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Practical Solutions to Ensure the Schedule Management of Ho Chi Minh City Urban Railway Project in Vietnam:

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Abstract The development of the construction industry is considered to be a significant factor contributing to the economic growth of states and countries. However, many studies have shown that the quality of time and schedule management on civil and construction projects has generally been poor. Thus, it is essential to investigate factors that significantly affect the project schedule. This research aims to examine the practice of time management on a particular construction transport project in a developing country, the urban railway project in Ho Chi Minh City, Vietnam, with its six main lines. The implementation of this project began in 2010, but so far, only two lines have been constructed. The implementation process has been struck by many difficulties leading to the slow implementation of the entire urban railway system. To investigate the main causes leading to project delays, a research survey was carried out in three main stages: (1) a questionnaire was designed (2) data was collected with the participation of experts, and (3) an analysis of the data verification of the research model. Then, the analytical hierarchy process approach was applied to assess the priority level of the proposed solutions to ensure the effectiveness of the schedule of the entire urban railway project.

Keywords Analytic Hierarchy Process, Civil Engineering, Construction Management, Urban Railway, Schedule Management, Project Delay

1. Introduction

In accordance with the 2020 Development Plan of the Ho Chi Minh City (HCMC) government approved by the Prime Minister, Phuc Xuan Nguyen, it was to have eight urban railway lines, with a total length of over 230km, which by 2020 was expected to have 2-3 lines completed [1]. At present, one line (Line 1: Ben Thanh – Suoi Tien) is still being constructed. This line was started in 2012 and was expected to be completed in 2016. In light of several problems, the project had to be rescheduled for an opening at the end of 2020. The whole railway project was expected to be completed and tested in 2019, officially operated in 2020. However, many issues have arisen, which have affected the progress and schedule of the whole urban railway project in Vietnam. In order to improve the above time management issues in the HCMC urban railway project, this paper presents the priority level of the proposed solutions to ensure the effectiveness of the schedule of the entire railway project based on the Analytic Hierarchy Process approach.

2. Literature Review

Railway construction projects are well represented in the transport infrastructure domain, and they consist of a group of interrelated subprojects. The constraints of each railway project do differ though, in practice, most railway construction projects are subject to schedule overruns [2]. To optimize the schedule, project managers first need to analyze the factors affecting the schedule overruns and eliminate them and to take measures to ensure on-time project completion. Mackenzie [3] has offered an expansive definition for project time management as it is the function required to maintain the appropriate allocation of time to the overall conduct of the project through the successive stages of its natural life-cycle, (i.e., concept, development, execution, and finishing) using the processes of time planning, time estimating, time scheduling, and schedule control. The construction project schedule and time required must be captured and managed in both individual and assigned tasks using appropriate tools [4]. Delays occur in almost every construction project, and the magnitude of delay varies considerably from project to project, ranging from a few days to several years [5, 6]. Many

difficulties occur during the execution of a project, and, in practice, the schedule is likely to be altered. Therefore it is necessary to have better schedule management from the start [7].

The literature review of schedule delay in projects in developed countries identified a total of 46 factors [8]. These factors were subdivided into eight sub-groups, as follows: contractor related delays, equipment-related delays, client-related delays, material-related delays, finance-related delays, consultant-related delays, external delays, and manpower-related delays [9, 10]. In developing countries, however, the priorities of these group factors may differ. Hence, this paper examines scheduling issues in a metro railway system project in Vietnam, in order to identify the causes of the delays in a developing country and to suggest remedial solutions.

The HCMC urban railway project (HUR) is to have six main lines, of which three lines are being implemented, and five sub-main lines are undergoing preparation for investment. The details are as follows [11]:

(i) Line 1: The starting point at Ben Thanh Market ends at Long Binh Depot. It has a total length of 19.7 km (2.6 km underground and 17.1 km surface), 14 stations (three underground stations and 11 surface stations). Commenced in 2012, this line is expected to be operational in 2020. In December 2018, the project implementation volume reached 60.9%.

(ii) Line 2: This line was started in the Northwest Urban Area (Cu Chi District) and ended at Thu Thiem. The total length of the whole line is to be 48 km with three segments. Segment one was expected to be running in 2019 and to be officially opened in 2020. The project is implementing ground clearance, completing office buildings, and undertaking auxiliary works at the Tham Luong Bidding was organized to select packages CP0, CP5, and bidding packages CP3a and CP3b (building tunnels and underground stations). Now it is expected that this line will be officially opened in 2024.

(iii) Line 5: The starting point is Can Giuoc Station (new), and the line is to end at the Saigon Bridge. The total length will be 23.39 km. According to the plan for the year 2018, construction and completion of the first segment will start in 2023. Currently, the project has completed the pre-feasibility study report, completed the evaluation and selection of the contractor to design the technical frame design (FEED design), and conducted land clearance.

(iv) Project lines No. 3a, 3b, 4, 4b, and 6 are carrying out investment preparation.

Among them, Line 1 (Ben Thanh – Suoi Tien) belongs to the HCMC urban railway system. The investor is the Management Authority for urban railways in Ho Chi Minh City, which is the agency directly assigned to manage and use capital to carry out construction investment activities. The Ho Chi Minh City People's Committee is the governing body, and the Japanese International Cooperation Agency (JICA) is the Foreign Sponsor for Line 1 [12]. The project uses special conditions for loans. Line 1 was expected to start construction in mid-February 2010 and complete operations in February 2014. In fact, Line 1 was started at the end of July 2012, after more than two years of delay. The date of completion of commercial operation is expected to be postponed until the end of 2020, six years later than originally expected. The scope of implementation of the bidding packages is as follows: (i) Package No. 1a (construction of 0.76km underground section from Ben Thanh station to the Opera House station) Accumulated volume has now reached 53% of the contract volume; (ii) Package 1b (construction of 1,745km underground section from City Theater station to Ba Son station) now has an overall construction volume of about 69% of the contract volume; (iii) Package 2 (construction of the elevated section and depot with a length of 17.1 km from Ba Son station to Binh Duong province) has a total construction volume of about 79% of the contract volume; (iv) Package 3 (procurement of electromechanical equipment, rolling stock, railroad tracks, and maintenance) has an overall construction volume of about 40% of the contract volume. Technical designs for subsystems have been approved. The contractor is still manufacturing some items (OCS columns/beams, parts of rolling stock, sleepers, and so on ...); and (v) Package No. 4 (information technology system for the operating company office) is preparing to implement the technical design.

3. Research Methodology

The determination of the factors affecting the implementation progress of the HCMC urban railway project was carried out in two stages: (1) Qualitative research to develop questionnaires, (2) Quantitative research to collect data using the questionnaires, collecting official data, data analysis, and research model verification. To measure the impact of the factors identified, a Likert scale of 5 points was used to assess the impact level of observed variables. The scale has five options: (1) No impact, (2) Less impact, (3) Medium impact, (4) Strong impact, and (5) Very strong impact were used for evaluation [13, 14].

Through the analysis of causes of the delay, a preliminary determination of 29 influencing factors was made as to the basis for the questionnaire. Leaders in the Department of Transportation, Railway Project Management Unit, Project Management Consultant and Construction Line 1 with ten years or more experience were invited to participate in the survey. Based on the preliminary data obtained from 20 experts and the results of preliminary measurement and extraction of factors, removal of the non-conforming factors and correction produced a formal questionnaire consisting of 25 factors. The influencing factors are presented and described in Table 1:

Table 1. Factors affecting the implementation progress of the Ho Chi Minh city railway project

N₀	Factors affecting the implementation progress of the HCMC urban railway project
1	Delay in procurement, production, construction, and installation of EPC contractors
1.1	Quality assurance plan and low-quality control process during design, procurement, production, construction, and installation.
1.2	Delayed due to the suspension of construction due to safety or accidents at the construction site.
1.3	Delayed because the subcontractor has no practical experience, lack of overall capacity, and specific experience on the Metro.
1.4	Delay due to changing materials and construction procedures.
1.5	Problems with the construction management team with weak supervision and inexperience.
2	Delay due to problems in project management and administration.
2.1	Weak and inexperienced project management team.
2.2	Delays in the approval of records: Planning, Design, Quality, Acceptance.
2.3	Delay due to project adjustment (increase in total investment or adjustment of planning).
2.4	Deferring decisions about changes in the contract
2.5	Delay in selecting the main contractor, affecting other construction work packages.
3	Delay due to national factors and financial influences.
3.1	Delay in changing standards or failure to agree on standards because approved documents conflict with current regulations.
3.2	Changes in laws changes policies in the national development process.
3.3	Unexpected geological conditions.
3.4	Payment delay due to the financial difficulties of the Investor.
4	Delay due to design conflict.
4.1	Lack of information, drawings, and technical instructions were not provided by the main contractors.
4.2	Delay due to making adjustments.
4.3	Delay due to design because of inexperienced designers.
4.4	Delay due to new or changed standards applicable to the project.
5	Delay in handing over the premises.
5.1	Handing over only part/or not handing over the whole time leads to the completion of the project.
5.2	Delay in moving existing utility facilities or obstructions in the boundary line.
5.3	Delay because the contractor cannot access the site due to obstruction by people.
5.4	Delay due to the contractor being unable to access the construction site
6	Delay due to a lack of coordination among project participants.
6.1	Lack of local coordination and authority level due to unclear regulations.
6.2	Lack of coordination with the investor due to unclear regulations.
6.3	Lack of coordination of the contractor, or the contractor does not understand the coordination procedure.

The progress of the HCMC urban railway project has been measured through six components: (i) procurement, production, construction and installation of the contractor, (ii) management and administration of the owner's investment, (iii) domestic and financial factors, (iv) construction design (technical design and construction drawing) of the contractor, (v) handover of premises and (vi) coordination among participants in the project.

4. Research Results

One hundred and fifty questionnaires were distributed, and 141 questionnaires were received. Of these, 125 were considered valid and included in the analysis. The required tables were encoded, input, and cleaned with SPSS 20 software. The test results showed that the groups of factors with Cronbach Alpha coefficients ranged from 0.7 or higher, and the observed variables in each group had a total variable continuation of the factor analysis, as presented in the following section.

Exploratory factor analysis (EFA), analysis results showed that: $KMO = 0.723$ satisfies $0.5 \leq KMO \leq 1$; Barlett

inspection is worth $\text{Sig.} = 0,000 < 0,05$ shows variables that are significantly correlated at reliability $\gamma = 95\%$. Eigenvalue coefficient of 6 extracting factors > 1 . The total variance extracted by the EFA factors = 66.699%, which means that more than 50% of the information has been extracted. Thus, six extracting factors ensure eligibility for regression analysis.

Multiple regression models were used to define and verify the relationship between dependent variables and independent variables extracted following the EFA factor analysis step. OLS (Ordinary Least Squares) method was used for regression analysis. Conducting multivariate regression analysis resulted in 6 groups of factors set into variables in the regression equation: Implementation of EPC contractor (X_1), executive management of investor (X_2), finance and domestic factors (X_3), construction design of EPC contractor (X_4), site handover (X_5), and coordination of implementation between project parties (X_6). The regression equation is as follows:

$$\text{Project progress} = 3,000 + 0,165X_1 + 0,370X_2 + 0,297X_3 + 0,272X_4 + 0,487X_5 + 0,282X_6$$

The regression equation shows the progress of the UMRT project implementation under the influence of the following factors: Implementation of the EPC contractor; Managing and managing investors; Finance and domestic factors; Construction design of EPC Contractor; Handover ground; Coordinate implementation between project parties. The impact of these six factors on the progress of the UMRT construction project is reflected by standardized beta (β) coefficients. Sorting in descending order gives the following result:

Table 2. The impact level of factors affecting the implementation progress of the Ho Chi Minh city railway project

Factors affecting the implementation progress of the HCMC urban railway project	Standardized beta (β) coefficients
Site handover	0,487
Executive management of investor	0,370
Finance and domestic factors	0,297
Coordination of implementation between project parties	0,282
Construction design of EPC contractor	0,272
Implementation of EPC contractor	0.165

The analysis of the influence of factors is presented below:

- i) Site handover: This factor has a normalized regression coefficient $\beta = 0.487$, meaning that when this factor increases to 1 unit, the average daily completion of the Metro project will increase to 0.487 units. This factor has the most significant impact on the progress of implementation and the completion date of the project. The influence of the X_5 variable on the project implementation schedule in the model is entirely consistent with the characteristics and nature of the project. Since the Metro lines in Ho Chi Minh City are planned to spread along urban corridors with a high population density and stability, this factor is a prerequisite for the success of the project to achieve a clean area.
- ii) Executive management of investor: With the coefficient $\beta = 0.370$, the effect of this variable on the dependent variable is second after the X_5 variable. When the impact level of this factor increases to 1 unit, the level of delay increases to 0.370 units. The influence of variable X_2 on the project implementation schedule in the model shows the investor's decisive role when the project is behind schedule, especially when considering public investment projects.
- iii) Finance and domestic factors: The impact level of this factor on the progress of the project with the coefficient $\beta = 0.282$ shows the specificity of the ODA-funded Metro project. Project implementation time is long and governed by changes in policies and laws of the country concerned [15, 16]. Underground construction is exposed to many risks due to unforeseen geological conditions. Finally, due to the huge amount of investment capital, the progress of the project depends heavily on the ability to pay on time, the ability to maintain a stable financial flow, and the ability to ensure reciprocal capital for the project.
- iv) Coordination of implementation between project parties: This is the third most influential factor with the coefficient $\beta = 0.297$. The influence of variable X_3 in the model reflects the nature of critical national projects. Coordination of implementation plays a crucial role throughout the state management from central to local levels, between functional departments, between investors, consultants, and construction contractors.
- v) The contractors capacity to implement project lines: This lower level of impact of this factor is shown through the factors X_4 and X_1 (design, procurement, production-manufacturing, construction, installation, and supervision) with the lowest impact level of the impact factors with coefficient $\beta = 0.272$ and $\beta = 0.165$. Such an impact reflects an objective reality that in the EPC bidding packages, the contractor's risk does not have a strong impact on the progress of the project because the contractor will have to mobilize maximum resources to catch up to the schedule in all risk situations.

5. Discussion

From the findings mentioned in the previous section, the chief causes are analyzed and synthesized below:

- a) Lack of coordination among project participants: The coordination between the participants in the project has not been positive and proactive. Because the project was of special importance, uses high technology, and is being implemented in Vietnam for the first time, the caution in investing is understandable but has led to certain limitations: (i) The main contractors have not actively coordinated with each other in terms of design, date of access between bidding packages, and coordination with departments and functional branches in the process of design and construction; (ii) There are many issues in coordinating between investors and departments and functional branches in the procedures for adjusting projects, the approval of dossiers according to regulations, and also in the transfer of construction sites that are no longer public; and (iii) Functional departments - local levels have been slow to coordinate in terms of providing compensation for land acquisition. Confirmation of payment records of central management agencies has often been delayed. Adjustments to procedures and laws have given rise to new conflicts and delays the implementation schedule.
- b) Operating management: Work progress has depended too much on the decisions of the investor. The investor needs to approve most of the project documents based on the evaluation report of the General Consultant. This includes the technical design prepared by the contractor, approved by the subcontractor, signed the quality acceptance test, payment records, issuing non-objection decisions for the types of construction progress dossiers, quality assurance procedures of contractors, making decisions on changes and adjustments. The very concentrated participation in the technical management of the investor in the EPC project has been one of the reasons for slow progress.
- c) Handing over the premises: At the time of commencement of Line 1 in July 2012, only 80% of the premises were handed over to the contractor. The whole site was handed over in early 2015, two years later than planned.
- d) Conflicts in construction design: The foundation for implementing the interface (the connection and coordination between design contractors) between the EPC contractors in the project began in the design phase and was specified in the contract. The contractor proposed that the interface be considered as the vital task of the process for the job. However, the bad interface led to a delay in the design due to the lack of design information. The problems include (i) The contractors disagreeing with the design solution (this contractor can change of the design of other contractors), (ii) failure to reach an agreement on the timing for provision of information (due to different work progress), and (iii) failure to determine which party is responsible for the delay in coordination.
- e) Bidding, construction (procurement, production, construction, and installation): Adjustments in the project faced many difficulties, which led to the plan for selecting contractors facing many adjustments. Typically, the CP3a package, CP3b of Line 2 had to extend the closing time and bid opening three times from June 2018 to January 2019 [11]. For Line 1, according to the loan agreement, Japanese contractors were the partners at the top of the partnership, working with a Vietnamese contractor. This provision had many advantages for local construction contractors participating in the project, although many contractors had no experience in Metro designing and construction. The lack of experience of the subcontractors and managers of the Main Contractor Line 1 has caused delays in some parts of the work in the project submission process and improving the quality management process on time.
- f) Changes in relevant legal documents: While the regulation indicated that the Sponsor is to use the FIDIC guidelines applied throughout the project, domestic procedures relating to investment and construction have changed between two and four times. These mandatory adjustments have delayed implementation progress. Table 3 shows the changes in the law occurring during the implementation of the HCMC urban railway project.
- g) Project disbursement: In terms of finance, ODA projects are considered as guaranteed by the committed capital. Disbursements are made in accordance with the order and legal procedures and following Vietnamese and donor regulations. The order and procedures, however, have been quite complicated, especially when there are expenses that exceed the total investment and exceed the authority of the investor. The case of slow disbursement of Line 1 is an example. Route 1 generated funding exceeding the total initial investment, but the National Assembly has not yet commented on the adjustment of the project and increased the total investment. Thus, in 2018, ODA capital was not disbursed, which led to the current situation. The debts of construction contractors exceed \$100 million.

Table 3. Changes in legal documents during the implementation of the HCMC urban railway project (Line 1)

Regulation	Number of changes	Year of changes
Law on Construction	3	2003, 2009, 2014
Law on Bidding	3	2005, 2009, 2013
Law on railway	2	2005, 2015
Decree on bidding	3	2008, 2009, 2014

Decree on construction management	4	2006, 2009, 2015, 2017
Decree on quality management	3	2004, 2013, 2015
Decree on bidding in construction	2	2010, 2015
Circular guiding quality management	3	2005, 2013, 2016

By June 2020, the HCMC urban railway project lines are behind schedule, so the research objective has been to develop solutions to ensure the project completion date lines up with the plan. Considering the factors that have been studied as potential risks to progress, Verzuh (1999) [17] has described five types of strategies to manage risk for a project: (i) accept, (ii) avoid, (iii) monitor, (iv) transfer, and (v) reduce risks. Based on this theory, there are 6 proposed solutions and 19 sub-factors. One of the best methods is to use the Analytic Hierarchy Process (AHP) developed by Saaty to determine the priority of solutions [18-20]. When solutions have the same goal and are classified into lower-level details, the AHP method is useful to assess their importance. The goal is the completion date of the UMRT project, Level 1 is the group of 6 solutions, Level 2 is the content from 01 to 19.

To evaluate the proposed solutions, survey data were collected through interviews with 20 people. Experts interviewed had more than ten years of experience, had been or were participating in the Metro project, were holding positions related to project management and management in various units of the Department of Transportation and Planning and Investment, Metro PMU, Project Management Consultant, or Metro Line 1 Contractor. Information on the survey sample is shown in Figure 1.

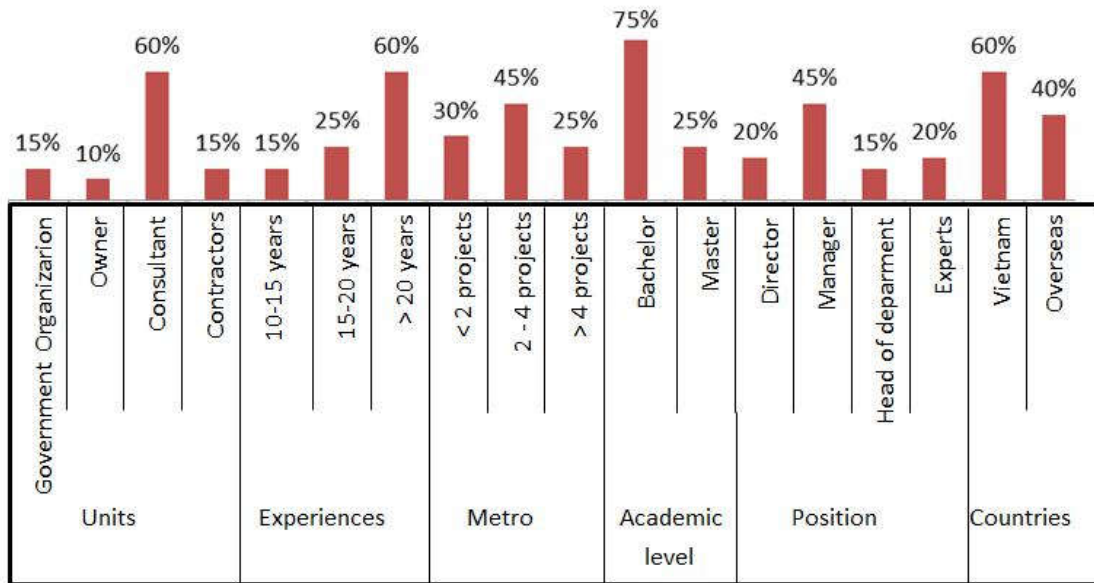


Figure 1. Summary of expert survey information

The calculation cycle was conducted through 02 levels. Cycle 01 is a crucial calculation of group 06 leading solutions. Cycle 02 is the crucial calculation of each content in each solution. To determine the priority items to be implemented for the entire project, the final key-value was determined by the product value obtained from cycle 01 and cycle 02. Table 4 presents a summary of these results. It shows that if the synchronous implementation of the 06 solution groups shown in the 19 sub-strategies above, progress will be ensured according to the adjustment plan, and line 1 can be completed in December 2020. And in general, the priority sequence of solutions should be implemented, as shown in the third column in the Table 4.

Table 4. Results of evaluating and prioritizing solutions

No.	Solution	The level of importance			
		Level 1	Level 2	Result	Priority
	Solution of Coordination	18.60%			
1	Applying the construction progress notification model		31.33%	5.83%	7
2	Prepare a specialized executive board and coordination forms		33.33%	6.20%	6
3	Coordinate adjustment of access dates between bidding packages		35.33%	6.57%	4
	Solution of management	15.31%			
4	The Owner-Developer model should limit technical decisions		19.97%	3.06%	16
5	Decision-making model based on EPC Contractor		23.54%	3.61%	13
6	Bidding package planning according to adjustment scale		32.94%	5.04%	11
7	Give early time adjustment to the Contractor		23.54%	3.61%	14
	Solution of Site	22.76%			
8	Additional clarification of regulations on handing overground		23.64%	5.38%	9
9	Extend the time to hand over contracts		27.38%	6.23%	5
10	Relocation of utilities		48.98%	11.15%	1
	Design	15.72%			
11	Perform a four-step interface		30.19%	4.74%	12
12	Design quality management		35.62%	5.60%	8
13	Manage changes and adjustments arising		34.19%	5.37%	10
	PMCI	10.50%			
14	Supervision of recruitment of the project executive board of the main contractor and subcontracting		27.12%	2.85%	17
15	Managing the implementation of plans and quality assurance processes		30.41%	3.19%	15
16	Adjust material approval process		20.66%	2.17%	19
17	Detection of safety risks in construction		21.81%	2.29%	18
	Domestic Factors	17.11%			
18	Managing the application of applicable laws		48.75%	8.34%	3
19	Set up a risk reserve fund		51.25%	8.77%	2

5. Conclusions

The objective of the research has been to propose solutions to ensure the implementation progress of the Ho Chi Minh city urban railway project in the case of Line 1, Ben Thanh - Suoi Tien. Based on the nature of the large scale metro project using ODA loans in Vietnam and the analysis and evaluation of the reasons that have slowed the progress of the project, the study built a system of weak-scale-factors affecting the implementation progress of HCMC urban railway project. Multiple regression models were also used to assess the influence of factors in metro construction to develop response solutions. The study has also applied the AHP to build priorities to selectively apply the solutions. The main solutions offered focus on improving the coordination between contractors and the risk management plan as well as design control. Such results can be useful for leaders and managers and reveal the importance of coordinating implementation from central to local levels, the degree of influence of their decisions on changes, and the adjustment of the project in the implementation process to build a clear, stable legal environment. The research results also showed the complicated institutional, legal, managerial, and compliance difficulties which arise with the international practice of managing large scale urban transport projects using ODA loans in a developing country like Vietnam. In an optimal investment environment, appropriate policy mechanisms, with the consent of the people and the responsibilities and capacities of the leaders, it is possible that the HCMC urban railway project can be properly completed within the specified time limit.

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