưởng; hạ tầng kỹ thuật; dự án PPP.

### 1. INTRODUCTION

PPPs have become a popular way to supply infrastructure around the world. The attraction of public private partnerships (PPPs) for governments is that the on-ground fructification of infrastructure projects is far higher than the traditional implementation route through public sector or departmental undertakings [1]. Public–private partnership (PPP) is an approach adopted to enhance the economic value of infrastructure outputs, and it encompasses a broad spectrum of public sector infrastructure [2]. However, compared with developed countries, most

developing countries have not been successful in attracting private investment in recent years [3].

This paper examines such a question for Vietnam, focusing on the institutional analysis of this country context. Set within the context of developing countries, we conduct a state of the art systematic review of project-focussed, public-private partnership literature published before 2024. The Government of Vietnam (GVN) has sought to address this gap by mobilizing private sector participation in infrastructure via Public Private Partnerships (PPPs). Since 2010 it has raised significant private capital through PPPs to upgrade its infrastructure and public service delivery. As of 2021, according to the Ministry of Planning and Investment (MPI), 336 infrastructure projects have been implemented as PPPs (US$70 billion from private finance), of which 220 were in transportation, 18 in power, and 18 in water supply, wastewater treatment, and the environment. Due to current budget constraints and the public debt ceiling, it is now even more important to attract private investment through PPPs [4]. There have, however, been some challenges implementing PPPs, most notably weaknesses in the legal and institutional framework that have encouraged non-transparent and uncompetitive procurement processes. Additionally, inconsistencies between Vietnamese laws have led to the failure of some PPP projects. The promulgation of the Law on public – private partnership investment No. 64/2020/QH14 [5] and Decrees guiding the implementation of this law (Decree No. 35/2021/ND-CP [33], Decree No. 28/2021/ND-CP [34]) have created a sufficiently strong legal corridor for relevant parties to fulfill their obligations in PPP contracts, a strong driving force in attracting PPP investment . The application of the form of public-private investment partnership (PPP) will initially reduce the burden on the state budget, contributing to a significant change in the appearance of urban areas in this country, opens up a relatively attractive market and investment opportunities for domestic and foreign private investors.

The ultimate goal of investors or project managers in general and PPP projects in particular is to manage costs effectively. It is very necessary to identify factors affecting cost management of investment projects in construction of technical infrastructure under the public-private partnership (PPP). This study aims identifying factors affecting and measuring the weight of their influencing to help managers, investors and units related to PPP projects have a more general view, review the gaps to have appropriate strategies and policies for their own units. The overview issues which have been simulated the factors affecting cost management effectiveness will be summarized in Table 1 below.

**Table 1. Factors affecting effective cost management**

| Factors | | Code | Source |
|---|---|---|---|
| Legal Framework (LF) | Legal documents on PPP | LF 1 | Nguyen et al (2024) [6], E. Moschouli et al (2018) [7], Do.Sy et al (2017) [8], G. Tian (2018) [9], Hanzhi Kou (2021) [10], R. A. Ojelabi et al (2020) [11], Huanming Wang et al (2019) [3], Hardcastle, C. Et al (2005) [12], Almeile et al (2024) [13], |
| | Clarity of Cost Management Rules | LF 2 | Nguyen et al (2024) [6], E. Moschouli et al (2018) [7], Hanzhi Kou (2021) [10], Ruiz Diaz (2017) [14], Carmona (2010) [15], R. A. Ojelabi et al (2020) [11], Huanming Wang et al (2019) [3], Almeile et al (2024) [13], |
| | Business support policy | LF 3 | Nguyen et al (2024) [6], G. Tian (2018) [9], Ruiz Diaz (2017) [14], Sharma (2012) [16], R. A. Ojelabi et al (2020) [11], Huanming Wang et al (2019) [3], Hardcastle, C. Et al (2005) [12] |
| | Inconsistency of specialized regulations | LF 4 | Ruiz Diaz (2017) [14], R. A. Ojelabi et al (2020) [11] Hardcastle, C. Et al (2005) [12], Almeile et al (2024) [13], |
| Capacity of parties (CP) | Financial capacity of investors | CP1 | Nguyen et al (2024) [6], Do. Sy et al (2017) [8], Huanming Wang et al (2019) [3], Lucia Xiaoyan Liu et al (2022) [17], Fredy Kurniawan et al (2015) [18], Almeile et al (2024) [13], Osei-Kyei et al (2015) [19], Pham Trang & Phan Tho (2017) [20] |
| | Capacity of Investor/ Project Management Board | CP2 | R. A. Ojelabi et al (2020) [11], Huanming Wang et al (2019) [3], Fredy Kurniawan et al (2015) [18], Almeile et al (2024) [13], Pham Trang & Phan Tho (2017) [20] |
| | Contractor's capacity | CP3 | Carmona (2010) [15], R. A. Ojelabi et al (2020) [11], Huanming Wang et al (2019) [3], Fredy Kurniawan et al (2015) [18], Almeile et al (2024) [13], |
| | Auditing unit capacity. | CP4 | Fredy Kurniawan et al (2015) [18], Chukwunedu et al (2011) [21], Cracel Viana et al (2022) [22], Almeile et al (2024) [13], Pham Trang & Phan Tho (2017) [20] |
| | Consulting unit capacity | CP5 | G. Tian (2018) [9], Hanzhi Kou (2021) [10], R. A. Ojelabi et al (2020) [11], Huanming Wang et al (2019) [3], Raisbeck, P (2009) [23], Fredy Kurniawan et al (2015) [18], Almeile et al (2024) [13], |
| | Cost management experience | CP6 | Nguyen et al (2024) [6], Hanzhi Kou (2021) [10], Sounman Hong (2016) [24], Mingrui Gou (2024) [25], Sharma (2012) [16], Caiyun Cu et al (2018) [2], R. A. Ojelabi et al (2020) [11], Huanming Wang et al (2019) [3], Pham Trang & Phan Tho (2017) [20] |
| | Risk management | CP7 | Nguyen et al (2024) [6], Hanzhi Kou (2021) [10], Nguyen Hieu (2022) [26], Sounman Hong (2016) [24], Mingrui Gou (2024) [25], Ruiz Diaz (2017) [14], Sharma (2012) [16], Carmona (2010) [15], |

| Factors | | Code | Source |
|---|---|---|---|
| | Participation and Partnership | CP8 | Caiyun Cu et al (2018) [2], R. A. Ojelabi et al (2020) [11], Huanming Wang et al (2019) [3], Almeile et al (2024) [13], Osei-Kyei et al (2015) [19], Nguyen (2018) [27], Pham Trang & Phan Tho (2017) [20]<br>Nguyen et al (2024) [6], Nguyen Hieu (2022) [26], Huanming Wang et al (2019) [3], Osei-Kyei et al (2015) [19] |
| Conditions (CO) | Unstable weather and climate | CO1 | Hanzhi Kou (2021) [10], Nguyen Hieu (2022) [26], Akomea-Frimpong et al (2024) [28] |
| | Complex and heterogeneous terrain and geology | CO2 | Hanzhi Kou (2021) [10], Nguyen Hieu (2022) [26], Akomea-Frimpong et al (2024) [28] |
| | Impact of climate change | CO3 | Hanzhi Kou (2021) [10], Nguyen Hieu (2022) [26], Akomea-Frimpong et al (2024) [28] |
| | Unstable economic-political-social situation | CO4 | Eleni Moschouli et al (2018) [7], Albert P. C. Chan et al (2010) [29], Sharma (2012) [16], Huanming Wang et al (2019) [3], Hardcastle, C. et al (2005) [12], |
| Construction solutions (CS) | Standard Design | CS1 | Raisbeck, P (2009) [23], Peter Raisbeck a & Llewellyn C.M. Tang (2014) [30], Hardcastle, C. et al (2005) [12] |
| | Undefined Project Scope | CS2 | R. A. Ojelabi et al (2020) [11], Hardcastle, C. et al (2005) [12] |
| | Construction technical measures | CS3 | Hardcastle, C. et al (2005) [12] |
| | Construction progress | CS4 | Hardcastle, C. et al (2005) [12] |
| Planning compliance (PC) | PPP project development planning | PC1 | Expert recommendation |
| | Material resource planning | PC2 | Expert recommendation |
| | The stability of industry planning | PC3 | Expert recommendation |
| PPP Market (PM) | Level of competition among investors | PM1 | Ruiz Diaz (2017) [14], Huanming Wang et al (2019) [3], Hardcastle, C. Et al (2005) [12], Almeile et al (2024) [13], Osei-Kyei et al (2015) [19] |
| | Payment and settlement | PM2 | Sharma (2012) [16], Carmona (2010) [15], Osei-Kyei et al (2015) [19] |
| | Inflation, depreciation | PM3 | Sharma (2012) [16], Carmona (2010) [15], Jón Helgi Egilsson (2020) [31], |
| | Interest rates and foreign exchange rates | PM4 | Sharma (2012) [16], Carmona (2010) [15], Jón Helgi Egilsson (2020) [31], |
| Organizational Modeling (OM) | Level of competition among investors | OM1 | Albert P. C. Chan et al (2010) [29], Hanzhi Kou (2021) [10], Mingrui Gou (2024) [25], Sharma (2012) [16], Carmona (2010) [15], Caiyun Cu et al (2018) [2], R. A. Ojelabi et al (2020) [11], Fredy Kurniawan et al (2015) [18] |
| | Project Variance Control | OM2 | Sharma (2012) [16], R. A. Ojelabi et al (2020) [11], Lucia Xiaoyan Liu et al (2022) [17], |
| | evaluation tools and Project monitoring | OM3 | Do. Sy et al (2017) [8], G. Tian (2018) [9], Mingrui Gou (2024) [25], Sharma (2012) [16], Caiyun Cu et al (2018) [2], Lucia Xiaoyan Liu et al (2022) [17], |

## 2. METHODOLOGY

### 2.1. Research Process

The research process of this topic is structured in the diagram below.

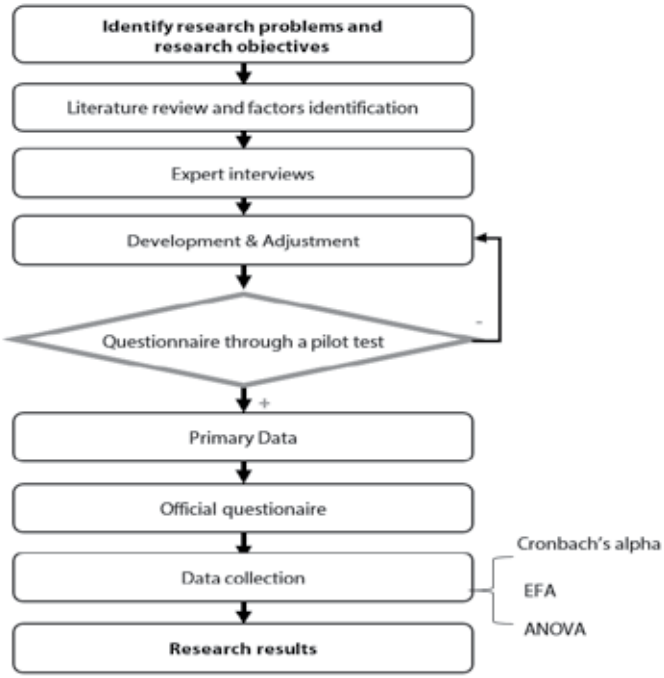


**Fig 1.** Research Process

To supplement into the theoretical basis and propose measures to improve the cost management of PPP project, authors really appreciate and acknowledge the advatages of the analyzing the factors affecting the effective cost management and those factors which impact the construction management. This analysis factors has meaning both scientific and practical. This will help managers to be able to recognize the influence of the factors.

In order to meet the purpose of the study, this section discusses the sample selection procedure, variables selection, the model used for the research and the statistical techniques. Firrst of all, The selection of questionnaire items was initially decided through two research group discussions. After expert consultation, some items were merged and some were deleted. Specifically, the proposed factors of each member's competency scale are merged into the main factors CP1 to CP8 while eliminating their individual competency factors. The survey process was conducted by experts in University of Transport Technology and Ha Noi Univeristy of Civil engineering to improve the questionnaire and finally refined the questionnaire items.

The survey was structured with a total of 30 factors and the extent of existence of all variables in the research area was measured on a five-point likert scale ranging from Very Unimportant to Very Important. Ranging from 1 to 5: (1) Very unimportant, (2) Unimportant, (3) Neutral, (4) Important, (5) Very important. After that, the source of data for this study is primary data acquired through questionnaire. This study mainly concentrated in both Google Form and paper questionnaires. Of the total 320 questionnaires distributed, 310 were collected, indicating a 96.8% response rate. Some incomplete and invalid questionnaires were eliminated, 305 valid questionnaires remained. The respondents answered the questionnaire anonymously and their privacy was protected. Based on the result and findings, most of the respondents are well experienced on cost management in the PPP projects.

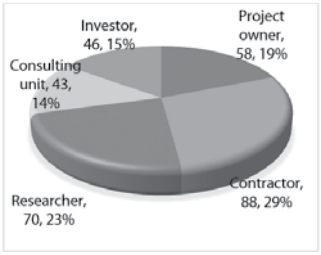


*Fig 2a. Respondents' roles*

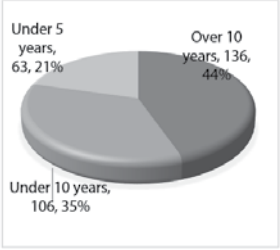


*Fig 2b. Working experience*

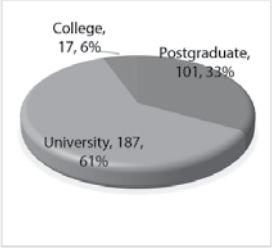


*Fig 2c. Education*

### 2.2 Hypothetical model

The next step of the research process, Exploratory Factor Analysis (EFA) was studied to identify the factors affecting cost management of PPP projects. [32]

The data set was used and analyzed by Excel 2021 software, SPSS software, which supports data analysis, descriptive statistics, correlation coefficients, linear regression, regression analysis to determine the weight of influencing factors. The significant level was 0.05. Hypothetical model is showed as Fig. 2

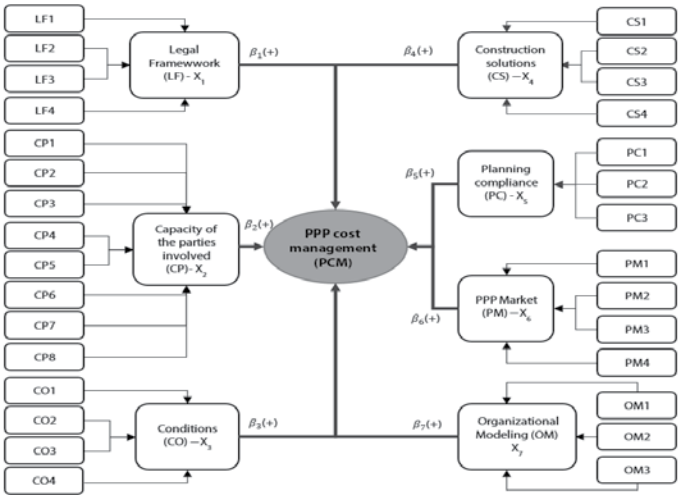


**Fig 2.** Theoretical model proposed – Framework

## 3. RESULTS AND DISCUSSIONS

Findings of the study are discussed, consist of: Data analysis and discussion; Reliability of the scale reliability of total items; Reliability of Total Items; Reliability of individual items; Model Summary; Coefficient & Hypothesis Testing.

The scale was administered to the respective sample in order to collect the data for the study. The scoring was done as per the instructions set by the respected authors in the manual.

The reliability of the questionnaire was checked, and the Cronbach's Alpha value was 0.606 >0.6 (see Table 2) (Hair et al. 2010; Hair et al., 2016). The correlation between overall satisfaction and

sub-dimensions satisfaction is proven by exploratory factor analysis and extraction of potential factors

In this reflective model convergent validity is tested through composite reliability or Cronbach's alpha. Composite reliability is the measure of reliability since Cronbach's alpha sometimes underestimates the scale reliability. There is GO5 variable (Cronbach's Alpha =0.847 >0.6 but Corrected Item-Total Correlation (Pvc) =0.189<0.3), so LF4 variable should be excluded from this model. Table 2a shows that composite reliability varies from 0.606 to 0.862 which is above preferred value of 0.5. This proves that model is internally consistent. To check whether the indicators for variables display convergent validity. Cronbach's alpha is used. From Table 2, it can be observed that all the factors are reliable (Cronbach's alpha > 0.60 and Pvc > 0.3).

**Table 2a. Item-Total Statistics; Cronbach's Alpha: .847; N of Items: 30**

| | Corrected Item-Total Correlation | Cronbach's Alpha if Item Deleted | | Corrected Item-Total Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|---|
| **Cronbach's Alpha: .653; N of Items: 4** | | | **Cronbach's Alpha: .825; N of Items: 4** | | |
| LF1 | .570 | .483 | CS1 | .670 | .769 |
| LF2 | .548 | .501 | CS2 | .660 | .774 |
| LF3 | .496 | .555 | CS3 | .638 | .784 |
| LF4 | .189 | .759 | CS4 | .628 | .788 |
| **Cronbach's Alpha: .888; N of Items:8** | | | **Cronbach's Alpha: .798; N of Items: 3** | | |
| CP1 | .648 | .875 | PC1 | .636 | .736 |
| CP2 | .579 | .882 | PC2 | .645 | .724 |
| CP3 | .638 | .876 | PC3 | .652 | .717 |
| CP4 | .718 | .868 | **Cronbach's Alpha: .752; N of Items: 4** | | |
| CP5 | .690 | .871 | PM1 | .454 | .746 |
| CP6 | .691 | .871 | PM2 | .537 | .702 |
| CP7 | .659 | .874 | PM3 | .653 | .635 |
| CP8 | .665 | .873 | PM4 | .558 | .690 |
| **Cronbach's Alpha: .793; N of Items: 4** | | | **Cronbach's Alpha: .734; N of Items: 3** | | |
| CO1 | .572 | .757 | OM1 | .541 | .667 |
| CO2 | .664 | .710 | OM2 | .590 | .608 |
| CO3 | .535 | .775 | OM3 | .542 | .666 |
| CO4 | .646 | .721 | | | |

**Table 2b. Rotated Component Matrix[a]**

| | Component | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| CP5 | .816 | | | | | | | |
| CP3 | .786 | | | | | | | |
| CP8 | .738 | | | | | | | |
| CP7 | .726 | | | | | | | |
| CP1 | .725 | | | | | | | |
| CP2 | .678 | | | | | | | |
| CS1 | | .801 | | | | | | |
| CS2 | | .791 | | | | | | |
| CS3 | | .766 | | | | | | |
| CS4 | | .751 | | | | | | |
| CO2 | | | .833 | | | | | |
| CO4 | | | .802 | | | | | |
| CO1 | | | .732 | | | | | |
| CO3 | | | .654 | | | | | |
| PM1 | | | | .782 | | | | |
| PM3 | | | | .710 | | | | |
| PM2 | | | | .693 | | | | |
| PM4 | | | | .645 | | | | |
| PC2 | | | | | .832 | | | |
| PC3 | | | | | .826 | | | |
| PC1 | | | | | .817 | | | |
| LF1 | | | | | | .803 | | |
| LF3 | | | | | | .795 | | |
| LF2 | | | | | | .795 | | |
| OM2 | | | | | | | .741 | |
| OM1 | | | | | | | .714 | |
| OM3 | | | | | | | .705 | |
| LF4 | | | | | | | | |
| CP6 | .542 | | | | | | | .769 |
| CP4 | .579 | | | | | | | .753 |

Variable LF4 was removed because its loading factor was 0.189 < 0.3. In addition, CP4 and CP6 were also removed from the model because these two variables loaded on both factors. After removing, three factors including LF4, CP4 and CP6, the results shown (table2b).

The KMO value (Kaiser-Meyer-Olkin, 0,5 ≤ KMO ≤ 1, measures the strength of relationship among the variables) is 0.807 >0.5 (Table 3), therefore it is suitable for factor analysis. The value of Bartlett's sphericity test is 3016.994 (p=0.000<0.005), which meant there is a correlation between variables and potential factors can be extracted (see Table 3). (Hair et al. 2016, Wynne et al., 1995)

**Tabel 3. KMO and Bartlett's Test**

| | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | .807 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 3016.994 |
| | df | 351 |
| | Sig. | .000 |

Finally, six potential factors were extracted because the extraction of each variable was sufficient and each potential factor has a clear meaning. The amount of Information extracted was 64.392% (Table 4), which was relatively sufficient. The Rotated Component Matrix was presented in Table 5. Then the potential factors of obtained factor scores were identified.

Model summary was shown in Table 4. Value of RSquare is 64.392 showed that 64.392%>50% variation in cost management of PPP project due to the independent variables

**Table 4. Total Variance Explained**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 5.024 | 18.607 | 18.607 | 5.024 | 18.607 | 18.607 | 3.619 | 13.402 | 13.402 |
| 2 | 3.702 | 13.711 | 32.317 | 3.702 | 13.711 | 32.317 | 2.670 | 9.889 | 23.291 |
| 3 | 2.548 | 9.436 | 41.753 | 2.548 | 9.436 | 41.753 | 2.660 | 9.852 | 33.143 |
| 4 | 1.959 | 7.255 | 49.008 | 1.959 | 7.255 | 49.008 | 2.246 | 8.319 | 41.462 |
| 5 | 1.709 | 6.330 | 55.338 | 1.709 | 6.330 | 55.338 | 2.182 | 8.082 | 49.544 |
| 6 | 1.283 | 4.750 | 60.088 | 1.283 | 4.750 | 60.088 | 2.068 | 7.658 | 57.202 |
| 7 | 1.162 | 4.304 | 64.392 | 1.162 | 4.304 | 64.392 | 1.941 | 7.190 | 64.392 |

Extraction Method: Principal Component Analysis

**Table 5. Rotated Component Matrix[a]**

| | Component | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| CP5 | .817 | | | | | | |
| CP3 | .772 | | | | | | |
| CP8 | .769 | | | | | | |
| CP7 | .748 | | | | | | |
| CP1 | .722 | | | | | | |
| CP2 | .698 | | | | | | |
| CS1 | | .801 | | | | | |
| CS2 | | .799 | | | | | |
| CS3 | | .767 | | | | | |
| CS4 | | .748 | | | | | |
| CO2 | | | .835 | | | | |
| CO4 | | | .797 | | | | |
| CO1 | | | .733 | | | | |
| CO3 | | | .647 | | | | |
| PM1 | | | | .770 | | | |
| PM3 | | | | .723 | | | |
| PM2 | | | | .690 | | | |
| PM4 | | | | .664 | | | |
| PC2 | | | | | .832 | | |
| PC3 | | | | | .826 | | |
| PC1 | | | | | .816 | | |
| LF3 | | | | | | .818 | |
| LF1 | | | | | | .813 | |
| LF2 | | | | | | .802 | |
| OM2 | | | | | | | .765 |
| OM1 | | | | | | | .761 |
| OM3 | | | | | | | .729 |

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

The rotation matrix results shown that 27 observed variables are divided into 7 factor groups, all of them have factor loading coefficients greater than 0.5 and all contribute to the model.

**Table 6a. Correlations**

| | | PCM | P_LF | P_CP | P_CO | P_CS | P_PC | P_PM | P_OM |
|---|---|---|---|---|---|---|---|---|---|
| PCM | Pearson Correlation | 1 | .489** | .557** | .021 | .373** | .324** | .009 | .380** |
| | Sig. (2-tailed) | | .000 | .000 | .719 | .000 | .000 | .871 | .000 |
| | N | 305 | 305 | 305 | 305 | 305 | 305 | 305 | 305 |
| P_LF | Pearson Correlation | .489** | 1 | .190** | .035 | .176** | .082 | -.036 | .139* |
| | Sig. (2-tailed) | .000 | | .001 | .548 | .002 | .151 | .535 | .015 |
| | N | 305 | 305 | 305 | 305 | 305 | 305 | 305 | 305 |
| P_CP | Pearson Correlation | .557** | .190** | 1 | -.073 | .245** | .152** | .030 | .309** |
| | Sig. (2-tailed) | .000 | .001 | | .206 | .000 | .008 | .600 | .000 |
| | N | 305 | 305 | 305 | 305 | 305 | 305 | 305 | 305 |
| P_CO | Pearson Correlation | .021 | .035 | -.073 | 1 | .067 | .070 | .503** | -.029 |
| | Sig. (2-tailed) | .719 | .548 | .206 | | .246 | .220 | .000 | .615 |
| | N | 305 | 305 | 305 | 305 | 305 | 305 | 305 | 305 |
| P_CS | Pearson Correlation | .373** | .176** | .245** | .067 | 1 | .289** | .027 | .446** |
| | Sig. (2-tailed) | .000 | .002 | .000 | .246 | | .000 | .643 | .000 |
| | N | 305 | 305 | 305 | 305 | 305 | 305 | 305 | 305 |
| P_PC | Pearson Correlation | .324** | .082 | .152** | .070 | .289** | 1 | -.007 | .260** |
| | Sig. (2-tailed) | .000 | .151 | .008 | .220 | .000 | | .904 | .000 |
| | N | 305 | 305 | 305 | 305 | 305 | 305 | 305 | 305 |
| P_PM | Pearson Correlation | .009 | -.036 | .030 | .503** | .027 | -.007 | 1 | .042 |
| | Sig. (2-tailed) | .871 | .535 | .600 | .000 | .643 | .904 | | .462 |
| | N | 305 | 305 | 305 | 305 | 305 | 305 | 305 | 305 |
| P_OM | Pearson Correlation | .380** | .139* | .309** | -.029 | .446** | .260** | .042 | 1 |
| | Sig. (2-tailed) | .000 | .015 | .000 | .615 | .000 | .000 | .462 | |
| | N | 305 | 305 | 305 | 305 | 305 | 305 | 305 | 305 |

**. Correlation is significant at the 0.01 level (2-tailed)

*. Correlation is significant at the 0.05 level (2-tailed).

In the result, 2 independent variables P_CO and P_PM are not correlated (sig >0.05), so they will be removed from the model. The results are shown below.

**Table 6b. Correlations**

| | | PCM | P_LF | P_CP | P_CS | P_PC | P_OM |
|---|---|---|---|---|---|---|---|
| PCM | Pearson Correlation | 1 | .489** | .557** | .373** | .324** | .380** |
| | Sig. (2-tailed) | | .000 | .000 | .000 | .000 | .000 |
| | N | 305 | 305 | 305 | 305 | 305 | 305 |
| P_LF | Pearson Correlation | .489** | 1 | .190** | .176** | .082 | .139* |
| | Sig. (2-tailed) | .000 | | .001 | .002 | .151 | .015 |
| | N | 305 | 305 | 305 | 305 | 305 | 305 |
| P_CP | Pearson Correlation | .557** | .190** | 1 | .245** | .152** | .309** |
| | Sig. (2-tailed) | .000 | .001 | | .000 | .008 | .000 |
| | N | 305 | 305 | 305 | 305 | 305 | 305 |
| P_CS | Pearson Correlation | .373** | .176** | .245** | 1 | .289** | .446** |
| | Sig. (2-tailed) | .000 | .002 | .000 | | .000 | .000 |
| | N | 305 | 305 | 305 | 305 | 305 | 305 |
| P_PC | Pearson Correlation | .324** | .082 | .152** | .289** | 1 | .260** |
| | Sig. (2-tailed) | .000 | .151 | .008 | .000 | | .000 |
| | N | 305 | 305 | 305 | 305 | 305 | 305 |
| P_OM | Pearson Correlation | .380** | .139* | .309** | .446** | .260** | 1 |
| | Sig. (2-tailed) | .000 | .015 | .000 | .000 | .000 | |
| | N | 305 | 305 | 305 | 305 | 305 | 305 |

**. Correlation is significant at the 0.01 level (2-tailed)

*. Correlation is significant at the 0.05 level (2-tailed).

The Pearson correlation test sig between the 5 independent variables P_LF, P_CP, P_CS, P_PC, P_OM and the dependent variable PCM are all less than 0.05, showing that there is a linear relationship between the independent variables and the dependent variable.

**Table 7. Model Summary[b]**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| 1 | .735[a] | .541 | .533 | .463 | 2.064 |

a. Predictors: (Constant), P_OM, P_LF, P_PC, P_CP, P_CS

b. Dependent Variable: PCM

Adjusted R Square 0.533=53.3% >50% means the independent variables entered into the regression affected 53.3% of the change in the dependent variable. Durbin-Watson test, which is used to detect the presence of autocorrelation in the residuals of a regression, values 2.064 inside of the range of 1.5 to 2.5, indicating that the autocorrelation is likely not present.

**Table 8. ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 75.573 | 5 | 15.115 | 70.410 | .000[b] |
| | Residual | 64.185 | 299 | .215 | | |
| | Total | 139.757 | 304 | | | |

a. Dependent Variable: PCM

b. Predictors: (Constant), P_OM, P_LF, P_PC, P_CP, P_CS

**Table 9. Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Tolerance | VIF |
| 1 | (Constant) | .482 | .212 | | 2.277 | .023 | | |
| | P_LF | .107 | .012 | .364 | 9.023 | .000 | .945 | 1.058 |
| | P_CP | .060 | .006 | .401 | 9.537 | .000 | .870 | 1.149 |
| | P_CS | .025 | .010 | .112 | 2.480 | .014 | .751 | 1.332 |
| | P_PC | .051 | .012 | .172 | 4.137 | .000 | .892 | 1.121 |
| | P_OM | .034 | .014 | .111 | 2.436 | .015 | .743 | 1.345 |

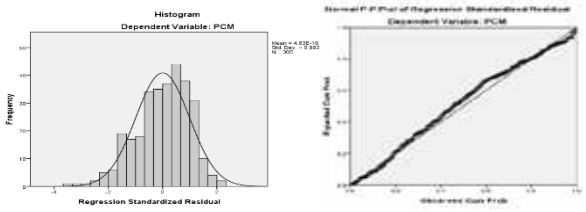


**Fig 3.** Histogram and Normal P-P Plot Graph

a. Dependent Variable: PCM

Extraction Method: Principal Axis Factoring; Rotation Method: Promax with Kaiser Normalization;a. Rotation converged in 6 iterations

The mean is close to 0, the standard deviation is 0.992 which is close to 1, so the residual distribution is approximately normal. The regression equation of factors affecting cost management of investment projects in construction of technical infrastructure under the public-private partnership (PPP) shown below:

***Y (PCM) = 0,364 LF + 0,401 CP + 0,112 CS + 0,172 PC + 0,111 OM***

The standardized regression coefficients Beta - of all variables are greater than 0, more specifically, values CP (0.401) > LF (0.364) > PC (0.172) > CS (0.112) > OM (0.111), then 5 factors including CP, LF, PC, CS, OM have a positive impact on the effectiveness of PPP project cost management, and the CP factor has the greatest impact.

## 4. CONCLUSION

The result also reveal that Capacity of the parties involved (CP) is the most important factor that influence on the effective cost management of investment projects in construction of technical infrastructure under the public-private partnership (PPP). The knowledge, qualifications and skills of the units participating in the PPP project are key factors for effective cost management. When asked, experts all agreed that risk management, cost management, anticipating situations of inflation, price fluctuations, and market issues, if the units participating in the project calculate and include them in the analysis and evaluation of the project, the project will certainly achieve good results.

The capacity of the parties participating in the PP project is considered the most important in the context of a fairly clear and transparent legal system. Decree No. 35/2021/ND-CP dated March 29, 2021 of the Government detailing and guiding the implementation of the Law on Investment in the Form of Public-Private Partnership and Decree No. 28/2021/ND-CP dated March 26, 2021 of the Government providing the financial management mechanism applicable to investment projects in the form of public-private partnership, and other guiding documents have supported and made PPP project management more transparent. The capacity for cost management, risk management to ensure the quality and progress of the PPP project, which will bring about effective cost management for this project, is assessed by experts. In addition, consultants, who have sufficient capacity in terms of expertise, skills, and attitudes in implementing the PPP project as well as good assessment of the PPP market, and have a vision expressed in a quality planning project, with construction organization methods and construction measures suitable for existing resources. In Vietnam, there are not too many harsh natural conditions or fluctuations in the political and economic situation. Controlling inflation and depreciation has been calculated in investment economic calculations. It is even more necessary to tighten management and thoroughly handle violations in the implementation of PPP projects, while attaching more importance to community participation. All of the above factors will contribute to improving the effectiveness of cost management of PPP projects in Vietnam.

**Conflict of interest:** There is no conflict to disclose.

**ACKNOWLEDGEMENT:** The authors are grateful to the "University of Transport Technology.

## REFERENCES

1. Mony, S., Ramachandran, N.: Impact of Management Control Systems on Sponsors' Profitability in Ppp Infrastructure Ventures. In: Biswas, R. and Michaelides, M. (eds.) Financial Issues in Emerging Economies: Special Issue Including Selected Papers from II International Conference on Economics and Finance, 2019, Bengaluru, India. pp. 123–143. Emerald Publishing Limited (2020); **2.** Cui, C., Liu, Y., Hope, A., Wang, J.: Review of studies on the public–private partnerships (PPP) for infrastructure projects. International Journal of Project Management. 36, 773–794 (2018). https://doi.org/10.1016/j.ijproman.2018.03.004; **3.** Wang, H., Liu, Y., Xiong, W., Song, J.: The moderating role of governance environment on the relationship between risk allocation and private investment in PPP markets: Evidence from developing countries. International Journal of Project Management. 37, 117–130 (2019). https://doi.org/10.1016/j.ijproman.2018.10.008; **4**. Vietnam Public-Private Partnership Implementation Support Final Report, https://www.marketlinks.org/sites/default/files/media/file/2021-07/LEAPIII_Vietnam%20PPP_Final%20Report_Feb%202021.pdf; **5.** https://english.luatvietnam.vn: PPP Law, Law No. 64/2020/QH14, https://english.luatvietnam.vn/law-on-investment-in-the-form-of-public-private-partnership-no-64-2020-qh14-dated-june-18-2020-of-the-national-assembly-186267-doc1.html;

6. Long, N., Tuan, N., Nguyen, T.: Xác định các tiêu chí sử dụng cho việc đánh giá và lựa chọn hình thức đầu tư PPP cho các dự án đầu tư hạ tầng giao thông thông minh. Khoa học công nghệ. 739, 141–144 (2024);

7. Moschouli, E., Soecipto, R.M., Vanelslander, T., Verhoest, K.: Factors affecting the cost performance of transport infrastructure projects. European Journal of Transport and Infrastructure Research. 18, (2018). https://doi.org/10.18757/ejtir.2018.18.4.3264; **8.** Sy, D.T., Likhitruangsilp, V., Onishi, M., Nguyen, P.T.: IMPACTS OF RISK FACTORS ON THE PERFORMANCE OF PUBLIC-PRIVATE PARTNERSHIP TRANSPORTATION PROJECTS IN VIETNAM. ASEAN Engineering Journal. 7, 30–52 (2017). https://doi.org/10.11113/aej.v7.15520;

9. Tian, G., Lin, Y., Xiang, W.: Research on the Influence and Demand of PPP Mode on Project Cost Management.

10. Kou, H.: Control and Management Measures of Highway Project Cost under the PPP Model. Journal of Architectural Research and Development. 5, (2021). https://doi.org/10.26689/jard.v5i1.1823

11. Ojelabi, R.A., Oyeyipo, O.O., Afolabi, A.O., Omuh, I.O.: Evaluating barriers inhibiting investors participation in Public-Private Partnership project bidding process using structural equation model. International Journal of Construction Management. 22, 3055–3064 (2022). https://doi.org/10.1080/15623599.2020.1840010

12. Hardcastle, C.1, , Edwards, P.J.2, , Akintoye, A.1 and Li, B.1: Critical Success Factors for PPPs in Infrastructure Developments: Chinese Perspective, https://ascelibrary.org/doi/abs/10.1061/(ASCE)CO.1943-7862.0000152

13. Almeile, A.M., Chipulu, M., Ojiako, U., Vahidi, R., Marshall, A.: Project-focussed literature on public-private partnership (PPP) in developing countries: a critical review. Production Planning & Control. 35, 683–710 (2024). https://doi.org/10.1080/09537287.2022.2123408

14. Ruiz Diaz, G.: The contractual and administrative regulation of public-private partnership. Utilities Policy. 48, 109–121 (2017). https://doi.org/10.1016/j.jup.2016.04.011

15. Carmona, M.: The regulatory function in public-private partnerships for the provision of transport infrastructure. Research in Transportation Economics. 30, 110–125 (2010). https://doi.org/10.1016/j.retrec.2010.10.012

16. Sharma, C.: Determinants of PPP in infrastructure in developing economies. Transforming Government: People, Process and Policy. 6, 149–166 (2012). https://doi.org/10.1108/17506161211246908

17. Liu, L.X., Clegg, S., Pollack, J.: Power relations in the finance of infrastructure public-private partnership projects. International Journal of Project Management. 40, 725–740 (2022). https://doi.org/10.1016/j.ijproman.2022.08.002

18. Kumiawan, F., Mudjanarko, S.W., Ogunlana, S.: Best Practice for Financial Models of PPP Projects. Procedia Engineering. 125, 124–132 (2015). https://doi.org/10.1016/j.proeng.2015.11.019

19. Osei-Kyei, R., Chan, A.P.C.: Review of studies on the Critical Success Factors for Public–Private Partnership (PPP) projects from 1990 to 2013. International Journal of Project Management. 33, 1335–1346 (2015). https://doi.org/10.1016/j.ijproman.2015.02.008

20. Trang*, P.T., Thọ, P.C.: Financial risk controlling of public - private - partnership transportation projects in Vietnam. UD-JST. 102–106 (2017)

21. Chukwunedu, O.S., Okafor, G.O.: The Challenges of Public Sector Audit as an Effective Accountability Tool in PPP Arrangements in Nigeria, https://papers.ssrn.com/abstract=1970070, (2011)

22. Cracel Viana, L., Moreira, J.A., Alves, P.: State audit of public–private partnerships: Effects on transparency, auditor's roles, and impact on auditee's reactions. Financial Accountability & Management. 38, 633–660 (2022). https://doi.org/10.1111/faam.12342

23. Raisbeck, P.: Considering design and PPP innovation: a review of design factors in PPP research. Procs 25th Annual ARCOM Conference, 7-9 September 2009, Nottingham, UK, Association of Researchers in Construction Management, 239-47.; **24.** Hong, S.: When does a public–private partnership (PPP) lead to inefficient cost management? Evidence from South Korea's urban rail system. Public Money & Management. 36, 447–454 (2016). https://doi.org/10.1080/09540962.2016.1206755

25. Gou, M., Yu, Y., Zhang, Y., Zhang, L.: Cost-benefit Analysis of PPP Construction Projects: Taking Y Bridge across the River in Y City as an example. Frontiers in Business, Economics and Management. 16, 335–344 (2024). https://doi.org/10.54097/1symbe40; **26.** Hoang H.N., Diễm Q.T., Kim Q.L., Thị O.N., Thu P.N.T.: Yếu tố ảnh hưởng đến ý định sử dụng đường cao tốc đầu tư theo hình thức BOT của người dân. TC KTPT. 91–100 (2022)

27. Nguyen T.K.T.: Nghiên cứu nhận dạng và khắc phục các nhân tố rủi ro chính làm tăng chi phí xây dựng các dự án giao thông đường bộ. Identifying the identification and removal of risk factors to increase the costs for building road traffic projects. (2018); **28.** Akomea-Frimpong, I., Agyekum, A.K., Amoakwa, A.B., Babon-Ayeng, P., Pariafsai, F.: Toward the attainment of climate-smart PPP infrastructure projects: a critical review and recommendations. Environ Dev Sustain. 26, 19195–19229 (2024). https://doi.org/10.1007/s10668-023-03464-x

29. Critical Success Factors for PPPs in Infrastructure Developments: Chinese Perspective | Journal of Construction Engineering and Management | Vol 136, No 5, https://ascelibrary.org/doi/abs/10.1061/(ASCE)CO.1943-7862.0000152; **30.** Raisbeck, P., Tang, L.C.M.: Identifying design development factors in Australian PPP projects using an AHP framework. Construction Management and Economics. 31, 20–39 (2013). https://doi.org/10.1080/01446193.2012.729133; **31.** Egilsson, J.H.: How raising interest rates can cause inflation and currency depreciation. Journal of Applied Economics. 23, 450–468 (2020). https://doi.org/10.1080/15140326.2020.1795526

32. Henseler, J., Hubona, G., Ray, P.A.: Using PLS path modeling in new technology research: updated guidelines. Industrial Management & Data Systems. 116, 2–20 (2016). https://doi.org/10.1108/IMDS-09-2015-0382

33. https://english.luatvietnam.vn: Decree No. 35/2021/ND-CP detailing the implementation of the Law on Investment in the Form of Public-Private Partnership, https://english.luatvietnam.vn/decree-no-35-2021-nd-cp-dated-march-29-2021-of-the-government-detailing-and-guiding-the-implementation-of-a-number-of-articles-of-the-law-on-investm-200401-doc1.html

34. https://english.luatvietnam.vn: Decree No. 28/2021/ND-CP the financial management for public-private partnership investment projects, https://english.luatvietnam.vn/decree-no-28-2021-nd-cp-dated-march-26-2021-of-the-government-prescribing-the-financial-management-mechanism-applicable-to-public-private-partnershi-200317-doc1.html