Critical factors affecting schedule performance of transportation infrastructure projects in the Eastern Districts of Ho Chi Minh City, VietNam

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Abstract. The study area is composed of Ho Chi Minh City’s East Urban Area including District 2, 9, and Thu Duc where have been oriented by the City’s Government to become the urban intelligence, a place to create Highly Interactive Innovation Districts with innovation development model applied for all aspects of economic, human living, eco environment, smart infrastructure and networking. Transportation infrastructure is one of the most important factors to contribute to build the future smart city in this area. However, in fact, many projects have been delayed directly affecting the development of this area that can slow down the progress of creating intelligent districts. The aim of this study is to investigate factors that influence the schedule performance of transportation infrastructure projects in the East of Ho Chi Minh City to contribute to the project management works. To achieve the goal, the survey conducted with 10 experts and 185 people working in this type of project implemented during the period from 2011 to 2018, using statistical analysis of responses on the attributes and factor analysis to group into six critical factors. Regression analysis was also used to test hypotheses and revealed that three groups of factors including Finance; Site compensation; and project fluctuations are strongly affecting the schedule performance. As a consequence, based on the interviews conducted with experienced practitioners, recommendations to deal with these factors are proposed.

1. Introduction
The existing population in Ho Chi Minh City (HCMC) is of around 8-million people (2014) and of around 18.5-million people for the larger city region (2014). These populations are projected to rise up to 12-millions (for HCMC) and up to 30-million (for the larger city region) by 2050. Due to a drastic population growth, combined with millions of yearly visitors and temporary residents, HCMC is rapidly expanding along four Priority Corridors: to the South towards the East Sea linking the planned Hiep Phuoc Harbour node; to the North connecting the new North West Township with the Moc Bai highway linking HCMC to Tay Ninh province, and further to Moc Bai border’s gate (Cambodia) before linking to Phnom Penh; to the Southwest linking the Mekong delta region; and to the East towards Hanoi with the upcoming new urban and finance center of Thu Thiem being one of the main nodes.

In this regional context, HCMC East has an extremely favourable location along the eastern development corridor towards Hanoi: directly bordering Ho Chi Minh City’s central area and Thu
Thiem’s CBD, the HCMC East larger area forms a key node on planned transport and economic corridors, particularly on the north-south economic axis and east-west transport corridors. HCMC East has great potential to leverage planned strategic infrastructure such as the expressway links and the high-speed rail to Hanoi. In addition, HCMC East is located in close proximity to major gateways such as the new airport and connections to the deep-sea port. HCMC East encompass Districts 2, 9 and Thu Duc. These districts already boost key existing functional areas, such as the High Technology Zone (Saigon Hi-tech Park), the Industrial Processing Zone (Linh Trung Export Processing Zone and Industrial Park) and the National University, which offer advantageous conditions for the Eastern Area to become a testbed for innovation with specific place making and identity qualities thanks to the presence of local cultural, touristic and sport areas such as the National Cultural History Park (History Ethnic & Cultural Park), the Suoi Tien Tourist Area (Suoi Tien Theme Park) and the Rach Chiec Sports complex. These existing functional nodes combined with strategic planned transport infrastructures, which will efficiently connect HCMC East to the key future gateways of the eastern airport-hub and the southern mega-port, give the potential to the HCMC East area to become the link and gateway drawing Ho Chi Minh city centre and nearby Thu Thiem to the existing surrounding economic corridors of Vietnam and further to the world.

Figure 1. Traffic Planning in HCMC East. Source: HCMC Department of Transportation

The demand for transportation infrastructure in HCMC East is rapidly increasing due to the development trend. To better meet the demand, the project management works of all parties involved in the construction of transportation infrastructure (bridge, road, railway, port…) have more schedule pressures that the projects need to be completed on time. According to the statistic data of the implemented transportation infrastructure projects reported by HCMC’s Department of Transportation, before 2011, more than 51% of the projects in HCMC were behind the schedule from one to three years, some projects even late for more than 5 years; from 2011 until now, the percentage of projects delayed has been gradually decreased but still exceed more than 40%.

Time performance is important to all construction parties. It concerns the completion date, the sequence of work, and money paid for direct and indirect costs. Assurance of project schedule has been considered as an important indicator of project success (Ling, Low, Wang, & Lim, 2009) [1]. Construction time usually interrelates and functions with the actual cost because increasing construction time always results in additional cost to the whole project and also erodes the company’s profits or the other way around. When the actual construction time is less than the planned time, the project is adjudged to be successful. Hence, there is a need to identify critical factors that affect schedule performance of transportation infrastructure projects. While causes of construction delay and
factors affecting project schedule performance were identified in various literatures, few studies have been conducted to investigate such critical factors for transportation infrastructure projects in HCMC, especially in the Eastern districts of HCMC. Therefore, this study aims to fill this knowledge gap by achieving the following objectives:

1. To identify critical factors affecting schedule performance of transportation infrastructure projects in the Eastern districts of HCMC;
2. To compare the factors affecting schedule performance; and
3. To provide recommendations to respond to these critical factors.

The findings from this study will provide a better understanding of the critical factors and help practitioners involving in transportation infrastructure projects to take measures to assure the achievement of project schedule objectives.

2. Literature Review

There are a variety of previous studies that analyzed factors affecting construction project schedule performance. Most of these studies focused on identification of major causes of delays in various construction projects. However, few studies have been conducted to investigate factors affecting the schedule performance of transportation infrastructure projects, especially in HCMC or in HCMC East. Summaries of research related to time performance but for general construction works are shown briefly in Table 1.

In the field of transportation infrastructure, S Meeampol and S O Ogunlana (2006) conducted a survey of 99 highway construction projects in Thailand, using statistical methods, comparing mean values and using t-test with Statistical significance of p <0.05 to rank the important factors affecting the project implementation time and cost [2]. Results of the study showed that ten most important factors for time performance are: (1) construction method; (2) construction resource management; (3) schedule management; (4) human resource management; (5) supervision and control; (6) budget management; (7) human resource management; (8) owner involvement; (9) team relationship; and (10) Communication and report.

Yogita H and Desai D B (2015) investigated the causes of delay in the construction of technical infrastructure projects, particularly highway construction projects in India [3]. 5 groups including Contractor Group, Investor, Consultant, Public Utilities, State Policy. The results of the author's analysis found the main reasons of delay including difficulty in licensing; unspecified or incorrect location for public utilities; difficulty in traffic to approach the project site; design standards related to utilities have not been clearly specified. That study also showed that the biggest consequence of time overrun will lead to over-budget problems, interrupted in traffic due to the project long lasting; litigation and disputes occurred.

Many other studies conducted in many countries such as:

- Cao H T and Swierczek (2010) studied on factors affecting the success of the project by surveying 239 infrastructure projects in Vietnam [4].
- Nabil A H (2017) studies the factors affecting the progress and cost overruns of Jordanian infrastructure projects by analyzing data of 40 technical infrastructure projects in 2000-2008 [5]. Through the study, the author has given 20 main causes of delay and cost overruns, the main causes related to topographic conditions, weather conditions, project fluctuations, labor availability for project and design error.
- Ephrem et al (2017) conducted research on factors affecting the completion schedule of construction projects in Ethiopia [6]; using factor analysis collected from 200 questionnaires with 35 possible reasons, each answer based on 5-linkert scale.
Table 1. Summary of previous studies.

| Researchers                  | Factors affecting schedule performance                                                                 |
|------------------------------|----------------------------------------------------------------------------------------------------------|
| Lo et al. (2006)             | Inadequate resources due to lack of capital; Unforeseen ground conditions; Exceptionally low bids; Inexperienced contractor; Works in conflict with existing utilities |
| Long et al. (2008)           | Poor site management and supervision; Poor project management assistance; Financial difficulties of owners; Financial difficulties of contractor; Design changes |
| Adel A K and Martin S (2009) | Delay in progress payments ; Site conditions                                                              |
| Remon F A (2013)             | Design changes; Lack of machinery and equipment                                                            |
| Hemant D et al. (2015)       | Inefficient in planning; Factors related to the contract; Factors related to labor, labor skills, and technical staff; Lack of communication between the parties |
| Kim S Y et al. (2015)        | Finance; Lack of communication between the parties                                                         |
| Bekr (2015)                  | Experience capacity; Policy; Late payment; Change design                                                  |

From the various research findings, it can be summarized that the issue of success factors is complex. It is a multi-faceted problem with solutions depending on the research context. There are many factors that may affect project performance, especially in terms of schedule performance for projects in the field of transportation infrastructure. It will be a good idea to compare and discuss the result by taking similar attributes with other countries. Accordingly, for this study based on the discussion and personal interviews of key construction professionals in HCMC, Viet Nam, 32 attributes were selected from the literature and project management textbooks.

3. Materials and methods
To achieve the objectives of this study, data was collected based on the questionnaire survey approach with information of transportation infrastructure projects in HCMC East, implemented during the period from 2011 to 2018.

The various steps used in the research and analyses are presented below:

- **Step 1: Identification of attributes that can cause effects on the schedule performance**
  Based on the literature including leading journals and project management textbooks, discussion, and personal interviews of key construction professionals in HCMC (Working in HCMC Department of Transportation and its management zones for supervising projects executed in Eastern Districts of HCMC), a list of 32 project performance attributes were identified and divided into 6 groups. Taking the suggestions made by these professionals, necessary modification has been made to the list of attributes. Due to the fragmented nature of the transportation construction industry, the above-identified attributes cannot be called exhaustive but the list covers a large portion of different types of construction projects. In order to assess the impact of these 32 attributes on schedule performance evaluation criteria, a questionnaire was prepared.

The questionnaire consisted of two main sections. The first section included questions meant to profile the respondents and their companies. In the second section, the 32 factors identified were presented. The respondents were asked to evaluate the frequency of these factors as well as their impact on schedule performance of transportation construction projects. A five-point Likert scale (1 = little; 2 = low; 3 = mid; 4 = high; 5 = very high) was used to gauge the respondents’ perceptions on the impact of each factor on schedule performance of each surveyed project. Responses on schedule performance of each surveyed project were sought
on a five-point ordinal scale in which “1” refers to “significantly delay”, “2” refers to 
“marginally delay”, “3” refers to “finished ontime”, “4” refers to “finished marginally sooner 
than scheduled” and “5” refers to “finished significantly sooner than scheduled.”

- **Step 2: Data collection**

Target respondents were engineers involved in transportation infrastructure projects 
implemented in HCMC East as officers in Department of Transporation or its Management 
Zones; engineers working in company as an Investor or a Contractor or a Consultant. Total of 
185 questionnaires were distributed to respondents selected randomly from the list available 
with these offices. A total of 185 responses were received. A summarized profile of the 
respondents is presented in table 2. As is shown this table, the respondents have a wide range 
of experience and number of years of service. Respondents with 5-10 years’ experience form 
the largest group. The responses were analyzed using SPSS software (version 20).

**Table 2. Profiles of companies and respondents.**

| Characteristics          | N   | %  |
|--------------------------|-----|----|
| Company Type             |     |    |
| Contractors              | 32  | 18.1% |
| Consultants              | 20  | 11.4% |
| Investors                | 66  | 37.5% |
| Project Management Unit (PMU) | 58  | 33.0% |
| Respondent Job title     |     |    |
| Senior management        | 19  | 10.8% |
| Project management       | 80  | 45.5% |
| Project engineer         | 74  | 42.0% |
| Others                   | 3   | 1.7%  |
| Years of experience      |     |    |
| <3                       | 24  | 13.6% |
| 3-5                      | 64  | 36.4% |
| 5-10                     | 71  | 40.3% |
| >10                      | 17  | 9.7%  |

- **Step 3: Data analysis method**

The statistical tests used in this study is conducted starting from Reliability assessment 
(internal consistency through Cronbach’s α coefficient) and factor analysis (Bartlett test of 
sphericity, KMO test, PCA with varimax rotation) to determine critical factors, then 
Multivariate Regression Analysis has been conducted, based on the regression model to test 
the research hypotheses and measure the importance of factors affecting the completion of 
transportation infrastructure projects in HCMC East. ANOVA, mean, median, standard 
deviation, and frequency were used to find out summary statistics of responses. To get an in-
depth understanding of the factors affecting transportation infrastructure projects, face-to-face 
interviews were conducted with four practitioners after the data from questionnaires had been 
collected. All the four interviewees had over tenyears of experience in the transportation 
construction industry, and were asked to explain how the critical factors identified by this 
survey affected the projects that they were engaged in.

**4. Results**

To gain the first objective of this study, identification of significant schedule performance attributes 
for transportation infrastructure projects was performed.

After collecting data from 185 questionnaires, there are 176 invalid responses which adequate 
information. Reliability assessment shown that all 32 attributes have “Cronbach’s Alpha if Item 
Deleted” from 0.635 to 0.906 and Corrected Item- Total Correlation all larger than 0.3. Therefore, 
those attributes are reliable for making factor analysis.

Factor analysis was carried out with PCA extraction method by eliminating variables classified into 
2 different groups with difference loading factor less than 0.3 and variables with factor loading factor
less than 0.424, finally, with data obtained, after extracting, there are 23 variables remained and classified into 6 groups of factors, the total variance explained is 72.318%, which could explain 72.318% the variations of the observed variables. The KMO and Barlett’s Test with KMO coefficient 0.849 larger than 0.5 and the hypothesis H0 (the correlation matrix is a unit matrix) of Bartlett's test has been discarded with a statistical significance 0.000 less than 0.05.

Table 3. KMO and Bartlett’s Test.

| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | .849 |
|--------------------------------------------------|-----|
| Bartlett's Test of Sphericity                     |     |
| Approx. Chi-Square                                | 2469.009 |
| df                                                | 253 |
| Sig.                                              | .000 |

Results of Factor Analysis identified critical factors that have potential effects on schedule performance of projects, shown in table 4.

Table 4. Factors affecting schedule performance of transportation infrastructure projects.

| Factor                                      | Loading | Variance explained |
|---------------------------------------------|---------|--------------------|
| **X₁- Financial difficulties**              |         | 17.951%            |
| Financial funding progress delayed compared to the project implementation schedule | 0.853   |                    |
| Disbursement procedures slowed down by investor and contractor                        | 0.782   |                    |
| Total investment budget overed in order to achieve the initial goal of the project    | 0.767   |                    |
| Investor delayed the payment for the contractor                                       | 0.752   |                    |
| The Investor's financial capacity is limited                                          | 0.728   |                    |
| The project lacks funding for site clearance                                            | 0.543   |                    |
| **X₂- Site conditions for project implementation**                                   |         | 13.115%            |
| Project location far away from construction materials’ supply                          | 0.827   |                    |
| Construction projects located at unfavorable positions in topography or near a densely populated area | 0.775   |                    |
| Unpredictable and inadequate survey in geological conditions                           | 0.751   |                    |
| High and complex technology required to do the project                                 | 0.698   |                    |
| **X₃- Factors related to Contractor/ Consultant**                                     |         | 10.952%            |
| Delay in solving the project’s problems by the contractor                               | 0.826   |                    |
| Late in payment to subcontractors and material suppliers by the contractor              | 0.749   |                    |
| Limited in experience capacity of the design consultant with regard to project scale and characteristics | 0.663   |                    |
| Limited in financial capacity of the contractor                                         | 0.627   |                    |
| **X₄- Site Clearance and Compensation**                                                 |         | 10.177%            |
| Difficulties in site clearance due to the residents living in the project area not agree with compensation’s plans and compensation prices | 0.864   |                    |
| Delayed by the authorities in preparing and approving the compensation and site clearance plans | 0.820   |                    |
Factor Loading Variance explained

Poor management of land by authorities, difficulties in determining the origin of the land. 0.819

\(X_5\) - Project fluctuation
- Fluctuations of material and equipment’s price during project implementation 0.772 10.151%
- Changing in construction methods 0.746
- Change of staff, key personnel of the Investor or Contractor or Consultant or PMU 0.727

\(X_6\) - Factors related to Investor/ PMU
- Limited in experience capacity of the Investor with the scale and characteristics of the project 0.775 9.973%
- The capacity of the Project Management Unit limited 0.775
- The Investor not actively coordinate with the authorities to solve compensation and clearance’s problems 0.631

Cumulative variance explained 72.318%

The second objective of this study is to compare the factors affecting schedule performance. To do that, after factor analysis, the Multivariate Regression Analysis was conducted.

The main purpose of a Multivariate Regression Analysis is to learn about the relationship among several factors (known as independent variables or explanatory variables) and another factor (known as the dependent variable or response variable). The regression model takes the form of the following equation:

\[
Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_n X_n + e
\]

Where \(Y\) is the dependent variable, \(X_i (i=1,2,...,n)\) are the independent variables, \(\beta_i (i=0, 1, 2...n)\) are the parameters to be estimated, and \(e\) is the error term.

This model was used in the study where “schedule performance” is treated as dependent variable and the six factors above as independent variables.

R square coefficient is an indicator used to assess the suitability of a regression model. "R square coefficient is a variation of the dependent variable explained by the model (independent variables)" (According to Nguyen Dinh Tho, 2016) [7]. The appropriateness of the multivariate linear regression model is reflected more closely, more safely when using adjusted R square instead of R square. As in table 5, the adjusted R square is 0.681, hence, the model's compatibility with the observed variables is relative and the ratio of 68.1% which means the regression model is constructed in accordance with 68.1% of the data, or independent variables affecting 68.1% of the change of dependent variables, the remaining 31.9% related to factors not considered in the study. Also, the Durbin - Watson test is performed with a value of \(d = 1.235\) in the range of 1 to 3, the model has no first-order correlation or in other words, no autocorrelation between the variables in model. In table 6, result of analyzing significance level Sig. = 0.000 <0.05, and \(F = 63.164\) is different from zero and with significance level sig = 0.000 <0.05, which shows that the model's suitability, the factors selected for the model actually have an impact on the dependent variables, and reject the hypothesis H0 that all regression coefficients are equal to 0.
Table 5. Model Summary.

| R   | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-----|----------|------------------|---------------------------|---------------|
| .832 | .692     | .681             | .60886                    | 1.235         |

Table 6. ANOVA.

| Model      | Sum of Squares | df | Mean Square | F     | Sig. |
|------------|----------------|----|-------------|-------|------|
| Regression | 140.492        | 6  | 23.415      | 63.164| .000 |
| Residual   | 62.650         | 169| .371        |       |      |
| Total      | 203.142        | 175|             |       |      |

The regression model can be illustrated in the equation:

\[ Y = -0.319X_1 - 0.118X_2 - 0.127X_3 - 0.243X_4 - 0.200X_5 - 0.133X_6 \]

Regression analysis results are presented in table 7 as follows:

Table 7. Regression analysis results.

| Model | Unstandardized Coefficients | Standardized Coefficients | t     | Sig.     | Collinearity Statistics | Ranked |
|-------|-----------------------------|---------------------------|-------|----------|-------------------------|--------|
|       | B   | Std. Error  | Beta |       | Tolerance | VIF  |
| (Constant) | 5.765 | .205 |       | 28.139 | .000 |      |
| X_1   | -347 | .069 | -.319 | -5.017 | .000 | .452 | 2.214 | 1 |
| X_2   | -148 | .074 | -.118 | -1.993 | .048 | .519 | 1.928 | 6 |
| X_3   | -176 | .088 | -.127 | -1.991 | .048 | .445 | 2.245 | 5 |
| X_4   | -249 | .047 | -.243 | -5.321 | .000 | .876 | 1.141 | 2 |
| X_5   | -256 | .075 | -.200 | -3.389 | .001 | .523 | 1.911 | 3 |
| X_6   | -147 | .071 | -.133 | -2.075 | .039 | .443 | 2.259 | 4 |

The highest level of influence on the schedule performance of transportation infrastructure project is \( X_1 \)-Financial difficulties (Beta coefficient = -0.319), followed by \( X_4 \)- Site Clearance and Compensation (Beta coefficient = -0.243), \( X_5 \)- Project fluctuation (Beta = -0.200), \( X_5 \)- Factors related to Investor/ PMU (Beta = -0.133), \( X_6 \)- Factors related to Contractor/ Consultant (Beta = -0.127) and finally \( X_2 \)- Site conditions for project implementation (Beta = 0.118). A negative coefficient indicates that the relationship between the independent variables and the dependent variable is inverse which means the stronger the factors occur, the slower the progress of completion.

5. Discussion
The above results help to gain the objectives (1) and (2) of this study. To achieve the third goal of providing recommendations to respond to the finding critical factors, face-to-face interviews with four experts were conducted for having an in-depth understanding of the factors affecting transportation infrastructure projects. The interviewees were asked to explain how the critical factors identified by this survey affected the projects that they were engaged in, and give their recommendations.

In-depth interviews of experts all confirmed that the current situation of many technical infrastructure construction projects was not completed in accordance with the original plan, affecting
the overall development goals of the city. They commented that the research results are reasonable and suitable to the current status of projects.

**Financial difficulty** has the highest affect on schedule performance. The problem of slow payment, slow funding, limited financing, and over-estimation are all considered as important factors affecting the success and schedule performance as the results of the other authors' research such as Cao H T (2010) [4], Razek M A (2008), Sweis et al. (2008), Adel A K and Martin S (2009) [8-10]. As consequence, some recommendations are proposed:

- Solving the problem of slowly disbursement of public investment. Strengthening the responsibility of the leader in the disbursement for the project’s funding from the state budget to ensure balance and allocate sufficient capital for the project.
- Solving problems of overed-budget: The state agencies should thoroughly inspect and review the loan documents, avoid the violations of the loan regulations of the Corporations as the Investor. Clarify which responsibilities belong to which ministries, branches, agencies, units when the project’s budget is overed; Improve the quality of construction estimates. Therefore, the survey needs to take seriously, provide necessary and accurate information, in accordance with technical standards and design processes.
- In macroeconomics, it is necessary to control inflation, especially the inflation of materials, labor, and machinery for construction.

**Site Clearance and Compensation** is also the big issue that influencing the schedule performance of transportation infrastructure projects. The most difficult problem for resident to agree to hand over the land is compensation’s price. The land prices have great differences at the time of construction compared with the beginning time of compensation. Therefore, when implementing construction, the compensation price must be suitable and close to the market price to avoid causing disadvantage for residents. Besides, it is necessary to promote propaganda to create a consensus of the people. All complaints and denunciations of residents must be settled promptly, reasonable, in accordance with regulations. Avoid changes in master planning that can cause conflicts because of project boundaries. It is necessary to clarify the legal basis for planning and notify to the residents. Improve management of land by authorities, to have adequate proof for determining the origin of the land.

**Project fluctuation** is ranked as the third affecting factor. In this group, price fluctuations, material and equipment price fluctuations during the project implementation period have the strongest impact on the group of factors. Also, the change of construction method because of mistakes in initial calculations for technical design and construction methods leads to wasting a lot of time for adjustments. The change of management personnel, key personnel affecting the project implementation schedule, the work is delayed due to lack of decision makers, new personnel need some time to learn and control full legal, technical information of the project, also information of subcontractors, material’s suppliers, contract information…Therefore, project management needs to consider and control these changes to reduce the risk of project delay.

**Factors related to Investor/ PMU and Factors related to Contractor/ Consultant** are the successive factors. Delayed in solving the project's problems, late in payment, limited in experience and finance capacity of parties involve in the project, poor coordinations… also have negative influences on schedule performance. Hence, there is need to check carefully and improve capacity of those who take part in implementing the project by taking adequate traning course for project management, project supervision, health, safety and environmental management, also need to improve the responsibility of officials and experts involved in project management and implementation.

**Site conditions for project implementation**: Construction of transportation infrastructure is often implemmented before the other industrial and housing projects; Therefore, access to transportation infrastructure project is often difficult, far from the supply of materials that affect the project completion schedule. In addition, projects requiring high technology and complexity such as the construction of Metro line, construction of Saigon river tunnel are also big challenges for project managers. Due to the special and complex nature conditions of the project, it is difficult for managers to fully schedule each task in the overall schedule. These reasons were also found in the study of other scientist, as in the research of Lo et al (2006), Enshassi et al. (2009) [11,12]. Once again, to improve
the experience capacity of engineers in survey and measurement work is so important, also, the project manager need to collect data from many different projects to have full estimate of time to conduct the work.

6. Conclusions
From qualitative analysis to quantitative analysis by using factor analysis and linear regression model, testing hypotheses, combining in-depth interviews, research results of the thesis have drawn 6 groups of critical factors affecting the schedule performance of transportation infrastructure projects in the Eastern Districts of HCMC. This study has been solved the research objectives, ranking the factors after identification and proposing recommendations for those issues.

Based on the study’s results, hopefully those factors will be considered in the project management works of parties involved in transportation infrastructure projects to build the management scheme and there will be a system to evaluate the effectiveness of them on the schedule performance. More studies should be conducted to investigate the effectiveness of applying the proposed solving method for the time management.

For further lines of research, there should be more comparable models to compare factors influencing on schedule performance of transportation infrastructure projects which different in project scale, total investment, project implementation form (PPP or ODA or project by the State’s fund, etc).

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