Team Project Report:

Thailand High Speed Rail Project

Course: ETM 545/645 Project Management

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Executive Summary

This project aims to study the project for the High Speed Rail Development Master Plan in Thailand and propose a project management plan for this project. From our preliminary surveys of the project, we found that Bangkok-Chiang Mai route is one of the highest potential projects for building high speed planned routes under Thailand's infrastructure investment program. Thai government expects that the modern system rail would help to improve economy and tourism industry in Thailand. This paper intends to develop the project management plan to support Thai government plan, which is Bangkok-Chiang Mai High Speed Rail project, and provide suggestions on what should be done further in the planning as well. The intense of possibility of high speed rail project can be analyzed from construction plan, investment cost, feasibility of construction, ridership potential, investment return and uncertainty factors. This project paper will also introduce some project management tools and methods that would help a better management for the construction project.

1. Project Introduction

According to the objective of high speed rail (HSR) project, Thai government expects to gain competitiveness to Thai industries, improve tourism and upgrade the existing rail system. [10] Table 1 shows the number of passengers for the existing rail system. [4, 6] From table 2 shows the number of tourists in Thailand from 1998 to 2010. Thailand's tourism industry contributes about 7 percent of the country's GDP. Thai government believes that the big potential of the high speed train in this country can attract and provide enough services to the tourists. [2, 3, 5, 7, 9] Due to the high investment cost of high speed rail project, Thai government wants partial investment from private business by inviting all organizations, which have capability to operate the project, join venture with Thai government. The capital cost for building Bangkok-Chiang Mai High Speed rail is estimated around 7,747 million dollars. From feasibility study, Thai government plans to build for 4 years which will be started from year 2011 to 2015. [8]

Table 1. Rail Passengers of existing rail in Thailand [6]

Year	Number of Passenger (Million people)
2011 (Jan-Mar)	15,597
2010	44,535
2009	47,500
2008	47,194
2007	44,631

Table 2 Tourist Arrivals in Thailand

Year	Number of Foreign Tourists All provinces (Million People)
2010	15.94
2009	14.15
2008	14.23
2007	14.46
2006	13.82
2005	11.52
2004	11.65
2003	10.00
2002	10.80
2001	10.06
2000	9.51
1999	8.58
1998	7.76

Source: Department of Tourism [3]

High-speed rail started in the early 90s. The definitions of High-speed are different from each union (see Appendix I). Generally, given by UIC (Intentional Union of Railways), the High Speed Rail System indicates its operation system is designed especially for over 200km/h speed capacity. [14] After Japan launched world's first high speed train "Shinkansen" in 1963, the high speed rail (HSR) has been developed rapidly from all over the world (see Appendix II and HSR development/under construction summarized in Table 3 and Table 4).

Table 3: High Speed Rail Development, 1964- 2009 Fall (kms) [15]

Period	Route Open kms	Countries:							
		Japan	Britain	France	Italy	Germany	Spain	China	Other
1964-73	676	676	-	-	-	-	-	-	-
1974-83	2,639	1,128	942	419	150	-	-	-	-
1984-93	1,459	31	-	412	98	447	471	-	-
1994-2003	2,522	214	74	709	-	428	598	-	499
2004-09	4,754	127	684	332	496	410	530	1,194	981
Total 1964-83	3,315	1,804 *54%*	942 *28%*	419 *13%*	150 *5%*	-	-	-	-
Total 1984-2009	8,735	372 *4%*	1,130 *13%*	1,453 *17%*	594 *7%*	1,285 *15%*	1,599 *18%*	1,194 *14%*	1,480 *17%*
Total 1964-2009	12,050	2,176 *18%*	1,700 *14%*	1,872 *16%*	744 *6%*	1,285 *11%*	1,599 *13%*	1,194 *10%*	1,480 *12%*

Source: UIC data 14 June 2009. Excluded: in Japan, the Akita Mini Shinkansen [127kms opened in 1997 and operating at 130kph], and the Yamagata Mini Shinkansen [62kms opened in 1999, operating at 130kph]

Table 4: HSRs under construction, 2009-12 (kms) [15]

Period	China	Spain	Russia	Turkey	All
2009-12	9,031	1,634	650	510	12,686
Grand total in 2012	10,025 *41%*	3,233 *13%*	650	745	24,736

Source: UIC data 14 June 2009. Excluded: in Japan, the Akita Mini Shinkansen [127kms opened in 1997 and operating at 130kph], and the Yamagata Mini Shinkansen [62kms opened in 1999, operating at 130kph]

2. Project Selection

The State Railway of Thailand (SRT) is the state-owned rail operator of Thailand (see Appendix III). SRT is the organization that directly controls all rail routes for the whole country. Because the SRT owns land plot along possible routes, Thai government has assigned the SRT to be responsible for construction the high speed rail project. Also, Mass Rapid Transit Authority of Thailand (MRTA) will join the work in particular part of technical operation. [10] The ordinary train in Thailand is operated with average speed 60 km per hour. Although, the number of passenger has increased every year, but the number of trip has decreased because they turned to use the car instead. The SRT seeks for improving and reconstructing the existing rail system. Besides, the rail development plan will help to emphasize the quality of State Railway in Thailand.

Chiang Mai, the largest and the most significant city in northern of Thailand, has become an increasingly modern city with population of 1.6 million people. Thai government has considered applying Chiang Mai province for "Creative City" to promote innovation and creativity for the development of this country. Besides, Chiang Mai has attracted over 5 million visitors each year and continues increasing every year. The world experiences show that HSR has been proved to be the best choice of the transportation than airplane overall. Considering the ticket fare, HSR may be able to shift some foreign tourism's choice from airplane to HSR. On the other hand, many local travelers in Thailand usually trip from Bangkok to Chiang Mai by ordinary train, since it is cheaper and safer than driving a car. However, it takes about 10-12 hours and needs overnight trip to arrive at Chiang Mai, which deeply frustrates those who have business across these two cities. The high speed rail is known for its fast speed, so it will cut off time for tourists and business people to only 3.5 hours, even faster than car's 8 driving hours. Additionally, this project would be benefit to freight transportation.

Therefore, building a high speed rail to link Bangkok, the center of Thailand, and Chiang Mai is valuable. Thai government expects the HSR project's benefits would affect to expand economic growth greatly and stimulate tourism industry in Thailand and to gain gross profit and lead to competitive position in Asian country [11].

2.1 Why HSR?

One may wonder why HSR is growing so rapidly and what are the motivations driving HSR. Recently, one of the hot issues is energy related, such as energy saving, energy efficiency, etc. That is also the reason why the concept "sustainability" becomes the focus of most government and popular in each country. Sustainability combines environment, social and economy together. According to IEA (International Energy Agency), transportation sector occupies close to 20% world's total delivered energy mainly from liquid fuels. On the other hand, the transportations also consume more than 50% world's liquid fuels and are forecasted to reach 60% by 2035. Therefore, with no doubt, HSRs fit in the transportation sustainability as shown in Figure 1 from UIC's 2010 high speed rail sustainability report. [16,17]

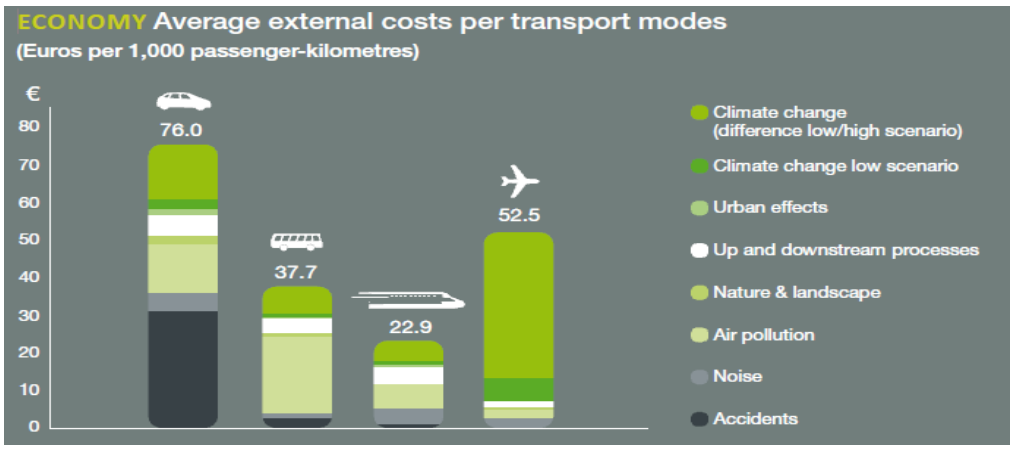


Figure 1

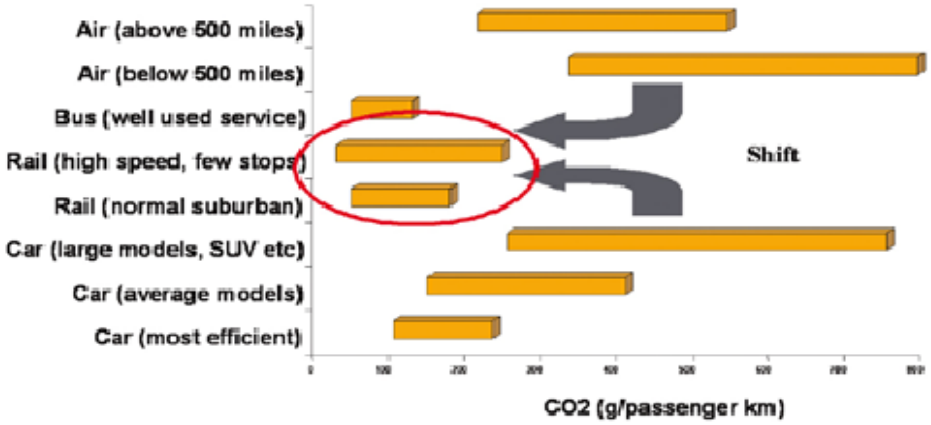


Figure 2 [18]

From the environmental perspective, we all notice the impact of climate changes. Lots of researches have been done in this area and found the GHG (green house gas) is the reason for global warming, which is directly related to CO2 emission. Based on UIC 2010 report, HSR has the least climate change effects in all scenarios. [16, 17]

From economic perspective, the external cost as shown in Figure 1 of high speed rail is the also the least. Besides, HSR increases the revenues from the world's experiences (See Figure 3) and shift road or air ridership to rail ridership (see Figure 2). [15] Spain, patricianly, according to UIC's record, the new high speed line between Madrid and Seville did increase the market share from 19% to 53%. And this influence is believed to keep increasing in the future according to the HSR trend (See Appendix II).

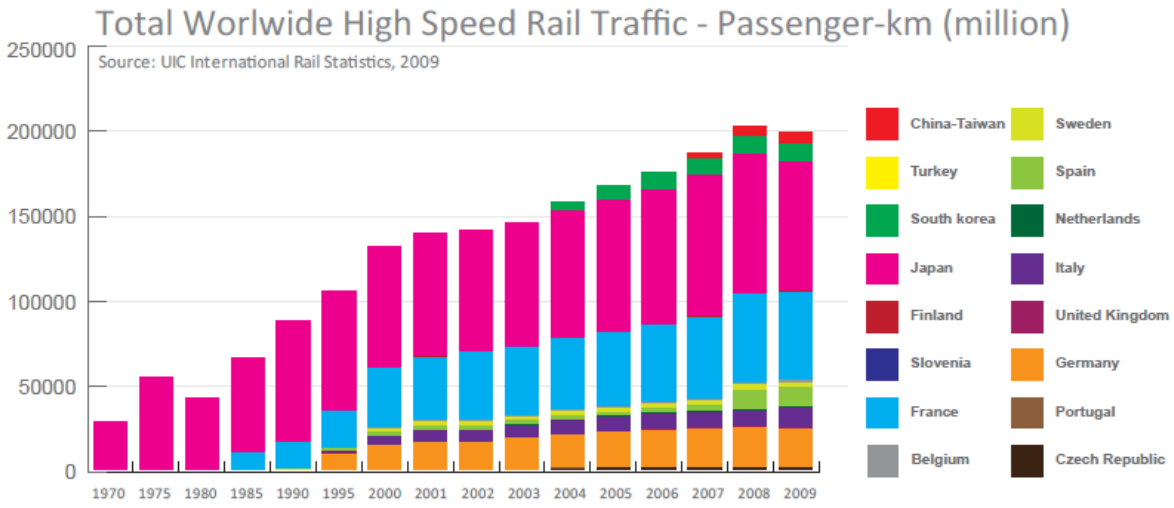


Figure 3 [16]

From social perspective, UIC statistics address the ability of UIC members decently employ 7,074,672 people worldwide, including 2 million in China, 1.4 million in India and 1.1 million in EU. The indirect employment is even much higher, such as job available in the supply chain, maintenance and other services to the industry. [16] In terms of safety concern, as shown in Figure 1, high speed rail has fewer accidents compared to cars and buses.

2.3 Feasibility Study for Thailand HSR

Knowing the benefits of HSR and learning other countries' experiences, now Thai government is also interested in this project. But there is one key concern here: is Thailand ready for HSR? We mention that currently the transportation tools between Bangkok and Chiang mai are buses, private cars, airplanes and conventional trains. As we know, the revenue of transportation is directly related to ridership. Despite the fact that the HSR fare is relatively higher than bus and conventional trains, HSR can save lots of time. For local people, once they know they have alternatives, they will compare their available choices then make a decision depending on their situation. The traveling mode changes are happening in China. For those who are time consuming, they take HSR instead of ordinary trains. And taking advantage by the regulation of China government, HSR fare keeps adjusting to average people's acceptance level, the HSR tickets are not much more expensive compared to ordinary trains. With similar culture, Thai government can also monitor the HSR system to make it more attractive to all kinds of travelers. According to China's report, the domestic airline gained revenue less than last year because some of their flights were canceled. The applications of high speed rail are different than those of airplane. The fact that HSR can cut travel time and its price is much cheaper is also impacting on people's choice. People have switched from flying to take the train because it is more convenient and save the time. Like in China, Domestic airline in Thailand might also have the same situation as airlines in China, after operating high speed rail system. [12]

There are several studies to compare the airplane users and HSR by reviewing all countries' HSR experiences. The main driven of European HSR is the Japanese big success on competing with airplanes after Japanese first ran the high speed train. Then European high speed system also achieved its goal. UIC defines: "There are three main types costs involved in HSR infrastructure: "Planning and land costs", including feasibility studies (both technical and economic), technical design, land acquisition and others (such as legal and administrative fees, licenses, permits, etc.), which normally representing between 5-10% in the total investment amount; "Infrastructure building costs" include all those costs related to terrain preparation and platform building. Its amount varies widely across projects depending on the characteristics

of the terrain, but usually represent between 10-25% of the total investment in new rail infrastructure; and "Superstructure costs" include rail specific elements such as guideways (tracks) plus the sidings along the line, signalling systems, catenary and electrification mechanisms, communications and safety installations, etc. Individually considered, each of these elements usually represents between 5-10% of total investment." [20] With respect to the costs analysis and the benefits of HSR's such as time saving, reliability, sufficient capacity and diversion, the studies concluded that since the investment on HSR is quite expensive, the best investment circumstance is when both more rail capacity and a commercial need for higher speeds are required. Besides, HSR is proved to rely heavily on future economic growth and on the assumption that demand for passengers. [19, 20, 22]

Nash's study on the HSR impact on tourism revealed that the role of HSR transportation is important, but introducing HSR would not directly and sufficient to increase the tourism economy. It requires the local or regional attractive strategies, integrated products and multiple public-private partners. Particularly, for short stays, HSR system can support the development of urban tourism or business tourism. [21] Another feasibility study on the Thailand HSR's patronage estimation indicated that the estimation is highly influenced by fares and associated costs. [13] So far, Office of Transport and Traffic Policy and Planning (OTTP) of Thailand already did a pre-feasibility study for the HSR from Bangkok to Chiang Mai project. The published result indicates that the project has the potential (see Figure 4). For all investment plans, the EIRR is 13.58%. The detailed plan information will be introduced in the later section. [23]

	Investment Portion			
	100% (Government)	50%	30%	Rolling Stock & Operation
FIRR	-0.71%	2.30%	4.68%	35.65%

Figure 4

Overall, since this project is assigned by SRT for the purpose of improving the economic, social infrastructures, Thailand transportation energy efficiency to achieve the sustainability, in

addition, the current Thai government will strongly support the project by all means to develop the high speed rail in Thailand. The government already starts to set the related strategies and laws. Moreover, studies show the government power in the public transportation construction, especially in Asian courtiers, we believe that this project is going to happen in Thailand. In fact, Thailand has generated interest in high speed rail project since 1993, due to the limitation of its industry and technology, Thailand is not qualified for this project until now. The improving of country in terms of technology and economy provides a good chance for the new public transportation model.

In order to manage this project properly, the project management plan (PMP) has to be developed. PMP helps projects to know what deliverables have to be presented in the end of the project, which team member has responsibility for which tasks, and how much time and cost will the project expenses. In our PMP, it includes organization chart, work breakdown structure, responsibility matrix, project schedule, and cost estimation. The detail of each of them will be described in the following chapters.

2. Project Organization

The first step of the project management plan is to figure out how many organizations will be in charge. Organization chart is one of the most common approaches to show the structure of organization relationship. For our project, constructing a high speed rail in Thailand, it has very complicated systems which are comprised of the state of art of many different elements. [25, 26] Generally, these elements are: [17]

- Infrastructure (Including civil engineering, works, track, catenary)
- Stations (location, function design, equipment)
- Rolling stock (technology, comfort, design)
- Operation (design and planning, control, rules)
- Signaling systems
- Maintenance policy and systems
- Financing
- Marketing procedures

- Management
- Legal issues

Based on these functions and the models of organization chart from California and Taiwan HSR system, we designed the HSR organization chart for Thailand's system shown in Appendix IV.

3. Project Planning

3.1 Work Breakdown Structure (WBS)

Work breakdown structure is an useful project management tool because it helps project managers to recognize which tasks have to be done in order to complete the project required deliverables. In our project, constructing a high speed rail in Thailand, the five deliverables that project managers can provide are project management & control, public education and communication, engineering criteria and communication, environmental review and other activities. [25] Under each deliverables, there are several tasks that project managers need to assign for the functional departments or participate with them. The relationship between these deliverables and tasks are shown below as Figure 5.

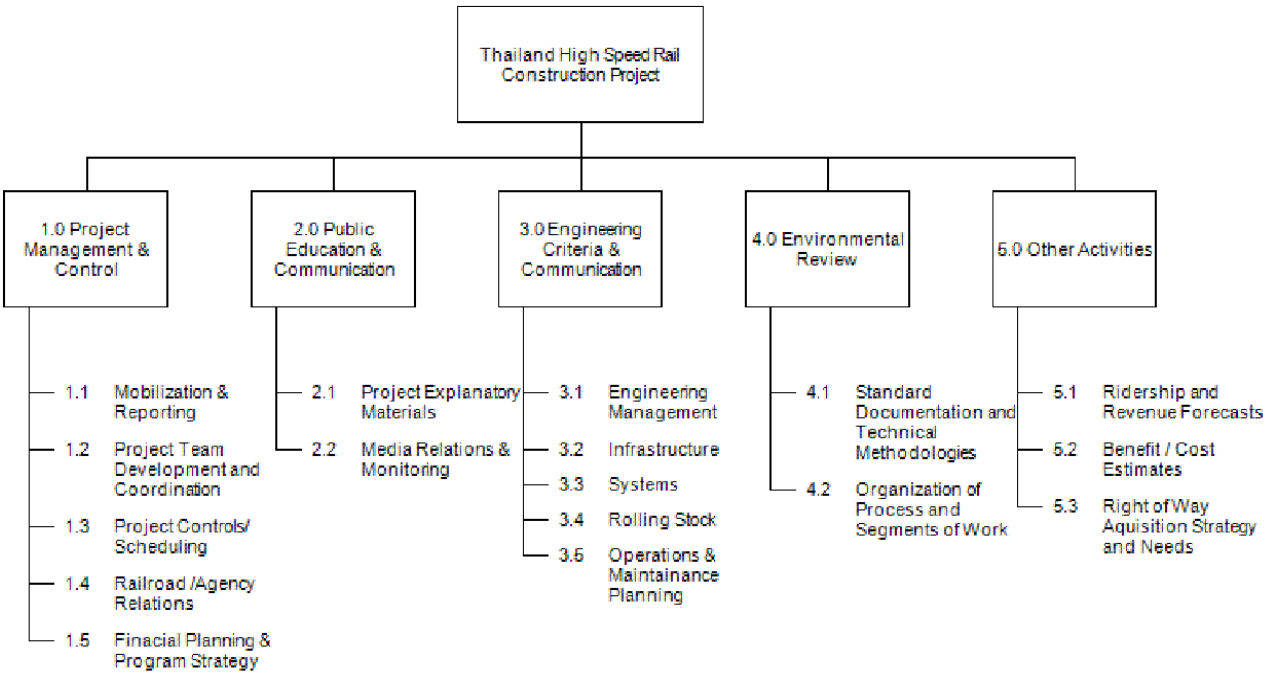


Figure 5: Work Breakdown Structure of Thailand HSR Construction Project

3.2 Responsibility Matrix

After the WBS has been developed, the next step that project managers have to do is to design the responsibility matrix (RM) based on the WSB tasks. There are totally ten departments' leaders involved in the project, which are deputy director, engineering manager, operation manager, environmental manager, construction manager, procurement manager, QA/QC manager, visual simulation manager, financial consultant and project manager. From the responsibility matrix, all participants could check their responsibility in each assigned task. For example, in the task 1.5, financial planning and program strategy the project manager is responsible to handle the project progress, and deputy director, operation manager, procurement manager, and financial consultant manager have to participate in this task and contribute it. The detail of responsibility matrix charts is shown below as Figure 6, 7, 8.

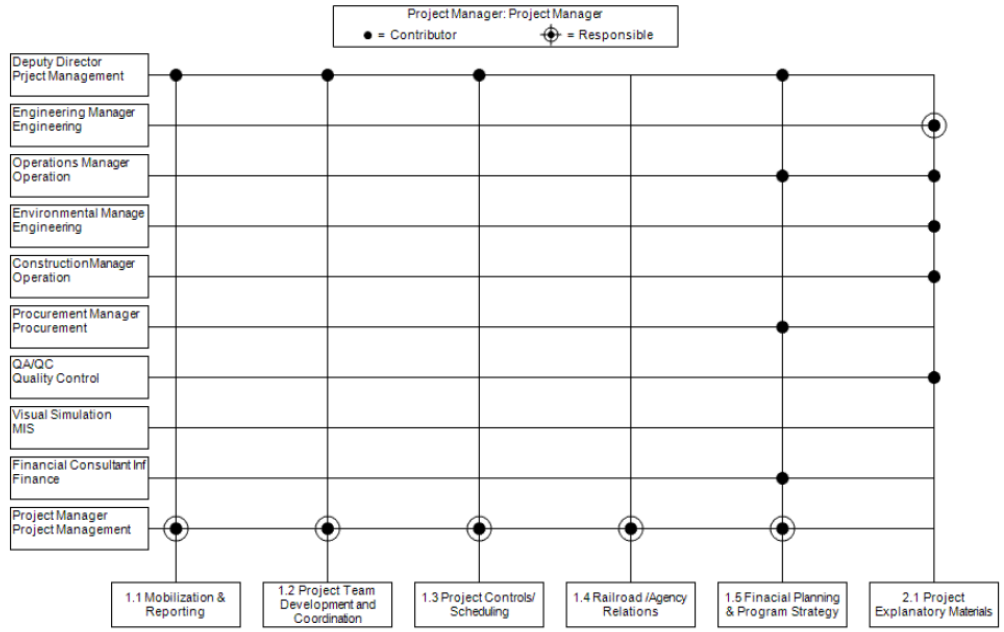


Figure 6: Responsibility Matrix of Thailand HSR Construction Project (I)

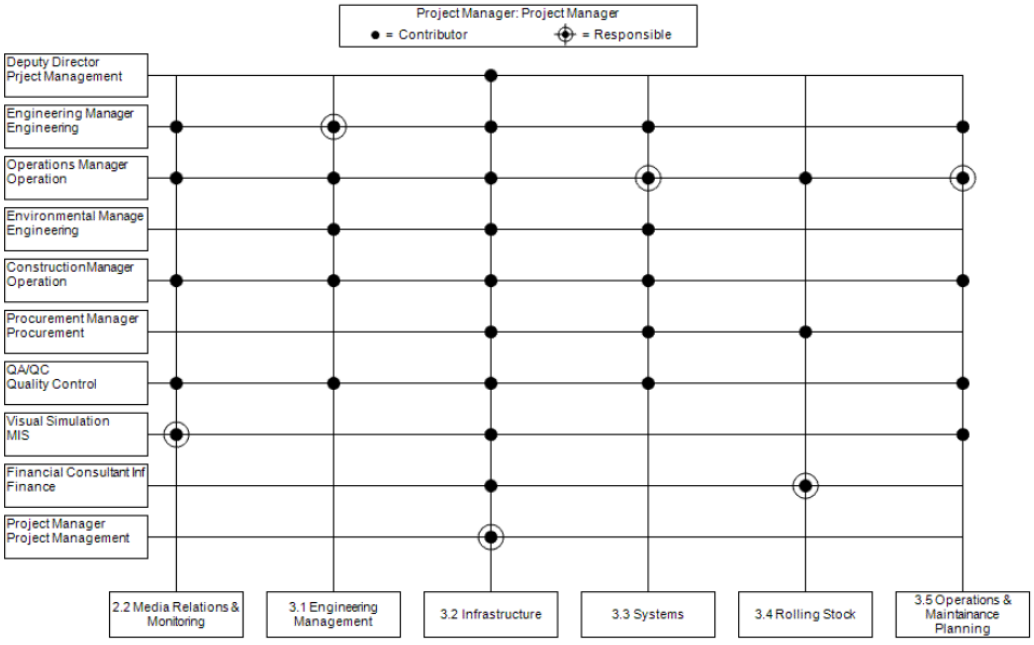


Figure 7: Responsibility Matrix of Thailand HSR Construction Project (II)

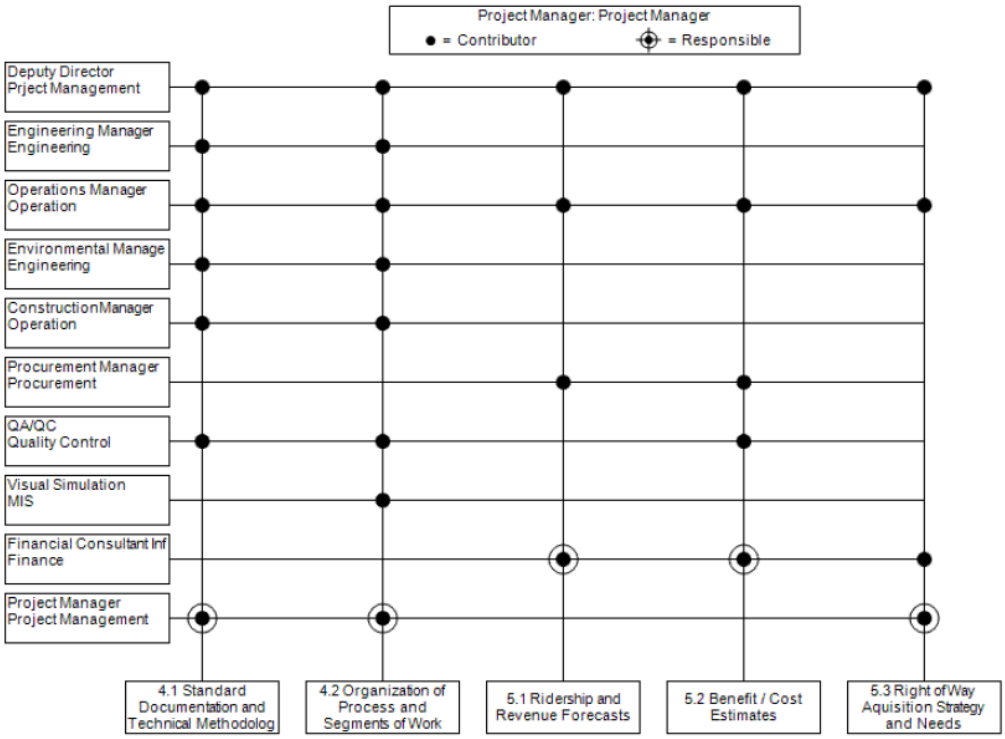


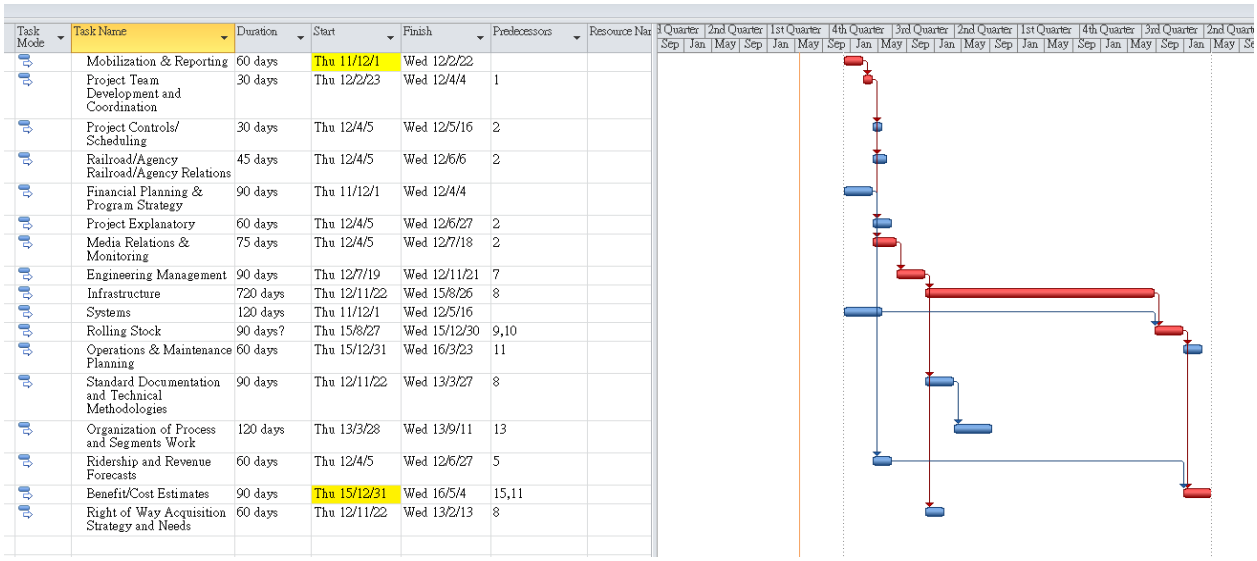
Figure 8: Responsibility Matrix of Thailand HSR Construction Project (III)

3.3 Scheduling

Scheduling is one of the most important segments in the project management. Before project managers design the project schedule, they have to discuss with other participants and confirm that all the task time durations are feasible. And then, project managers have to define the dependency relationship between relevant tasks. For example, completing the infrastructure is the preceding task of setting up the rolling stock, project managers need to put them in the correct order.

Our project schedule has been developed by Microsoft Project. The detail has been shown below as Figure 9 (See Appendix V in large). From this chart, project managers could see clearly how when which task starts and when it has to be end. Also, the red route, the critical path, indicated the critical tasks in this project are mobilization and reporting, project team development and coordination, media relation and monitoring, engineering management, infrastructure, rolling stock, and benefit/cost estimates. In order to complete the project on

time or ahead the planned finished day, project managers should track these critical tasks and make sure each of them could be completed in the regular time. If the project managers notice that any of these tasks is behind the schedule, they should make contingency plan such as adding more human resource or money to ensure the whole project can be completed on time.



Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Nar
	Mobilization & Reporting	60 days	Thu 11/12/1	Wed 12/2/22		
	Project Team Development and Coordination	30 days	Thu 12/2/23	Wed 12/4/4	1	
	Project Controls/ Scheduling	30 days	Thu 12/4/5	Wed 12/5/16	2	
	Railroad/Agency Railroad/Agency Relations	45 days	Thu 12/4/5	Wed 12/6/6	2	
	Financial Planning & Program Strategy	90 days	Thu 11/12/1	Wed 12/4/4		
	Project Explanatory	60 days	Thu 12/4/5	Wed 12/6/27	2	
	Media Relations & Monitoring	75 days	Thu 12/4/5	Wed 12/7/18	2	
	Engineering Management	90 days	Thu 12/7/19	Wed 12/11/21	7	
	Infrastructure	720 days	Thu 12/11/22	Wed 15/8/26	8	
	Systems	120 days	Thu 11/12/1	Wed 12/5/16		
	Rolling Stock	90 days?	Thu 15/8/27	Wed 15/12/30	9,10	
	Operations & Maintenance Planning	60 days	Thu 15/12/31	Wed 16/3/23	11	
	Standard Documentation and Technical Methodologies	90 days	Thu 12/11/22	Wed 13/3/27	8	
	Organization of Process and Segments Work	120 days	Thu 13/3/28	Wed 13/9/11	13	
	Ridership and Revenue Forecasts	60 days	Thu 12/4/5	Wed 12/6/27	5	
	Benefit/Cost Estimates	90 days	Thu 15/12/31	Wed 16/5/4	15,11	
	Right of Way Acquisition Strategy and Needs	60 days	Thu 12/11/22	Wed 13/2/13	8	

Figure 9: the Overall Schedule of High Speed Rail Construction in Thailand

4. Cost Analysis

4.1 The cost of building HSR infrastructure

Building HSR system requires a lot of advanced materials. Because of this fact, a lot of money has to be spent if Thai government wants to implement the high speed train.

There are three main types of HSR infrastructure costs: planning and land costs, infrastructure building costs, and superstructure costs. For planning and land costs, it includes feasibility studies, land acquisition, technical design, and legal licenses and permits. In most cases, the costs could be high when costly land expropriations are required. For infrastructure costs, it includes terrain preparation and platform building. And for superstructure costs, it includes rail specific elements such as electrification mechanisms, signaling systems, etc. [20]

From our research, we found the estimated amounts of investments that Thai government roughly calculated. In the next part, costs and payback period will be discussed.

4.1.1 Payback Period

To build a successful project, it is necessary to know how long it will take to get the return of the investment. In other words, it is called “Payback Period”. Payback period in capital budgeting refers to the period of time required for the return on an investment to "repay" the sum of the original investment. In our case, the Thai government had provided sufficient data to calculate the payback period when they proposed the HSR project. First, the government had four possible scenarios of investment and also the investment amount for each scenario (see Table 5).

	Scenario	**Investment (in million $)**
Option 1	100% Government Investment	7,747
Option 2	Government Investment in Civil Work	7,379
Option 3	50% Government Investment	3,993
Option 4	30% Private Investment	5,423

Table 5: Scenarios & Investment Amount for each Scenario [23]

Second, the government has estimated the passengers who are going to ride the HS train from year 2017 to 2032 which is shown below.

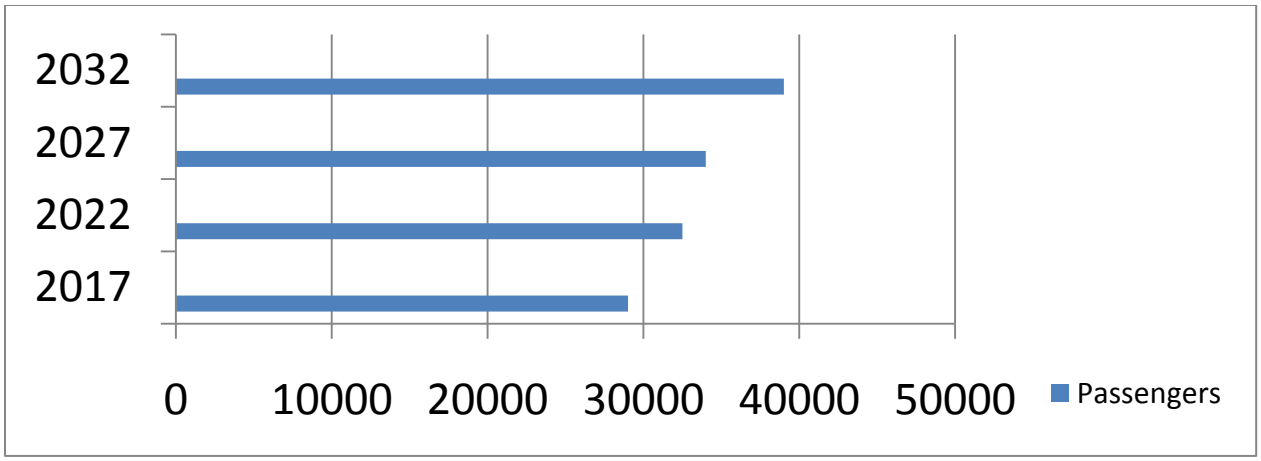


Figure 10: Estimated Ridership (Bangkok-Chiang Mai HSR Project) [23]

From the figure, it clearly shows that the government is optimist by predicting that there will be around 29,000 passengers/ day in year 2017, 32,500 in year 2022, 34,000 in year 2027, and 39,000 in year 2032, respectively. By multiplying these numbers with 365 days, we will get the numbers of passengers per year for each specific year.

In 2017: Total of passengers per year is 29,000 * 365 = 10,585,000

In 2022: Total of passengers per year is 32,500 * 365 = 11,862,500

In 2027: Total of passengers per year is 34,000 * 365 = 12,410,000

In 2032: Total of passengers per year is 39,000 * 365 = 14,235,000

After that, we assume that the total of passengers per year increases equally for each interval. For example, in order to determine how many passengers increase, we subtract the numbers of passengers of year 2022 from that of 2017 and then the result will be divided by the numbers of years between 2017 and 2022 as shown below.

Subtracting 2022's passengers from 2017's passengers:

11,862,500 – 10,585,000 = 1,277,500

The difference divided by the numbers of years: 1,277,500/ 5 = 255,500

As a result, we found that the numbers of passengers will increase 255,500 every year from 2017 to 2022. We do the same calculation for the rest and finally we have all the numbers of passengers per year for each year from 2017 to 2032.

Since the ticket price is set as $40, we can determine the revenue (Selling Price * Passengers) The table below represents the cost analysis showing the revenue, accumulated revenue, cost, rate of return, passengers of 100% government investment case.

Year	Revenue(in million)	Accumulated Revenue(in million)	Cost(in million)	ROI(in million)	Passengers/ day	Passengers/ year
2017	423.4	423.4	7746.97	-7324	29000	10585000
2018	433.62	857.02	7746.97	-6890	29700	10840500
2019	443.84	1300.86	7746.97	-6446	30400	11096000
2020	454.06	1754.92	7746.97	-5992	31100	11351500
2021	464.28	2219.2	7746.97	-5528	31800	11607000
2022	474.5	2693.7	7746.97	-5053	32500	11862500
2023	478.88	3172.58	7746.97	-4574	32800	11972000
2024	483.26	3655.84	7746.97	-4091	33100	12081500
2025	487.64	4143.48	7746.97	-3603	33400	12191000
2026	492.02	4635.5	7746.97	-3111	33700	12300500
2027	496.4	5131.9	7746.97	-2615	34000	12410000
2028	511	5642.9	7746.97	-2104	35000	12775000
2029	525.6	6168.5	7746.97	-1578	36000	13140000
2030	540.2	6708.7	7746.97	-1038	37000	13505000
2031	554.8	7263.5	7746.97	-483	38000	13870000
2032	569.4	7832.9	7746.97	86	39000	14235000

Table 6: The Cost Analysis Table of 100% Government Investment Case

From the table above, we take accumulated revenue and cost to plot on the graph so we can see the breakeven point which is somewhere before year 2032.

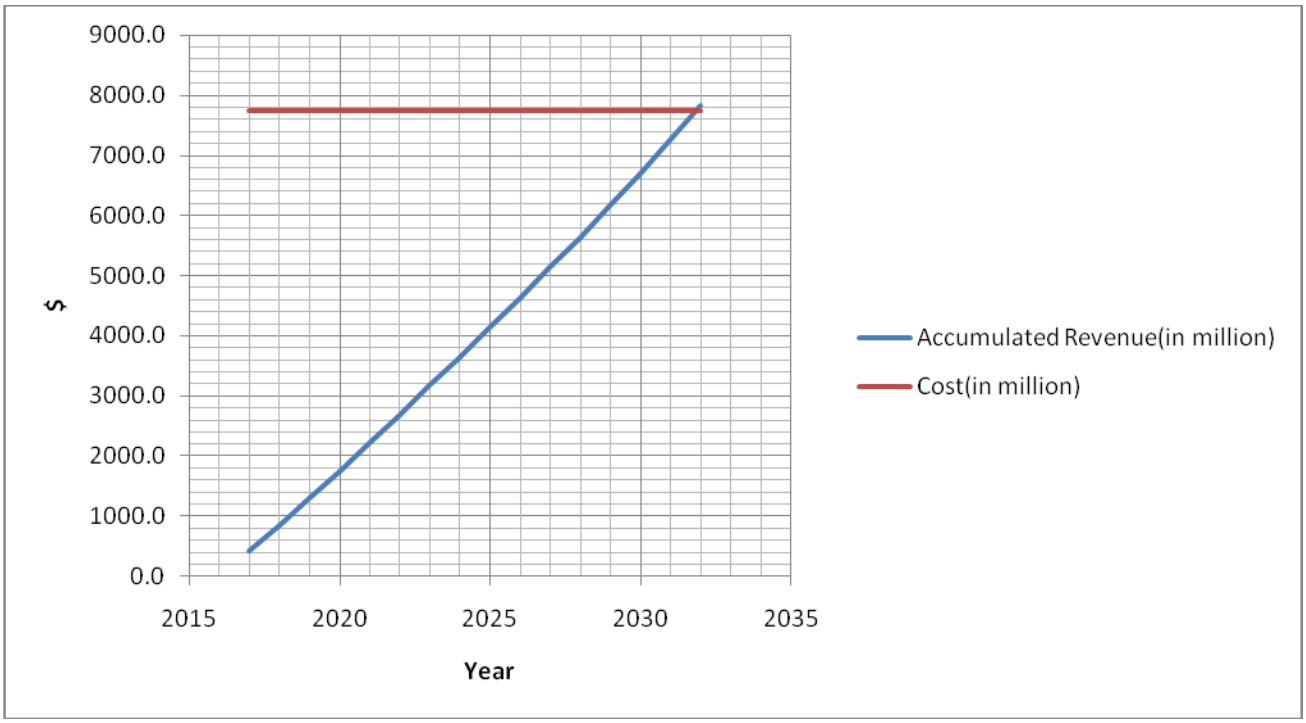


Figure 11: The Breakeven Point Chart (100% Government Investment Case)

According to the data from table 6 and figure 11, it will approximately take government 15 years in order to acquire the return of the investment if the government decides to invest 100%.

Based on the same methodology, we can determine the payback period for each scenario as shown below.

Investment Type (Public)	Payback Period
1) 100% Government Investment	2032
2) Investment in Civil Work only	2032
3) 70% Government Investment	2028
4) 50% Investment	2025

Table 7: Payback Period for each scenario

From the table 7, it seems that 50% investment should be the most preferable choice for the government since it has the fastest payback period which is 8 years from the beginning. That's the reason why the government is searching for a professional team from private sector to work with them.

4.2 The cost of operating HSR

According to UIC data, there are two types of operating costs: infrastructure operating costs and the rolling stock operating costs. [20] From our literature research, we could not find the information of the operating cost for Bangkok-Chiang Mai HSR project since it is somewhat confidential, but we found the operating costs of some European countries that are operating the HS train.

The data illustrates that each European country's expense of infrastructure maintenance varies because they are different in many factors such as the systems they use, the distance of the tracks they have, the weight of the trains, etc. Based on this information, Thai government can estimate the infrastructure operating costs based on the HS system they will use and the distance of the track it will be.

4.3 The external costs of HSR

Based on UIC data, the external costs are environmental costs. The construction and operating costs produce the environmental costs such as land take, barrier effects, visual intrusion, air pollution, noise, and contribution to global warming at the end. [20] From our research, we could not find the information of the external costs for Bangkok-Chiang Mai HSR project since it is somewhat confidential.

5. Project Termination

In our project, the project will be terminated after all infrastructures have been built and the HSR system starts to run. The first thing that project managers need to do before the end of project is to make sure all project process and data are documented. And then, Project managers have to design which departments need to stay and which departments need to leave. For the remaining departments, they should keep controlling the HSR systems and maintain the service quality. On the other hand, for the leaving department, project managers have to allocate this human resource to other projects such as designing and constructing the HSR in other regions of Thailand.

6. Follow-on Research

The profit of HSR project directly depends on its ridership, which from the study of estimating passengers models, the ridership highly impacted by fares. Regarding to the project development process, such facts as weather condition, labor strike will cause the construction delay, and so on. All these must be considered and monitored by the project managers. Therefore, the follow-on research should focus on how can the project managers forecast and be ready for uncertain events.

In addition, studies show that the huge impact is the government to public construction. There is one thing we did not consider in our HSR project: election. The current government has proposed this project and wanted this project to start as soon as possible for a few years. Unfortunately, the fact that the Thai's election is about to occur could be a limitation to launch the project. If the current government is elected again, there will not be a problem since the project can be continued. However, if another party is elected instead, that party may not want to do it. The reasons are that the cost of building the project is immensely high and also there are a number of big projects that the next government should do rather than spending a lot of their budget on a single project.

7. Recommendation

7.1 Project Manager

Studies done by UIC summarized the three important responsibilities as rail managers with energy efficiency, including the management process, the technical development and the training and motivation of staff. [24] Combing with the lecture that Dr. K mentioned about the successful PM, we suggest the following six characteristics that PM of this project need to be considered when selecting project manager:

- Be powerful and confident. Because this is a mega project, it needs someone who can control and be able to lead a lot of people to stay on the right path.
- Define the goal clearly and eager to achieve it. Because there are a lot of tasks to achieve, having a clear goal for this project is really essential for PM since it prevents him from losing the track. Besides,
- Bring the project to the right people and be motivated. Because this project requires a lot of expertise to finish, having right people to do the right jobs and cheer them up is necessary to ensure the jobs done effectively.
- Convey your idea clearly and effectively. Because there are a lot of tasks and a lot of teams, good communication from PM is required to ensure that everyone understands the same thing.
- Be a good guider, correct mistakes promptly and learn from them. Because errors can happen anytime no matter how well you prepare, PM should realize the mistakes he makes, learn from them, and try not to make the same mistake again.
- Be able to harmonize the teams. Because there will be a lot of teams in the project, PM should know how to stick those teams together and have them work as a unit so that the working process will be smooth.

7.2 Project Monitor and Control

In order to better control the project, earned value concept can be applied in our project. As we mentioned before, the most critical task in our project is infrastructure task because it takes the longest time duration. Based on earned value concept, we can estimate if this task is behind or ahead the schedule and the cost will be under or overrun budget.

7.3 Cost control recommendation

As we mentioned in the cost analysis section, there are many costs that are involved in this project such as building costs, operating costs. If Thailand wants this project to be successful, all of the costs have to be controlled or reduced as much as possible. Based on UIC study, there are five main elements to reduce costs: knowledge of high speed systems & elements, definition of max speed and performance, standardization, financing, and market procedures. [20]If the people who will involve in the HSR project understand and know how to cope with these issues, the costs will be vastly minimized.

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Appendix I: Definitions of High-Speed

(1) EU Definition (DIRECTIVE 96/48/EC APPENDIX):

1. Infrastructure

a) The infrastructure of the trans-European High Speed system shall be that of the lines of the trans- European transport network identified in Article 129C of the Treaty:

-those built specially for High Speed travel,

-those specially upgraded for High Speed travel. They may include connecting lines, in particular junctions of new lines upgraded for High Speed with town centre stations located on them, on which speeds must take account of local conditions.

b) High Speed lines shall comprise:

Specially built High Speed lines equipped for speeds generally equal to or greater than 250 km/h,

Specially upgraded High Speed lines equipped for speeds of the order of 200 km/h,

Specially upgraded High Speed lines which have special features as a result of topographical, relief or town-planning constraints, on which the speed must be adapted to each case.

2. Rolling stock

The High Speed advanced-technology trains shall be designed in such a way as to guarantee safe, uninterrupted travel:

-at a speed of at least 250 km/h on lines specially built for High Speed, while enabling speeds of over 300 km/h to be reached in appropriate circumstances,

-at a speed of the order of 200 km/h on existing lines which have been or are specially upgraded,

-at the highest possible speed on other lines.

3. Compatibility of infrastructure and rolling stock

High Speed train services presuppose excellent compatibility between the characteristics of the infrastructure and those of the rolling stock. Performance levels, safety, quality of service and cost depend upon that compatibility.

(2)Definition in Japan:

High speed lines are called "Shinkansen" (Shinkansen originally meant 'new trunk line' in Japanese).

The official definition of "Shinkansen" is "*a main line on which a train is able to run at over 200km/h along almost all the route" (the law: Zenkoku Shinkansen Tetsudou Seibi Hou).*

The Shinkansen network is a complex high speed railway transportation system with specific technical standards (i.e. dedicated high speed track without level crossings, standard track gauge and a special loading gauge). The Shinkansen train or Japanese HSRS, is a special class of RS that forms just one part of the overall Shinkansen transportation system.

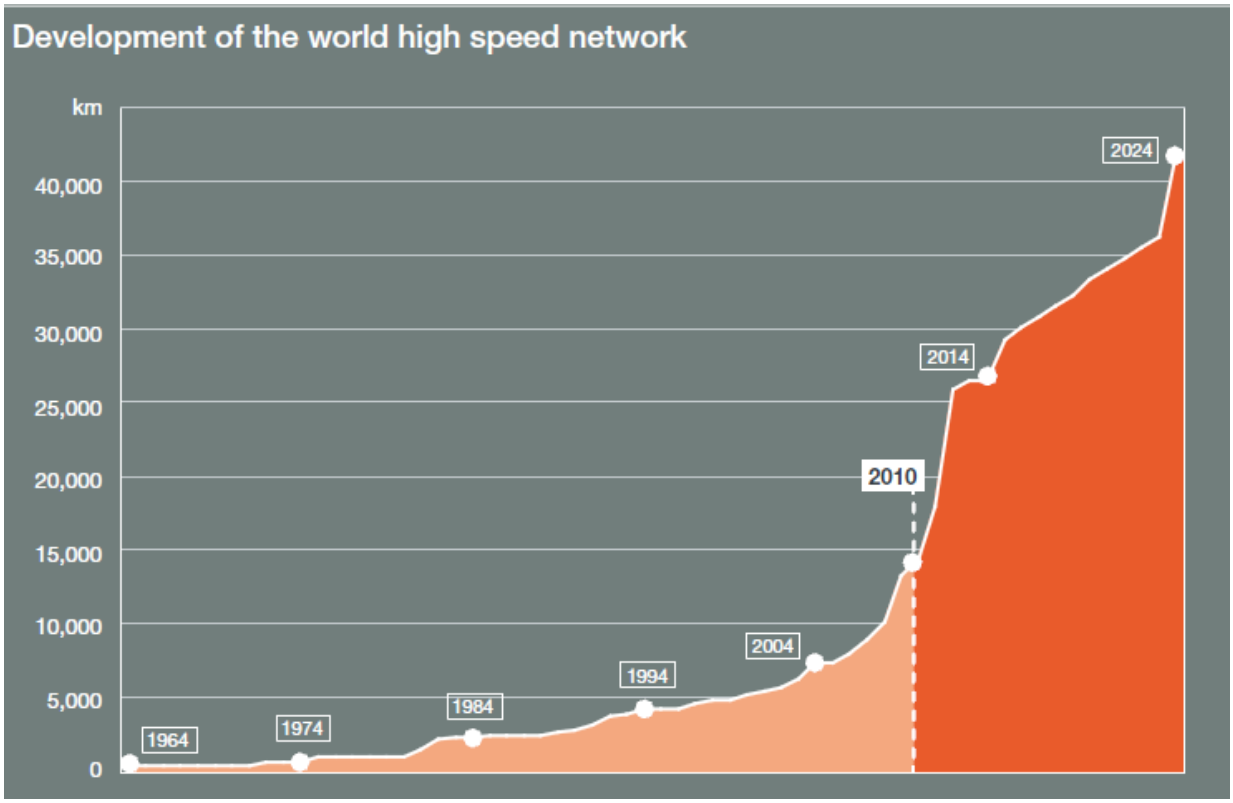
(3) US Definition ("Vision for HIGH-SPEED RAIL in America", Department of Transportation):

-HSR – Express. Frequent, express service between major population centers 200–600 miles apart, with few intermediate stops. Top speeds of at least 150 mph on completely grade-separated, dedicated rights-of way (with the possible exception of some shared track in terminal areas). Intended to relieve air and highway capacity constraints.

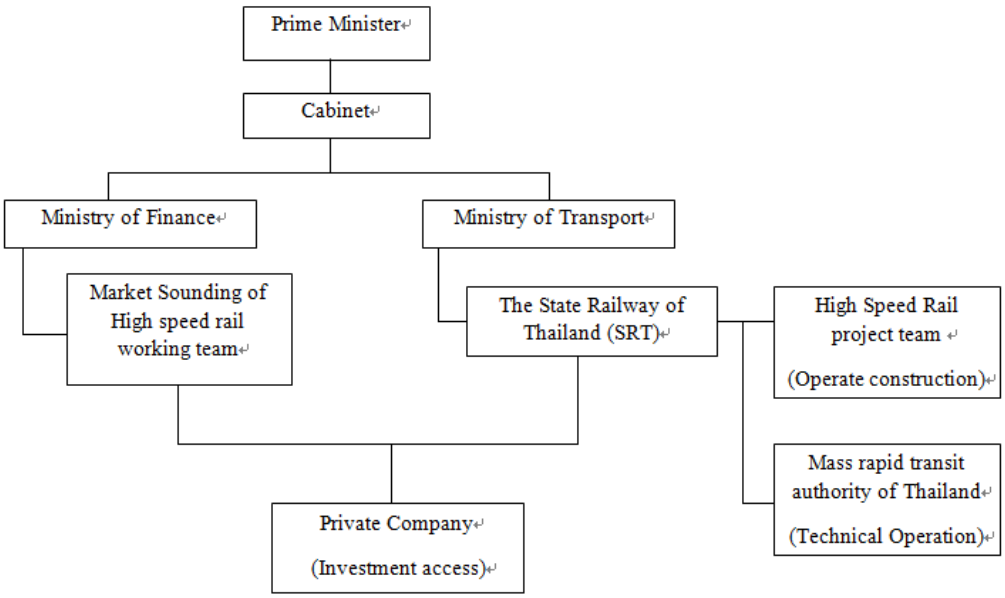
-HSR – Regional. Relatively frequent service between major and moderate population centers 100–500 miles apart, with some intermediate stops. Top speeds of 110–150 mph, grade-separated, with some dedicated and some shared track (using positive train control technology).

Intended to relieve highway and, to some extent, air capacity constraints.

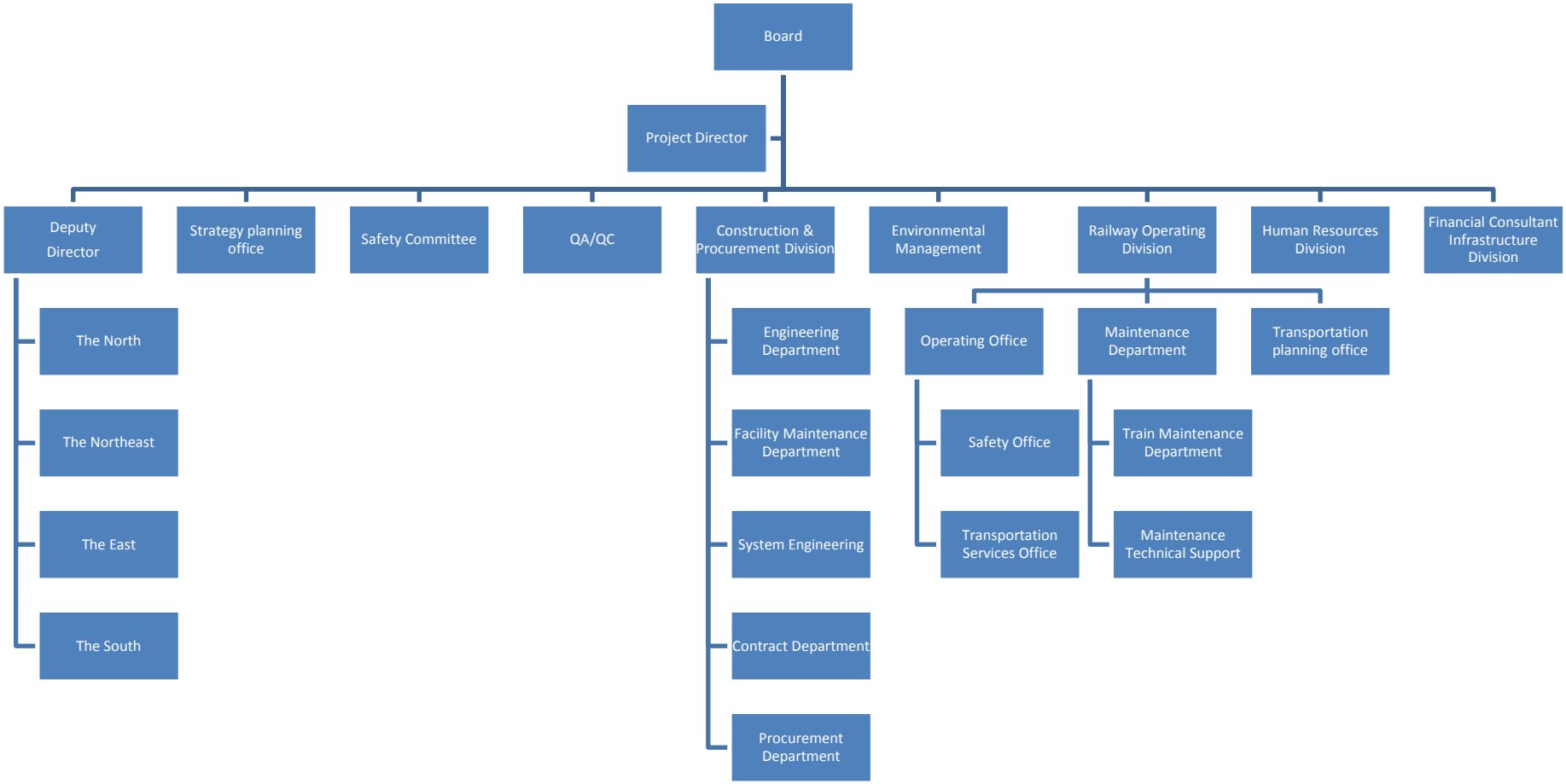
Appendix II World HSR development from UIC [17]



Appendix III SRT Organization Chart



Appendix IV Thailand HSR Orgnazitional Chart



Appendix V Scheduling Plan

Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Nar
	Mobilization & Reporting	60 days	Thu 11/12/1	Wed 12/2/22		
	Project Team Development and Coordination	30 days	Thu 12/2/23	Wed 12/4/4	1	
	Project Controls/ Scheduling	30 days	Thu 12/4/5	Wed 12/5/16	2	
	Railroad/Agency Railroad/Agency Relations	45 days	Thu 12/4/5	Wed 12/6/6	2	
	Financial Planning & Program Strategy	90 days	Thu 11/12/1	Wed 12/4/4		
	Project Explanatory	60 days	Thu 12/4/5	Wed 12/6/27	2	
	Media Relations & Monitoring	75 days	Thu 12/4/5	Wed 12/7/18	2	
	Engineering Management	90 days	Thu 12/7/19	Wed 12/11/21	7	
	Infrastructure	720 days	Thu 12/11/22	Wed 15/8/26	8	
	Systems	120 days	Thu 11/12/1	Wed 12/5/16		
	Rolling Stock	90 days?	Thu 15/8/27	Wed 15/12/30	9,10	
	Operations & Maintenance Planning	60 days	Thu 15/12/31	Wed 16/3/23	11	
	Standard Documentation and Technical Methodologies	90 days	Thu 12/11/22	Wed 13/3/27	8	
	Organization of Process and Segments Work	120 days	Thu 13/3/28	Wed 13/9/11	13	
	Ridership and Revenue Forecasts	60 days	Thu 12/4/5	Wed 12/6/27	5	
	Benefit/Cost Estimates	90 days	Thu 15/12/31	Wed 16/5/4	15,11	
	Right of Way Acquisition Strategy and Needs	60 days	Thu 12/11/22	Wed 13/2/13	8