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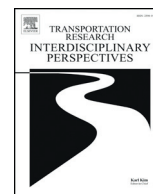
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# Comparative studies into public private partnership and traditional investment approaches on the high-speed rail project linking 3 airports in Thailand

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### ABSTRACT

At present, PPP (Public-Private Partnership) plays an important role in infrastructure project development. This is attributable to the fact that many governments around the world have a budget constraint and may try to prioritize their budget for other developments in need. Allowing a private sector to participate in investment is an important step towards the cost-saving for a government. The private sector has an advantageous opportunity in the investment partnership, and public users tend to have superior service. Thai government envisages potential advantages of PPP and adopts this practice in various projects. However, the new mega project linking 3 airports is one of the first high-speed rail projects in Thailand of which the Thai government has insufficient experience. There are serious concerns whether the PPP adoption could enable a viable option. Therefore, this study aims to analyze benefits and risks of PPP adoption in the High-Speed Rail Project Linking 3 Airports in Thailand. Lifecycle assessment has been carried out by breaking down the project into various phases. Field data have been gathered from different sources such as an official website, feasibility study reports, annual reports of related government agencies, and opinions from technical experts in private sector. Financial analysis is used to analyze and calculate related financial values. The results reveal that the PPP adoption in this project yields different benefits and risks depending on each phase of the project. Adopting PPP can overcome key limitations and provide some real benefits that the traditional approach cannot. Simultaneously, there are risks incurred from the PPP adoption due to the complexity in PPP partnership such as additional transaction costs and interrelation complexity. However, the risks can be managed by a rigorous plan and practice. Both governmental and private sectors need to collaborate to ascertain the project's success.

## 1. Introduction

PPP (Public-Private Partnership) plays an important role in any investment that needs high initial capital such as a railway project. Thailand has also started using this approach to invest in infrastructure projects. The most recent project that has adopted this investment approach is the new High-Speed Rail Project, connecting 3 airports including Suvarnabhumi International Airport, Don Mueang International Airport, and U-Tapao International Airport (Eastern Economic Corridor Office, 2018). PPP is the mutually preferred choice because the government aims to retain political, legal and project selection risks, while the private sector aims to retain construction and operational risks. At the same time, both private and governmental sectors can share economic and market risks. PPP can then promote the smoothness of the project's implementation because no party has to take care of an excessive level of risk (Ogunbode, 2016; Kaewunruen et al., 2016).

In recent years, PPP has gained popularity because of its advantages. In the government's perspective, PPP can be adopted to generate financial value and allocate operational risk to the private sector, which has experience and expertise in a particular business or a specific technical field. Moreover, it gives an opportunity for the government to learn and receive specialized technologies from the private sector. In the private sector's viewpoint, PPP can promote business opportunities because the private sector can advise the government on efficient operations, and some pressing risks can be alleviated by the government e.g. certain legal processes. Through public users' eyes, better value-for-money services can be stemmed from the expertise of the private sector and the appropriate price subsidized by the government (National Science Technology and Innovation Policy Office, 2015).

In contrast, PPP also has some disadvantages. PPP is more complex than traditional investment approaches so that there are additional risks from PPP. Moreover, PPP is generally a long-term agreement and is comparatively inflexible so it cannot envisage and predict all events in the future. Some people concern that PPP can either instigate the government's instability or lead to the government's loss if the partnership agreement is not properly written due to the lack of experience (Government of the Republic of Lithuania., 2015).

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This study aims to highlight benefits and risks of adopting PPP over the mega project period. In this study, the project lifecycle phases are broken down into pre-construction, construction, operation, maintenance, and decommissioning. Each phase will be considered to compare the differences between PPP and the traditional investment approaches in order to identify benefits and risks. This study focuses on the primary revenue only, which is stemmed from the fare income.

## 2. Background

The high-speed rail (HSR) project connecting 3 airports will be implemented on existing infrastructures and route corridors of existing ARL (Airport Rail Link Line). This HSR project adopts the standard-gauge rail track system. Its additional extensions are from Phayathai – Don Mueang and Lad Krabang – U-Tapao (Rayong). The project will connect 3 international airports - Suvarnabhumi Airport, Don Mueang Airport, and U-Tapao Airport. Its corridor contains 9 high-speed stations, namely, Don Mueang, Bang Sue, Makkasan, Suvarnabhumi, Chachoengsao, Chonburi, Sriracha, Pattaya, and U-Tapao.

The business space development to support the railway services in Makkasan area, which belongs to SRT (State Railway of Thailand) of 150 rai, needs to be integrated with the development of the HSR line extensions to maximize benefits and value. Moreover, the area of 25 rai at Sri Racha station can be also re-developed as a Transit-Oriented Development (TOD) immediately (Fig. 1).

The total estimate cost of the HSR project is shown as follows:

The duration of PP is agreed to be 50 years while the construction phase spans over 5 years. The project is planned to commence the operations in 2023. The HSR project linking 3 airports will be operated as a PPP with an initial contract period of 50 years. The detail of relevant parties in the private sector consortium in this PPP can be shown as follows:

## 3. Literature review

Despite significant advantages, PPP cannot guarantee the success of a project. This is because there exist uncertainties and risks from the complexity of the project and its stakeholder interrelationship. Li et al. (n.d.) collected the relevant risks in PPP projects by classifying risks at each level, consisting of micro, *meso*, and macro risks. The micro-level risks are incurred within a PPP organization. The macro-level risks are ecological variables and the meso-level risks are ranged somewhere between macro and micro levels. Wu et al. (2018) indicated the risk-sharing between the public and private sectors in infrastructure projects in China by applying the 3-dimension framework. They applied the Analytic Network Process (ANP) to determine the weight of risk factors. Then, they assessed risk level by considering 3 aspects, uncontrollability, probability, and losses. Their study identified the top 5 risks, including imperfect industrial standard, unstable policy, insufficient operation income, lack of experience in PPP, and imperfect charging technology, respectively (Binti Sa'adin et al., 2016a, 2016b, 2016c). From the study, it can be seen that Thailand is very prone to these risks since Thailand will implement PPP in the HSR project for the first time (Kaewunruen et al., 2018; Alawad et al., 2020). Thai officials do not have sufficient experience on HSR so they will implement the project based on the standard and technology from other countries.

There are many interconnected risks in PPP projects and the details of risk can be different depending on the type of project. Ogunbode (2016) grouped risks into the following categories: political risk, legal risk, project selection risk, construction risk, operation risk, economic risk, and market risk. Then, he used a questionnaire survey to collect data from 155 experts in PPP projects in Nigeria who had more than 5-year experience in infrastructure concession projects. The result from the analysis revealed the most appropriate parties to deal with each risk. The public sector should take care of political risk, legal risk, and project selection risk. The private sector should be responsible for construction risk and operation risk. Both of them should mutually share economic and market risks. This is consistent with a study by Chan (2011) who found that the public sector prefers

to take political, legal, and social risks. Meanwhile, the private sector prefers to take construction risks and operational risks, which are in accordance with Meng et al. (2018), who concluded that the private sector prefers to take construction, operation, and relationship risks. Also, both the public and private sectors prefer to take economic and market risks so they are willing to share these risks together.

One of the most significant benefits of PPP adoption is assigning particular risks to certain parties, who can best deal with those particular risks. Although PPP is popularly used, the success of a project can be uncertain. It is found that most PPP failures are resulted from inappropriate risk allocation and a lack of information to make projects succeed in specific situations (Chou and Pramudawardhani, 2015). Transferring all risks to the private sector is not a good practice. Mouraviev and Kakabadse (2013) studied 11 kindergarten PPP projects in Kazakhstan and found that completely transferring risk to the private sector was expensive and could significantly induce the over-budget situation for the public sector and value of PPP. In addition, it missed the opportunity to create incentives for operation quality improvement and take advantage of economies of scale (Kaewunruen et al., 2015; Kaewunruen and Lee, 2017; Rungskunroch et al., 2020; Kaewunruen et al., 2020). Therefore, it can be seen that proper risk sharing is the best way to optimize the benefits of applying the PPP approach.

It is apparent that, even though PPP is an effective way to execute mega projects, it needs proper risk allocation to assure that projects can be run smoothly. There are many studies that have discussed risk allocation in PPP projects. Depending on the type of project, each study may have different approaches to allocate particular risks to the public sector, private sector, or both.

## 4. Methodology

This study is performed by conducting critical literature review, collecting governmental statistics and information, as well as expert interviews, in order to gather required data, such as the performance of the private sector and the governmental synergy. Some data are collected from related authorities and agencies such as the State Railway of Thailand (SRT). Some assumptions used in the estimation will be made by relative correlations using available relevant data from other sources such as the World Bank or the Asian Development Bank (ADB).

- (i) For qualitative analysis, the content assessment will be conducted to compare with other projects with the same characteristic.
- (ii) For quantitative analysis, financial evaluation will play an important role in this study. First, the cash flow of the project is considered in order to determine the net income and revenue of each year. This can be conducted by using the total financial return of the project with the determined discount rate and the growth of passenger number. The discount rate can be obtained from the official project report on the section of economic return (The Eastern Economic Corridor Policy Committee, 2018). From the official report, the financial return of the project is 127,985 million THB when the discount rate during the 1st-50th year and 51st-100th year are 6.06% and 2.5% respectively (The Eastern Economic Corridor Policy Committee, 2018). The growth of passenger numbers can be obtained from the feasibility report of the project (State Railway of Thailand, 2017), which equal to 2.34%. When the cash flow of the project is known, the benefits and risks of applying PPP in this project can be calculated in terms of net present values, which can be used to benchmark with the traditional approach.

## 5. Results

### 5.1. Benefits of PPP adoption for the highspeed rail project linking 3 airports in Thailand

#### 5.1.1. Benefits from synergy

Firstly, revenue synergy is a potential gain when two or more companies are merged together. It is attributable to the fact that the merging companies can sell more products and services, or get more revenue than a

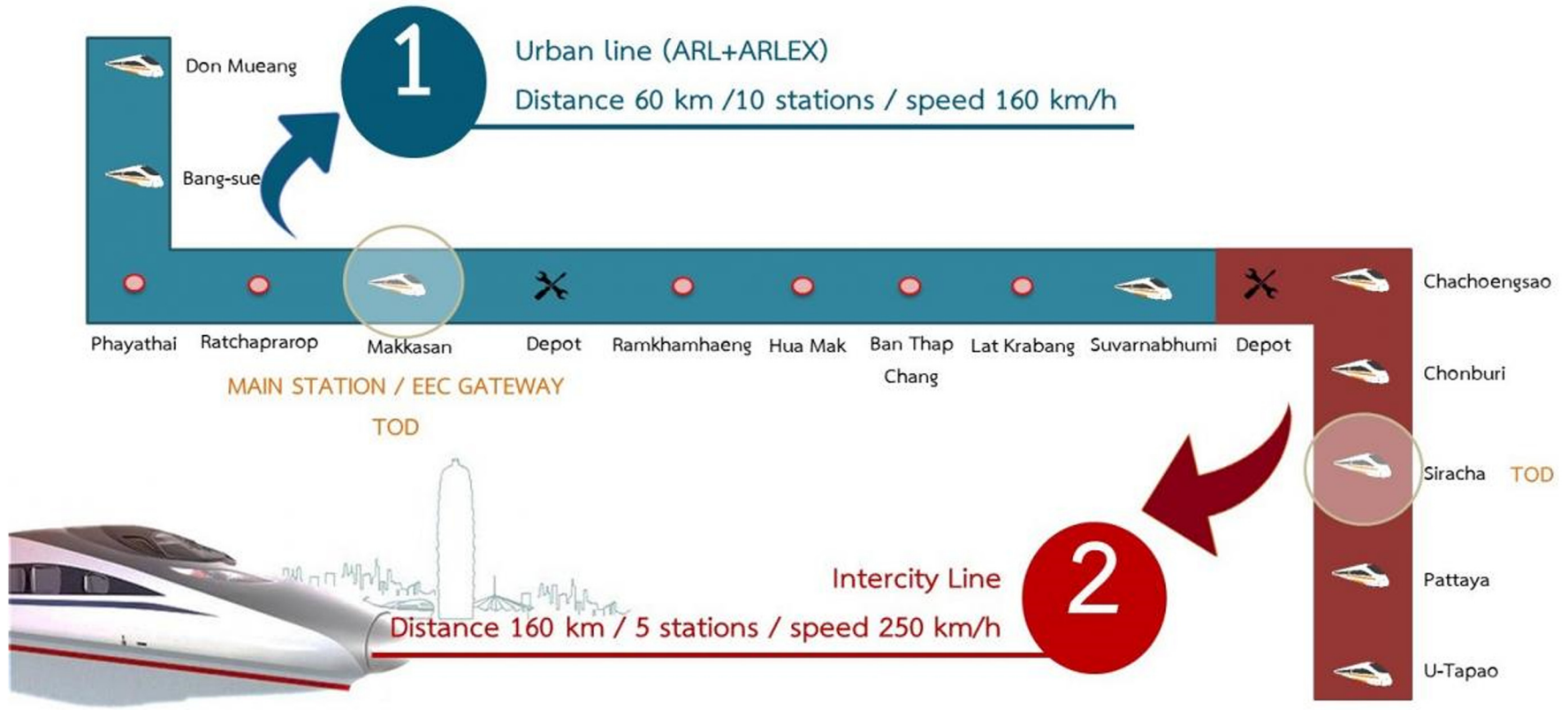


Fig. 1. Concept of the High Speed Rail Linking 3 Airports Project (The Eastern Economic Corridor Policy Committee, 2018).



separate individual. In this context, the additional revenue tends to be generated from the better performance of the combined business management in the railway operation, TOD, commercial, and maintenance in the operation and maintenance phase. Secondly, cost synergy is a potential cost reduction stemmed from the synergy. For general example, PPP can save costs in terms of logistics, storage, marketing expenses, training expenses (from knowledge sharing and technology transfer), staff reduction, system integration, and consolidation (Vaidya, 2019; Rungskunroch et al., 2019). Thirdly, financial synergy is a benefit of lower interest (or lower weighted average cost of capital) because the company with more capital capacity has better capital structure and cash flow. The bank can then offer a better interest rate of a loan. Normally, the interest rate of the loan for a contractor who bids for the public infrastructure is around the Minimum Loan Rate (MRR) + 2% (Kasikornbank Public Company Limited, 2018a). From Kasikornbank Public Company Limited (2018b), the interest rate of the loan for contractors is around 8.25% per year. However, from the negotiation with the government, CP can obtain a special interest rate of 3% (Komchadluek, 2019) while the normal interest rate whose CP needs to pay for the loan is higher, around 4%–6% (Longtunman, 2017). From Table 1, the total cost of the construction is 103,747 million THB (117,227 million THB is subsidized by the government (Bunloet, 2019)) and the cost of the right to operate the existing ARL is 10,671 million THB. The benefit of financial synergy can be calculated from the interest rates of contractors and CP. It can be assumed that the interest rate of CP is around 5%. Therefore, the total benefit from the financial synergy can be estimated to be 5660 million THB.

5.1.2. Benefits from legal issues

The highspeed rail project linking 3 airports is an essential part of the Eastern Economic Corridor (EEC) according to the government's economic policy. Therefore, the highspeed rail project is prioritized and receives the benefits of EEC, including Matching Grants for Investment, Permission to own land, Rights to lease state land, and 5-year work permit (Eastern Economic Corridor Office, 2018).

5.1.3. Tax benefit

Initially, this project gets a benefit from the exemption from corporate income tax for 13 years according to the Investment Promotion Act (Eastern Economic Corridor Office, 2018). In Thailand, the rate of corporate income tax is 20% of the net profit (Revenue Department, 2018). From the EEC study, the financial return is expected to be 127,985 million THB (The Eastern Economic Corridor Policy Committee, 2018). According to the feasibility study of the HSR project (State Railway of Thailand, 2017), the average growth rate of ridership is 2.34%. This rate is used to assume the growth of the primary revenue. By this methodology, financial return in the first year of the operation is 1945 million THB and the return in

**Table 1**  
Cost of the High-Speed Rail Linking 3 Airports Project (State Railway of Thailand, 2017).

Cost components	Million THB	
	Government	Private sector
High speed rail		
Land acquisition	3570	
Civil works		120,515
E&M		24,712
Rolling stocks (initial)		15,491
Others		4430
Makkasan land development		
Makkasan area		40,193
TOD around HSR station		3513
Public utility		1449
Existing ARL cost		
Right to operate existing ARL		10,671
Existing ARL civil works	22,558	
Total	26,128	220,974

the 50th year is 6041 million THB. The NPV (net present value) of the project during the first 50 years is expected to be 43,512 million THB. From the estimation, NPV during the first 13 years of the operation is 29,157 million THB. Based on BEM's financial report (Securities and Exchange Commission, 2019), the average net profit margin of BEM is 21.62%. Therefore, the profit is estimated to be 6304 million THB and the benefit from tax exemption is around 1261 million THB. Other tax benefits are the exemption of import duties on machinery and the corporate income tax rate of 17%.

5.1.4. Benefits of land acquisition

The land acquisition process can be more certain and reliable because, in Thailand, the power to expropriate the land by the government and the private sector are different. The private sector has more flexibility and more capital to buy the land. The process can be done quickly. However, owners of the lands have the right to deny the sale of their lands to the private sector. This implies that the private sector may not be able to buy all desirable lands while the government has full authority according to the laws to expropriate land. Therefore, the process can be more certain and reliable because eventually, the government can obtain all desirable lands. In general, the process of land acquisition takes around 2 years for the government in the cases that the landowner does not want their lands to be expropriated. This makes it much easier to plan the project because the time frame of the process can be reliably predicted.

5.1.5. Improved risk profile

For the traditional investment approach, the government has to take the risk alone. However, when adopting PPP, the government can share some risks with the private sector or transfer certain risks to the private sector. Vice versa, the private sector does not need to handle all risks by themselves. Overall, the risk profile can be improved because there is no single party that takes excessive risk alone.

5.1.6. Increasing financial capacity and certainty

The adoption of PPP model can attract significant funds from the private sector. Moreover, in reality, the private sector is an alliance of private companies. Its financial capacity is higher than the government's one. The alliance of private sector improves the financial certainty, lowering the likelihood of unforeseen circumstances due to its higher commercial experience.

5.1.7. Construction cost contingency

The overall cost of the construction tends to be lower when compared with the traditional investment approach. In practice, contingency (associated with total risks) is included in the bidding price. If it is reduced, the construction cost can be saved. To consider the benefit of cost contingency, the contingency included in the construction cost needs to be assessed. From the authors' experience and expert interview, Thai contractors usually include 10% of contingency in the total estimated construction cost. This can be evidenced by many relevant sources. Designing Buildings Ltd. stated that 10% of contingency is included in the construction cost (Designing Buildings Ltd., 2019), also by Compton Construction (2015). Based on the available information, the cost shown in Table 1 is calculated by setting the contingency to be 10%. The data from the Asian Development Bank (ADB) related to different railway projects are also collected to determine the contingency of the projects. The contingency of 20 projects during the past 5 years (2015–2019) from Asian Development Bank (Asian Development Bank, 2019d; Asian Development Bank, 2019b; Asian Development Bank, 2019d; Asian Development Bank, 2018c; Asian Development Bank, 2017c; Asian Development Bank, 2018d; Asian Development Bank, 2018a; Asian Development Bank, 2018e; Asian Development Bank, 2018b; Asian Development Bank, 2019a; Asian Development Bank, 2017b; Asian Development Bank, 2016a; Asian Development Bank, 2016b; Asian Development Bank, 2016c; Asian Development Bank, 2015b; Asian Development Bank, 2015a; Asian Development Bank, 2015c; Asian Development Bank, 2014; Asian Development Bank, 2017a;

Asian Development Bank, 2012; Asian Development Bank, 2019a, 2019b, 2019c, 2019d) is 5.7%. When the contingency decreases from 10% to 5.7%, the benefit derived from cost saving is 7965 million THB.

5.1.8. Better performance in time, cost, and quality

Note that there are 3 contractors in the partnership of this project and they are also the main investors of the project. Considering principal-agent concept, this can partially guarantee that the time, cost, and quality of the project will be better when compared with the traditional investment approach. As the key stakeholders, they need the project to be completed as soon as possible because the PPP period is limited to 50 years only. If the completion of the project is late, it means that they have a higher cost due to delays and a shorter time to generate revenues. In addition, they need to save costs as much as possible since every expenditure is their investment. With respect to quality, because the construction issues can affect the operational reliability, the service quality can thus affect the revenue. The private sector will need to prioritize the quality of the construction in order to assure that there will be no disruption in the revenue generation.

5.1.9. Knowledge sharing and technology transfer

Although this project will be fully operated by the private sector, the government has a key role to control, assure and monitor the services during operations. The government has an opportunity to learn from the private sector in terms of management, operation, and technology. This will add benefits for the government in the future when new projects exist. In the future, the government can use the gained experience to either handle projects by itself or manage PPP projects better.

5.1.10. Addition fees from right to operate the existing ARL

This project includes the right to operate the existing ARL and allows the private sector to exploit the ARL's infrastructures. From the SRTET Annual report (S.R.T. Electrified Train Company Limited, 2018), SRTET, who currently operates the existing ARL, hardly has any profit from the operation. Appointing the private sector to operate the integrated system seems to be the better option for the government, private sector, and users. The existing ARL will form a part of the new and highly integrated network, which will be developed within this project.

To estimate the revenue and expense of the existing ARL, the data from annual reports have been analyzed. Revenue and expense of ARL by SRTET during 2014–2018 are shown in Fig. 2.

To estimate the future revenue and expense, the time frame of the project needs to be considered. From the project plan, the construction will start in 2020 and take 5 years to be completed. Therefore, the operation will commence in 2025. The overall duration of PPP is 50 years. From the

timeframe and trend line, revenue and expense of each year of the agreement can be estimated. To be more realistic, the discount rate is considered to be the discount rate of ARL, which is 3% according to the study (The Eastern Economic Corridor Policy Committee, 2018). The estimated revenue and expense of existing ARL during PPP (2025 to 2074) are 16,231 and 17,117 million THB respectively. However, the cost for the right to operate the existing ARL according to Table 1 is 10,671 million THB. In summary, the benefit in the viewpoint of the private sector is the additional revenue from the integration of the existing and new systems while the benefit in the viewpoint of the government is 11,557 million THB [10,671 + (17,117 - 16,231)].

5.1.11. Improvement of organization culture

Private sector employees are normally more enthusiastic than state enterprise employees. The work quality of the private sector is relatively better as well. This is because the work pressure is relatively different in Thailand. State enterprise employees have very little chance of being laid off so they could pay less attention to their work. On the other hand, private sector employees have more work pressure because their performance affects their job security. Therefore, the efficiency of the work can be improved when adopting PPP (Table 2).

5.1.12. Lower internal organizational problem

In some cases, internal organizational problems can be the cause of low management efficiency. In this case, the labor union is often referred to. The State Railway Union of Thailand (SRUT) is a labor union of SRT. The original purpose of SRUT is to protect the employees' right. However, having bargaining power in the labor union can obstruct the development. For example, in 2015, the government had an idea to found the Department of Rail Transport to take care of the railway system in the country. SRUT opposed the founding of the Department of Rail Transport because they were concerned that it may reduce employment. In contrast, adopting PPP enables the private sector to operate and maintain the project by its workforces. Therefore, the project will not be severely affected by trade unions and can be performed much smoother.

5.2. Risks of adopting PPP in the High-Speed Rail Project Linking 3 Airports in Thailand

5.2.1. Fairness of the agreement

The fairness of the agreement is a critical issue because each party naturally seeks to gain benefits. The government needs to consider the public benefit. At the same time, the incentives must enough to attract the private sector to invest. The government has to balance the benefit for each

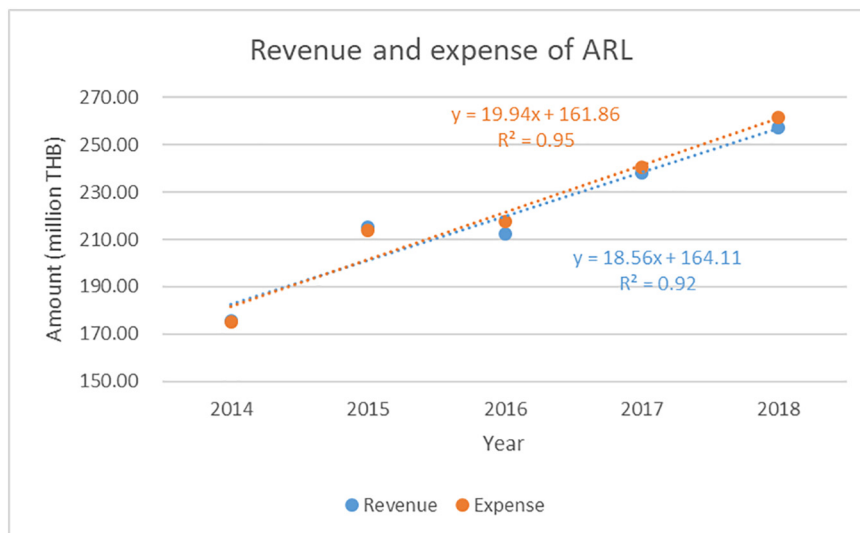


Fig. 2. Revenue and expense of ARL (S.R.T. Electrified Train Company Limited, 2018).

**Table 2**  
Companies in PPP of the High-Speed Rail Linking 3 Airports (InfoQuest, 2018).

Parties	Share (%)	Business
Charoen Pokphand Holding Limited (CP)	70	Agribusiness and food, retail and distribution, and the telecommunications industries
Bangkok Expressway and Metro Public Company Limited (BEM) and CH Karnchang Public Company Limited (CK)	15	Transportation company and Construction
China Railway Construction Corporation Limited (CRCC)	10	Construction and engineering
Italian-Thai Development Public Company (ITD)	5	Construction and Railway system
Possible investment partnership		
Japan Overseas Infrastructure Investment Corporation for Transport & Urban Development (JOINT)		Finance
CITIC Group Corporation (China)		Finance
China Resources (Holdings) Company Limited		Energy, retail, property
Japan Bank for International Cooperation (JBIC)		Finance
Ferrovie dello Stato Italiane (Italy)		Operation and maintenance system
Siemen (Germany)		Rolling stock and signaling system
Hyundai (South Korea)		Rolling stock and signaling system
CRRC-Sifang (China)		Rolling stock

stakeholder; otherwise, either the public will lose out or there will be no investment from the private sector. For the private sector, its first priority is to generate a profit. They will invest in this project only when they can predict that the project will be profitable. At the same time, because this project needs a high capital, the risk will be high. The careful consideration must be taken otherwise the private sector will suffer because the total duration of this PPP is 50 years.

**5.2.2. Delay of negotiation**

Both the government and the private sector need to consider the agreement carefully. The negotiation may take a long time until every party agrees on the agreement. For example, the latest negotiation took place on 7 February 2019 that CP has 11 conditions to negotiate with the government to maintain its benefits. Unfortunately, on 9 April 2019, these conditions were no longer considered because they are contrary to the tender conditions (Bunloet, 2019).

**5.2.3. More complexity and excessive contract variation**

PPP results in more complexity due to the nature of PPP that involves many more parties. Although the variation is normal in construction projects, the involvement of many parties can result in excessive deviation because different parties may have different demands and opinions. In a traditional project, the variation is an important cause of project delays or cost overrun. In PPP projects, it tends to be worsened because there are many more parties related.

**5.2.4. Inflexibility of the agreement**

The duration of the project is generally long and it is difficult to predict events and uncertainties. However, both the government and the private sector cannot change the agreement whenever they wish. The inflexibility of the agreement is a significant risk for the project during the pre-construction phase because the agreement done in this phase will be effective from the start to the end of the project.

**5.2.5. Political interference**

Political interference is the most significant problem in infrastructure projects. The project may be affected by the change in the government's policies or the direct involvement of the government. The government may want to control and improve the performance of the project; however, it

is likely to negatively affect the project as well. Moreover, it affects the confidence of the private sector both in this project and other PPP projects in the future.

**5.2.6. Corruption and bribery**

Corruption and bribery make projects more expensive and less efficient. At the same time, the private sector will lack confidence in the investment. The agreement and the tendering need to be transparent to ensure that the government will deliver the best performance while the private sector can use the capital with full efficiency. At the same time, passengers and public users should be delivered with the best services.

**5.2.7. Completion of criteria evaluation**

Generally, the government will set the criteria for the private sector to meet in order to deliver reasonably good services to passengers. The completion of criteria evaluation is critical because it is related to the revenue, fine, and serviceability of the project. Lack of the completion of criteria can cause a dispute between the government and the private sector when the project is in full operation.

**5.2.8. Monopoly**

A monopoly concerns many people because the private sector has the right to operate this project for 50 years. At the same time, this project has less competition because it is difficult to develop a large project, requiring significant investments and large-scale services. To mitigate this risk, the agreement needs to identify the revenue sharing in terms of profit in order to ensure that the government will not lose the benefit from providing the complete right for the private sector to operate the project.

**5.2.9. High-interest burden**

The most significant risk of this project is the high interest rate of borrowing. If the private sector borrows a significant amount of money, the high interest needs to be returned. Besides the construction cost that the private sector has to invest, the subsidy, which the government will support the private sector, also causes the interest. This is because the government will provide the subsidy after the construction is completed and the operation is opened. Therefore, during the first 5 years of the construction, if the private sector needs to borrow a significant amount of money, they have to pay the huge cost of interest as well, which is around 3517 million THB annually.

The maximum loan is limited by the interest, which must not exceed the revenue of each year. In this case, the revenue of the first year is 1945 million THB so the maximum loan is 64,831 million THB based on a 3% interest rate. As a result, in the first year, the return is 1945 million THB, which equal to the interest so there is no profit in the first year. However, the principal decreases every year onward, as well as the interest, while the revenue will continue to increase. From this scenario, the total return of the project is 22,072 million THB or CBR (cost-benefit ratio) is 1.21 over 50 years. It can be seen that the CBR of the project is not high and the higher loan results in a lower return. From the sensitivity analysis, the available loan is sensitive to CBR as demonstrated in Fig. 3. It shows that the range of CBR is 1.21–1.75 depending on the amount of the loan. Note that these scenarios are based on primary revenues only.

**5.2.10. Risk from high investment**

In terms of construction cost, PPP plays an important role in the achievement of the project. If the government does not subsidize for this project, it is almost impossible that the primary revenue can generate a profit. In fact, even though the project is subsidized by the government, the change in the construction cost also affects the CBR of the project. The result from the sensitivity analysis can be shown in Fig. 4. It can be seen that if the private sector does not use the loan, the total construction can increase up to 42% and CBR will be 1. If the private sector uses the maximum loan to invest in the project, the total construction cost can increase up to 15% and CBR will be 1. This is because the amount of the subsidy is fixed and paid by the government. Then, the investment can be considered

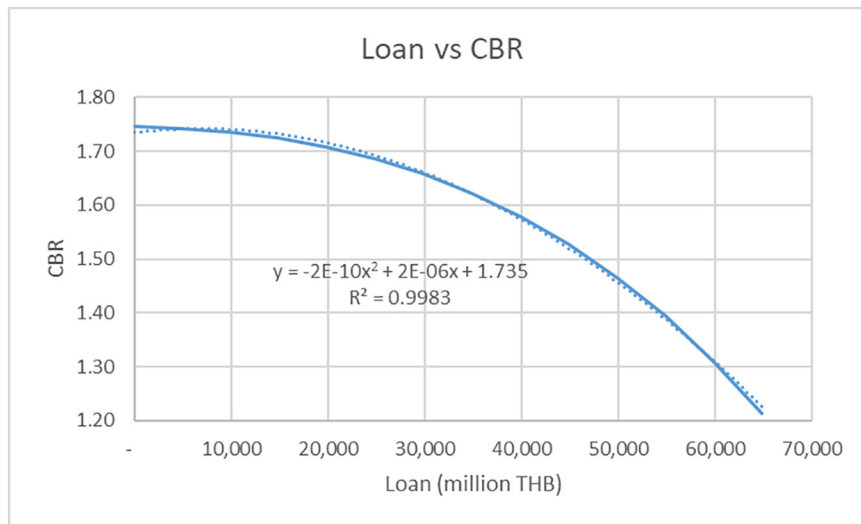


Fig. 3. Sensitivity analysis of varied loan and CBR.

as low risk and high CBR from the viewpoint of the private sector because the government subsidizes for this project. Note that the CBR shown in Fig. 4 is for 50 years, and the primary businesses of each party can generate more returns than the HSR business.

5.2.11. Overestimated ridership

Ridership highly affects the profitability of the HSR project because it directly affects the primary revenue of the project. Normally, the passenger forecast in railway projects tends to be an overestimation. Therefore, if the exact ridership is less than the forecast, the primary revenue will decrease. The sensitivity analysis of CBR can be demonstrated in Fig. 5. From Fig. 5, if the private sector does not exploit the loan, the ridership can decrease up to 42% and the CBR will be 1. If the private sector uses the maximum loan to invest in the project, the ridership can decrease up to 8% and the CBR will remain as 1.

5.2.12. Lack of supporting infrastructure

This project is relevant to other projects in EEC, including U-Tapao Airport, Laem Chabang Deep Sea Port, Map Ta Phut Port, and Phase II Maintenance, Repair and Overhaul (MRO) facilities. These other projects

can all affect the demand of the HSR project. If one project cannot be completed according to the plan, the demand forecast will not be precise and it normally results in a negative effect.

5.2.13. Loss of professionalism

The HSR will be maintained by the private sector. There is a risk that the government may have a small participation in this project. Without a good monitoring and management system, the government can actually lose professionalism and competency (Pikelchik, 2017) because the government does not need to take any responsibility and risk during the maintenance phase. In particular, this project is the first HSR project in Thailand, so losing the opportunity to learn from the private sector is deplorable.

5.2.14. Cost and complexity of a transition period

During the transition period, the private sector transfers the ownership of the project to the government. There are costs and complexities, which take place during this transaction time. These could be unknown and uncertain. Examples of these unknowns are financial and fiscal factors, regulations, technical issues, social issues, legal, and jurisdictions. Therefore, the PPP needs a well-planned preparation and management to smooth the transition.

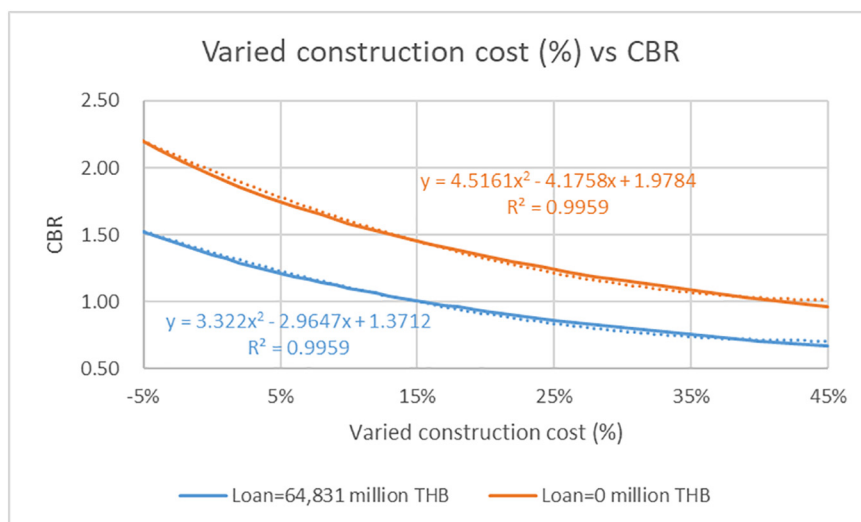


Fig. 4. Sensitivity analysis of varied construction cost and CBR over 50 years.



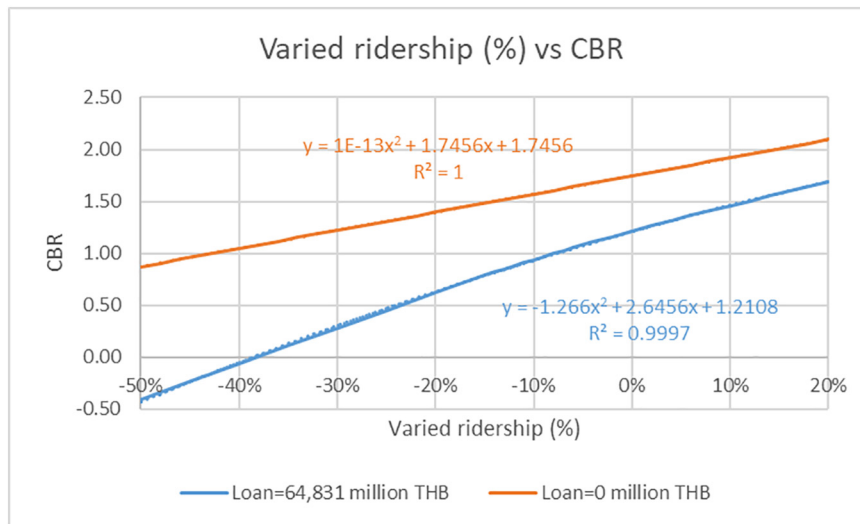


Fig. 5. Sensitivity analysis of varied ridership and CBR over 50 years.

6. Discussion

Based on the analysis results, adopting PPP in the High-Speed Rail Project Linking 3 Airports in Thailand has 12 benefits and 14 risks compared to implementing the traditional approach. The private sector will have benefit from the synergy, which could extend further for secondary revenues. From this study, the financial synergy on the primary revenue is 5660 million THB from the saving of interest. This is because CP as the main company in the party can get the loan with a lower interest rate when comparing to other constructors. At the same time, there are experienced contractors and competent operators participating in the party. Therefore, the performance of the project tends to be satisfactory. The private sector also gets the benefit from the tax exemption of 1261 million THB because the government provides the privilege for the private sector to invest in this project. A lower contingency cost can save the construction cost of 7965 million THB because there are contractors participating in the PPP and they can be the responsible investors in this project. Therefore, they do not need to include the high contingency in the construction cost. The government also gets the benefit of transferring the right to operate the existing ARL system onto the private sector of 11,557 million THB during the PPP period. This can save the cost of the government to invest in other projects. At the same time, the overall performance and serviceability of the project tend to be improved because the project is operated by the private sector that normally has more flexibility and the capability to manage the project. From these, PPP can be considered as a superior approach to invest in other mega infrastructure projects because the government can save the budget to invest in other areas while the private sector can have business opportunities that they do not have in the normal situation. However, PPP also has risks that every party needs to consider.

Importantly, the key risks of PPP adoption are the fairness and the agreement and the completion of the criteria evaluation. The government allows the private sector to invest in the infrastructure project and provides the opportunity for the private sector to make a profit from the secondary revenue. However, the government has to balance the benefit to attract the private sector and public values to the country. If the offer is not attractive enough, there would not be any private sector wanting to invest. If the offer is overly promised to the private sector, the country and public users will lose the societal benefit of the project. The government has to establish the agreement that is clear and fair. The criteria used to evaluate the performance of the private sector needs to be transparent also to avoid the dispute in the future and to maintain the quality of the project after being transferred to the government at the end of the agreement. The construction cost and ridership are the other important risks of the project. However, certain part of risks can be reduced due to the fact that the government subsidizes the project. Without the subsidy, it is very difficult to make the project financially viable due to the

high investment and low return, which are the typical characteristic of a passenger railway project.

7. Conclusion

This study highlights the benefits and risks of the PPP adoption by comparison with the traditional investment approach in the High-Speed Rail Project Linking 3 Airports in Thailand. The benefits and risks of adopting PPP have been demonstrated and compared with the traditional investment approach. It is clear that the PPP adoption is beneficial for the government, the private sector, and general public users. However, there are various related risks that can negatively affect the government, the private sector, and users simultaneously. Therefore, relevant risks need to be managed carefully to ensure that they can be limited as much as possible. Risk management should be carried out by both the government and the private sector with ample collaboration and coordination. Some principles and standards can be used for risk management as well such as ISO 31010:2009.

The agreement is a very important initial step. The government and the private sector have to effectively manage and negotiate for the fairness of the agreement. At the same time, the private sector has to rigorously evaluate the project in details and plan to maximize the revenue of the project because the returns from the primary revenue of the project are not very significant. The private sector needs to find a way to generate more secondary revenues from TOD and commercial development in order to maximize the financial viability and profit of the project. Otherwise, the project might gain a higher risk until it may not yield a satisfactory profit. However, the right to develop areas at Makkasan and Sri Racha is a highly valuable business opportunity that the government provides to the private sector. The private sector alone will not have this right unless the private sector takes part in this PPP project. The secondary revenue from this opportunity has significant potentials to overcome the low return of the fare revenue or the primary revenue. Moreover, the synergy of the private sector can offer an outstanding return on investment in Thailand's mega infrastructure projects. It can create significant benefits that an individual's investment cannot. On this ground, this HSR project will be a new paradigm for other future projects, which will adopt this PPP investment approach.

Author contributions

Conceptualization, S.K. and J.S.; Data curation, J.S.; Formal analysis, J.S.; methodology, J.S.; Investigation, J.S.; Methodology, J.S.; Project administration, S.K.; Resources, S.K.; Supervision, S.K.; Validation, J.S.; Visualization, J.S.; Writing - original draft, J.S.; Writing - review & editing, J.S.;

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## References

- Alawad, Hamad, Kaewunruen, Sakdirat, An, Min, 2020. Learning from Accidents: Machine Learning for Safety at Railway Stations. *IEEE Access* 8 (1), 633–648. <https://doi.org/10.1109/ACCESS.2019.2962072>.
- Asian Development Bank, 2012. Kingdom of Thailand: Accounting and Financial Management System Reform of Thailand's Railway Sector.
- Asian Development Bank, 2014. Kingdom of Cambodia: Capacity Development for Public-Private Partnerships.
- Asian Development Bank, 2015a. Colombo Suburban Railway Project.
- Asian Development Bank, 2015b. Dhaka Metro Project.
- Asian Development Bank, 2015c. People's Republic of China: Policy Study on the Development of Intercity Railway in the Beijing-Tianjin-Hebei Region.
- Asian Development Bank, 2016a. Central Asia Regional Economic Cooperation Railway Connectivity Investment Program: Project Preparatory Technical Assistance Report.
- Asian Development Bank, 2016b. Connecting the Railways of the Greater Mekong Subregion.
- Asian Development Bank, 2016c. People's Republic of Bangladesh: Railway Sector Investment Program (Tranche 4).
- Asian Development Bank, 2017a. People's Republic of Bangladesh: South Asia Subregional Economic Cooperation Railway Connectivity Investment Program.
- Asian Development Bank, 2017b. Philippines: Metro Manila Transport Project, Phase 1.
- Asian Development Bank, 2017c. The Republic of the Philippines: preparing the Metro Manila transport project. Phase 1.
- Asian Development Bank, 2018a. India: Railways Track Electrification Project.
- Asian Development Bank, 2018b. Kingdom of Cambodia: Supporting Sustainable Integrated Urban Public Transport Development (Financed by the Japan Fund for Poverty Reduction).
- Asian Development Bank, 2018c. Railway Sector Development in Central Asia Regional Economic Cooperation Countries.
- Asian Development Bank, 2018d. Republic of the Philippines: Railway Project Implementation Support and Institutional Strengthening.
- Asian Development Bank, 2018e. Turkmenistan: Preparing the Central Asia Regional Economic Cooperation Corridors 2, 3 and 6 (Turkmenabat-Mary-Ashgabat-Turkmenbashi) Railway Modernization Projects.
- Asian Development Bank, 2019. Mongolia: Regional Road Development and Maintenance Project—Additional Financing.
- Asian Development Bank, 2019a. AZE: Railway Sector Development Program.
- Asian Development Bank, 2019b. India: Advancing Gender Budgeting in Select States.
- Asian Development Bank, 2019d. Proposed Multitranchise Financing Facility Republic of the Philippines: Malolos-Clark Railway Project.
- Binti Sa'adin, Sazrul Leena, Kaewunruen, Sakdirat, Jaroszweski, David, 2016a. Operational readiness for climate change of Malaysia high-speed rail. *Proceedings of the Institution of Civil Engineers - Transport* 169 (5), 308–320. <https://doi.org/10.1680/jtran.16.00031>.
- Binti Sa'adin, Sazrul Leena, Kaewunruen, Sakdirat, Jaroszweski, David, 2016b. Risks of Climate Change with Respect to the Singapore-Malaysia High Speed Rail System. *Climate* 4 (4), 65. <https://doi.org/10.3390/cli4040065>.
- Binti Sa'adin, Sazrul Leena, Kaewunruen, Sakdirat, Jaroszweski, David, 2016c. Heavy rainfall and flood vulnerability of Singapore-Malaysia high speed rail system. *Australian Journal of Civil Engineering* 14 (2), 123–131. <https://doi.org/10.1080/14488353.2017.1336895>.
- Bunloet, B., 2019. Suffering of CP from interest of HSR 3 airports Komchadluek.
- Chan, A.P.C., 2011. Empirical Study of Risk Assessment and Allocation of Public-Private Partnership Projects in China. *J Manage. Eng.* 27, 136–149.
- Chou, J.-S., Pramudawardhani, D., 2015. Cross-country comparisons of key drivers, critical success factors and risk allocation for public-private partnership projects. *Int. J. Proj. Manag.* 33, 1136–1150.
- Compton Construction, 2015. 7 things you need to know about contingency budgets [Online]. Available: <http://comptonllc.com/contingency-budgets/>, Accessed date: 16 July 2019.
- Designing Buildings Ltd, 2019. *Contingencies in Construction*.
- Eastern Economic Corridor Office, 2018. *Investment Benefits on EEC*.
- Government of the Republic of Lithuania, 2015. In: Institution, S.B. (Ed.), *PPP Advantages and Disadvantages*.
- InfoQuest, 2018. *Competition between CP and BSR in The High-Speed Rail Linking Three Airports* 12 November 2018.
- Kaewunruen, Sakdirat, Alawad, Hamad Ali H, Cotruta, Silviu, 2018. A decision framework for managing the risk of terrorist threats at rail stations interconnected with airports. *Safety* 4 (3), 36. <https://doi.org/10.3390/safety4030036>.
- Kaewunruen, Sakdirat, Lee, Cheul Kyu, 2017. Sustainability Challenges in Managing End-of-Life Rolling Stocks. *Frontiers in Built Environment* 3, 10. <https://doi.org/10.3389/fbuil.2017.00010>.
- Kaewunruen, Sakdirat, Sresakoolchai, Jessada, Peng, Junying, 2020. Life Cycle Cost, Energy and Carbon Assessments of Beijing-Shanghai High-Speed Railway. *Sustainability* 12 (6), 206. <https://doi.org/10.3390/su12010206>.
- Kaewunruen, Sakdirat, Sussman, Joseph M, Einstein, Herbert H., 2015. Strategic framework to achieve carbon-efficient construction and maintenance of railway infrastructure systems. *Frontiers in Environmental Science* 3, 6. <https://doi.org/10.3389/fenvs.2015.00006>.
- Kaewunruen, Sakdirat, Sussman, Joseph M, Matsumoto, Akira, 2016. Grand Challenges in Transportation and Transit Systems. *Frontiers in Built Environment* 2, 4. <https://doi.org/10.3389/fbuil.2016.00004>.
- Kasikornbank Public Company Limited, 2018a. Construction credit [Online]. Available: <https://kasikornbank.com/sme/construction-credit>, Accessed date: 11 July 2019.
- Kasikornbank Public Company Limited, 2018b. Lending [Online]. Available: <https://kasikornbank.com/sme/construction-credit>, Accessed date: 11 July 2019.
- Komchadluek, 2019. 'HSR Linking 3 Airports' CP Group is Carrying Enormous Interest 7 February 2019.
- Li, B., Akintoye, A. & Hardcastle, C. Risk analysis and allocation in public private partnership projects. 17th Annual ARCOM Conference, 5–7 September 2001 2001 University of Salford. Association of Researchers in Construction Management, 895–904.
- Longtunman, 2017. How much debt does CP has ? [Online]. Available: <http://longtunman.com/831>, Accessed date: 11 July 2019.
- Meng, J., Xiu, G., Qian, F., 2018. Public-private partnership project risk management in education industry\*. *Kuram ve Uygulamada Egitim Bilim.* 18, 2941–2948.
- Mouraviev, N., Kakabadse, N.K., 2013. Risk allocation in a public-private partnership: a case study of construction and operation of kindergartens in Kazakhstan. *J. Risk Res.* 17, 621–640.
- National Science Technology and Innovation Policy Office, 2015. *Public-private partnership*. Horizon magazine.
- Ogunbode, E., 2016. Risk Management in Public Private Partnership Building Construction Projects.
- Pikelchik, E., 2017. *Public-Private Partnership for the IR Infrastructure Maintenance Functions*. Master of Science in Railway System Engineering & Integration. University of Birmingham.
- Revenue Department, 2018. *Corporate Income Tax*.
- S.R.T. Electrified Train Company Limited, 2018. *Annual Report*.
- Rungskunroch, Panrawee, Kaewunruen, Sakdirat, Shen, Zuo-Jun, 2019. An Improvement on the End-of-Life of High-Speed Rail Rolling Stocks Considering CFRP Composite Material Replacement. *Frontiers in Built Environment* 5, 89. <https://doi.org/10.3389/fbuil.2019.00089>.
- Rungskunroch, Panrawee, Yang, Yuwen, Kaewunruen, Sakdirat, 2020. Does High-Speed Rail Influence Urban Dynamics and Land Pricing? *Sustainability* 12 (7), 3012. <https://doi.org/10.3390/su12073012>.
- Securities and Exchange Commission, 2019. *Financial Statement (Full Version) Bangkok Expressway and Metro Public Company Limited*.
- State Railway of Thailand, 2017. *Feasibility study report of High-Speed Rail Linking 3 Airports Project*.
- The Eastern Economic Corridor Policy Committee, 2018. *The High Speed Train*.
- Vaidya, D., 2019. Synergy in M&A | types of synergies in mergers and acquisitions [Online]. *WallStreetMojo* Available: <https://www.wallstreetmojo.com/types-of-synergies/>, Accessed date: 11 July 2019.
- Wu, Y., Song, Z., Li, L., Xu, R., 2018. Risk management of public-private partnership charging infrastructure projects in China based on a three-dimension framework. *Energy* 165, 1089–1101.