Term Project

Boston-Cambridge Public Transit

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Revision History *<required for all Draft submissions. Not required for the final Project Report>*

9/26/2021	Draft #1: Original proposal
10/01/2021	Draft #2: Revised Scope, Funders, and Technical approach
10/17/2021	Draft #3: WBS, RACI matrix, Activity Diagram

1. Purpose

This project will make travelling easy for people of Massachusetts living particularly in Boston, Cambridge, and nearby towns. The new Subway route between Boston and Cambridge will provide quicker public transport as compared to the transport available now. It will also help young students and senior citizens save money by avoiding the high-cost taxi services and gas. This project will help environment by creating less pollution in these two major traffic prone cities and provide easier and smooth travel services to people.

2. Objective

The objective of this project is to provide subway public transportation to the people of Massachusetts to decrease the travel time and cost. The target recipients of this project will be students of MIT, Harvard, Boston University, Northeastern University, and senior citizens.

3. Scope

This project will connect Boston with Cambridge by railroad consisting of 6 stations. Three of the stations will be underground and other three will be on the street.
Overall, following will be the deliverables:

1. Design of the railway route over the street and underground.
2. Construction of stations, bridges, and tunnels.
3. Pilot testing of the railway
4. Handover of the project

After finalizing the technical feasibility, acquiring land, architects will create a railroad map showing the route of the subway. Cite/Field engineer will look after construction of subway stations, bridges, tunnels, entry and exits, and parking. Design engineer will look after the in-dept design of railway platforms, railway tracks, bridges, etc. Quality assurance team will monitor and control the risks associated with the project and finance team will look after the budget tracking.

4. Funder/Investor

Stakeholders involved in this project include-

1. MassDevelopment
2. MBTA
3. Construction Agency
4. Residents of Massachusetts

MassDevelopment is a finance agency and since this project is to improve the public transportation of Massachusetts, MassDevelopment and MBTA both will fund the project. After the delivery of the project the growth and development for government is analyzed to be around 15% in the first year. The government will recover around 25% more than the first year, in the next five years. There will be app-based payments along with the ongoing Charlie Card option which will attract more travelers. The students can opt for discounted monthly, or semester pass from universities, seniors above 58 years can opt for senior citizen pass and the employers can opt for business pass which will provide people with more discounted rates.

5. Technical Approach

Initially, project requirements and team background will be decided. The resources will be assigned to the team, and they will use tools and techniques for the project. The tools and techniques used during the project will be AUTOCAD, REVIT, NAVISWORK (for co-ordination of the project), Building Information Modelling (effective communication with stake holders- virtual meetings), MS Project, Primavera, P6 (for scheduling and monitoring projects), MS Word, and Excel (for communication tools). The objective, scope and purpose will be decided in the planning phase and Work Break Down Structure will be created. During the execution phase, forecasting risk, monitoring and control, budget tracking, analyzing the project report will be done.

6. Critical Success Factors

It is important to understand Critical Success Factors for this project to make sure of its successful completion and execution. Following are the critical success factors of the project:

a. On time delivery of construction materials and equipment
b. Zero delay in construction of stations
c. Research on ground water levels to ensure feasibility of the project
d. Legal investigation of the construction sites to avoid legal constraints
e. Safety and emergency options for all the workers in case of emergency.

7. Assumptions

The project assumes that,

a. The ground water does not cause delays or obstruct project work
b. No natural disasters occur during the project
c. Serve people public transport and ease of travel between Boston and Cambridge
d. Positive feedback from the commuters
e. Increase in use of public transport due to cheap ticket prices
f. Safety of the commuters

8. Organization

Typical construction projects which are handled by the government follow projectized structure. There is a Project Manager who controls the entire project and has authority over the entire team under him/her. He will overlook Legal and Finance team, Design team, Construction team, Quality Assurance team and administrative support team. There are multiple managers of each group who manage their team and report to the Project Manager as this is a big project. Hence, we can say that the department managers are the project managers of their team and not just functional managers. They will be reporting managers for their team officers and engineers.

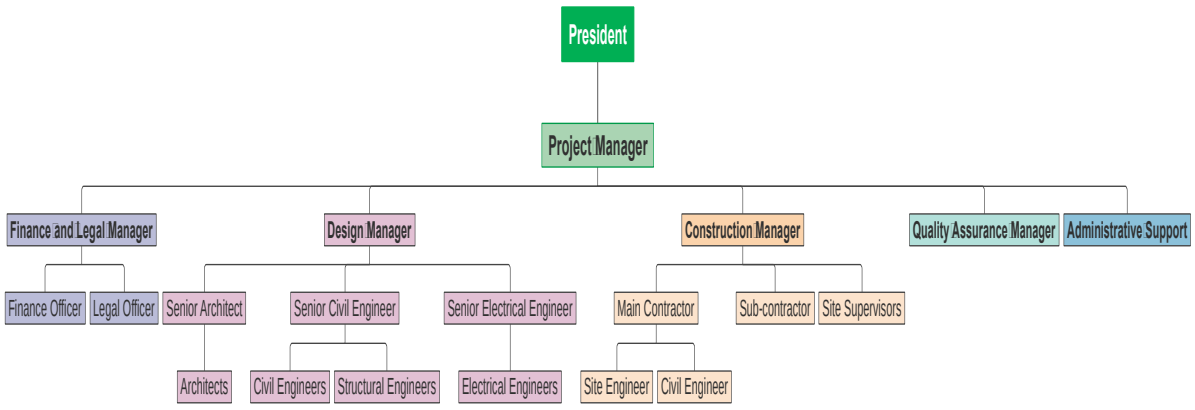


Figure 1: Project Organization

In the above Figure 1, only main structure of the organizational structure is shown. In addition to above officers and engineers, quality team and administrative team will have similar breakdown.

9. Project Plan

a. Work Breakdown Structure

The WBS is a foundational building block to initiating, planning, executing, and monitoring and controlling processes that are used to manage projects as they are described in the *PMBOK® Guide*—Third Edition (PMI, 2004). Table 1 shows high level list of tasks necessary for the project, the responsibility of each task, time needed to complete each subtask, any preceding tasks, and additional comments. This table includes only important tasks and not work packages or work units in detail.

Table 1: Work Breakdown Structure (WBS)

	Steps	Responsibility	Time (weeks)	Prec.	Additional Info.
1	**Planning and Design**				
a	Feasibility study	Project Manager	3		Feasibility tests and research
b	Land acquisition	Legal Manager	5		Acquire land
c	Legal contracts	Finance Manager	5		
d	Design railway route	Architect	8	1.a	
e	Technical design	Civil Engineer	4	1.d	Technical drawings
2	**Contract**				
a	Finalize contractor	Project Manager	1	1.e	
b	Extend contracts to sub- contractors	Main Contractor	1	1.e	
3	**Pre- construction**				
a	Procurement	Main Contractor	2	1.b	
b	Earth moving equipment	Civil Engineer	3	3.a	
4	**Construction**				
a	Off- site construction	Main Contractor	52	2.b	
b	Tunnels	Main Contractor	52	2.b, 3.a, 3.b	
c	Bridges, overpass, underpass	Main Contractor	20	2.b, 3.a, 3.b	
d	Underground Stations	Main Contractor	52	2.b	
e	Street Stations	Main Contractor	52	2.b, 3.a, 3.b	Street level stations
f	Passenger facility	Main Contractor	8	4.e	Benches, Ticket machine
5	**Power, tracks and signaling**				
a	Power generation	Electrical Engineer	8	4	

b	Power distribution	Electrical Engineer	8	4	Electricity box
c	Laying tracks	Main Contractor	4	4	
d	Overhead wires	Main Contractor	4	5.a, 5.b	
e	Safety and emergency equipment	Main Contractor	2	4	
6	**Testing**				
a	Test trial 1	Quality Assurance Manager	1	5e, 5d	
b	Test trial 2	Quality Assurance Manager	1	6.a	
c	Certification	Quality Assurance Manager	1	6.b	
7	**Launch**	Project Manager	1	6.c	

b. Resource Plan and Responsibilities (RACI)

The tasks shown in WBS in Table 1 needs more than one person to complete the entire task. RACI stands for Responsible, Accountable/ Approval, Consult, Inform. It defines roles and responsibilities, and helps in keeping track of who is responsible, who must/should be consulted, who is accountable, and who must be notified for a task (Jack R. Meredith, 1999). Project Manager is responsible for major tasks and remaining tasks are managed by other managers leading their teams.

Table 2: RACI matrix

	Task	Proj. Man.	Fin. Man.	Legal Man.	Des. Man.	Arch.	Civil Engg.	Elec. Engg.	Con Man.	Main Cont.	Qua. Man.
1	Feasibility study	R				C	C				C
2	Land acquisition	I	C	R	A	I			I		
3	Legal contracts	I	R	C	A	I					
4	Design railway route	A			C	R	C				
5	Technical design	I			A	C	R				
6	Finalize contractor	R			I	C	C		C		
7	Extend contracts to sub-contractors	A							C	R	
8	Procure-ment	I							A	R	C
9	Earth moving equipment						R		A	C	

10	Off- site construction	A					C		C	R	
11	Tunnels	A					C		C	R	
12	Bridges, overpass, underpass	A					C		C	R	
13	Underground Stations	A					C		C	R	
14	Street Stations	A					C		C	R	
15	Passenger facility	A					C		C	R	
16	Power generation	A					C	R		A	
17	Power distribution	A					C	R		A	
18	Laying tracks	A					C		C	R	
19	Overhead wires	A					C	I	C	R	
20	Safety and emergency equipment	A					C	I	C	R	
21	Test trial 1	A					C		I	C	R
22	Test trial 2	A					C		I	C	R
23	Certification	A					C	I		C	R
24	Launch	R			I	I	C	C		C	C

c. Financial Plan

Financial plan for each quarter

Table 3 Financial Plan

Quarterly Budget					
Tasks	Estimates	Q1	Q2	Q3	Q4
1.a	$60,000	$60,000			
1.b					
1.c					
1.d					
1.e					
2.a	$40,000	$40,000			
2.b					
3.a	$500,000	$500,000			
3.b					
4.a	$20,000,000		$10,000,000	$10,000,000	
4.b					
4.c					
4.d					
4.e	$12,000,000		$500,000	$700,000	
4.f					

5.a	$60,000			$10,000	$50,000
5.b	$150,000			$50,000	$100,000
5.c	$80,000			$40,000	$40,000
5.d	$140,000			$70,000	$70,000
5.e	$100,000			$50,000	$50,000
Total	$33,130,000	$540,000	$10,500,000	$10,920,000	$310,000

d. PERT Chart

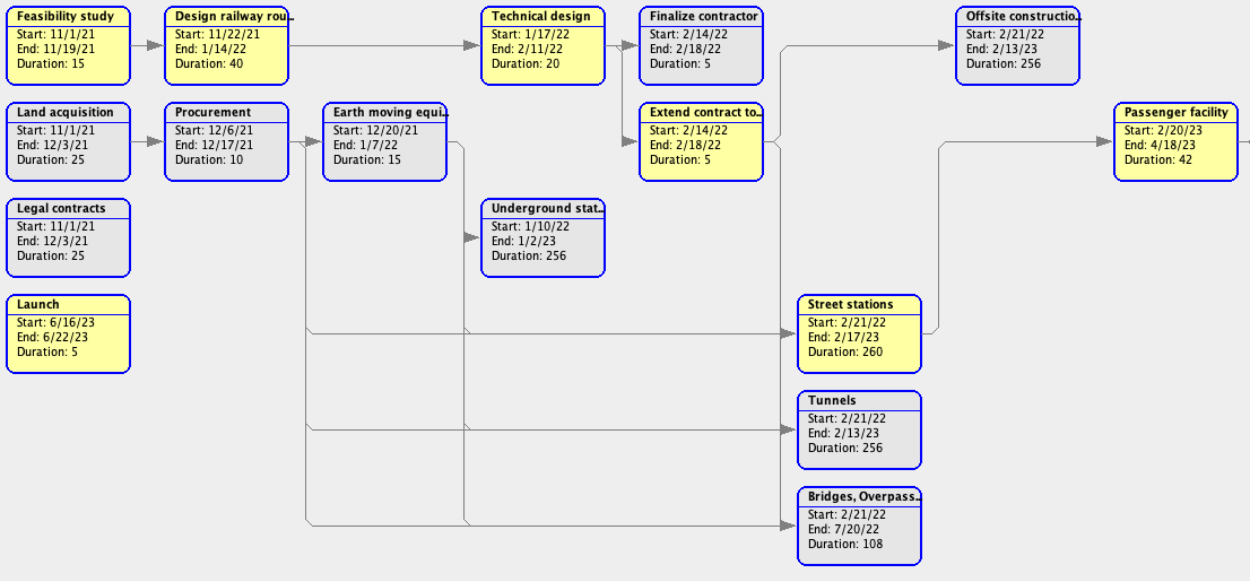


Figure 2 PERT Chart

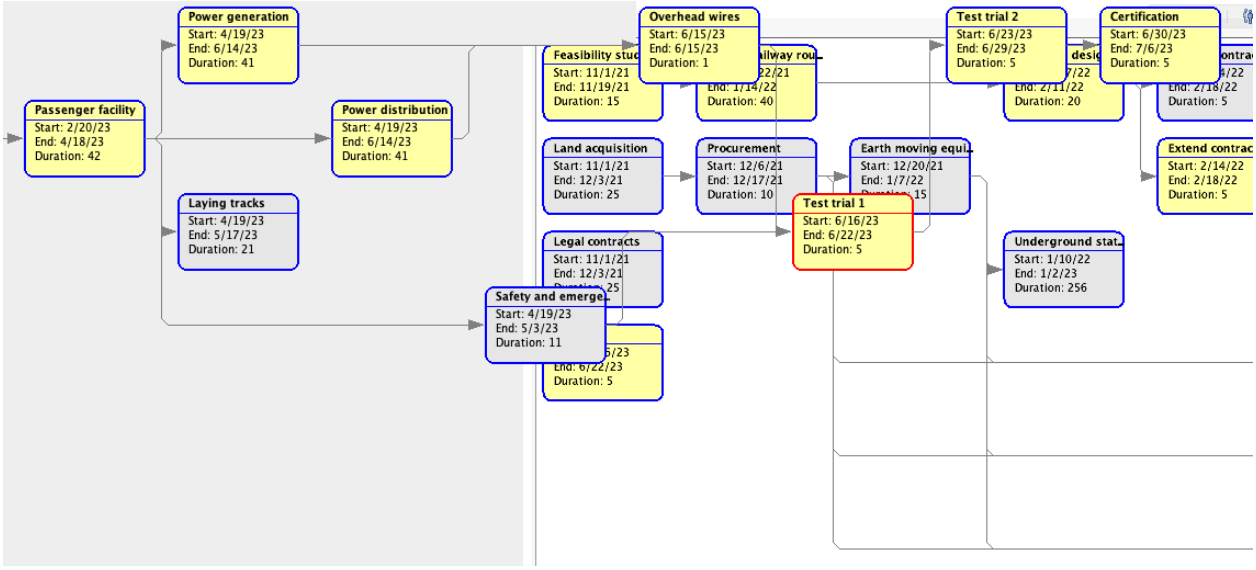
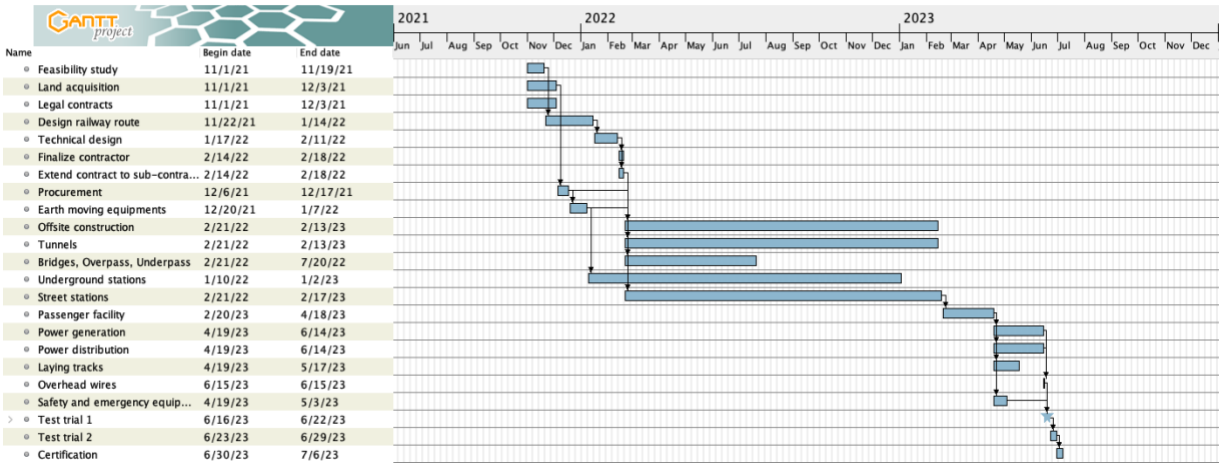


Figure 3 PERT Chart continued

e. GANTT Chart



Name	Begin date	End date
Feasibility study	11/1/21	11/19/21
Land acquisition	11/1/21	12/3/21
Legal contracts	11/1/21	12/3/21
Design railway route	11/22/21	1/14/22
Technical design	1/17/22	2/11/22
Finalize contractor	2/14/22	2/18/22
Extend contract to sub-contra...	2/14/22	2/18/22
Procurement	12/6/21	12/17/21
Earth moving equipments	12/20/21	1/7/22
Offsite construction	2/21/22	2/13/23
Tunnels	2/21/22	2/13/23
Bridges, Overpass, Underpass	2/21/22	7/20/22
Underground stations	1/10/22	1/2/23
Street stations	2/21/22	2/17/23
Passenger facility	2/20/23	4/18/23
Power generation	4/19/23	6/14/23
Power distribution	4/19/23	6/14/23
Laying tracks	4/19/23	5/17/23
Overhead wires	6/15/23	6/15/23
Safety and emergency equip...	4/19/23	5/3/23
Test trial 1	6/16/23	6/22/23
Test trial 2	6/23/23	6/29/23
Certification	6/30/23	7/6/23

Figure 4 GANTT Chart

10. Risk Assessment

Major risks and threats are identified in the SWOT analysis below. The risks are then quantified to prepare the risk matrix.

Strengths	Weakness
S1: Similar projects are done by MBTA which will provide experience S2: Experts needed for the project are available S3: Receiving funding is easy as government project S4: Long term project	W1: Incapability of following a modern framework by the team W2: High initial investment W3: Lack of co-ordination between workers to work on a task W4: Challenges in building tunnel W5: Competition time of the project is long ~ 1 year
Opportunities	**Threats**
O1: Generate job opportunities during difficult times O2: Attract people to use public transport instead of private cars or Uber O3: Experience in developing difficult construction projects Q4: Study and research on ground water levels O5: Project can be made sustainable	T1: High level of ground water which can derail project T2: Legal resistance and delays caused during acquiring land. T3: Environment protection standards are not followed T4: Other initiatives are taken and sudden change in direction T5: Natural disasters like floods, earthquakes, cyclones, etc.

Figure 5 SWOT Analysis

The risks identified in the above SWOT table are represented in the risk matrix below to measure the impact and probability which will provide us how much risk is associated with each threat.

Table 4 RPN calculation

Risk	Impact	Probability	Inability to Detect	RPN
1. Ground water appearing on surface	4	3	2	24
2. Delay in acquiring land	2	2	4	16
3. Non- compliance of environmental standards	4	3	2	24
4. Change in prioritization of the project	5	2	4	40
5. Natural disasters	5	1	10	50

The above risks are plotted in the Risk matrix according to their Impact and Probability as shown below. The Impacts and Probability are plotted from 1 to 5, 1 being the least and 5 being the greatest.

Table 5 Risk Matrix

Probability						
5						
4						
3				1, 3		
2					4	
1		2			5	
	1	2	3	4	5	6

Impact

Risk assessment and backup plan
Backup plan or risk mitigation steps are identified in the table below, for above identified risks to prevent them in advance.

Table 6 Risk Assessment

Risk	Backup Plan
1. Ground water appearing on surface	Do prior research on ground water levels in the area and find which areas are completely free of risk and start working there. Take steps to avoid ground water appearance in other areas.
2. Delay in acquiring land	Identify difficulties in advance and plan backup land for the project
3. Non- compliance of environmental standards	Follow the standards strictly and identify in advance the areas to keep a check on compliance
4. Change in prioritization of the project	Keep a track of other projects and its timeline. Make sure to follow our project timeline and keep in touch with stakeholder
5. Natural disasters	Prepare for safety of workers and impact on structures

11. Appendix

a. Mind Map

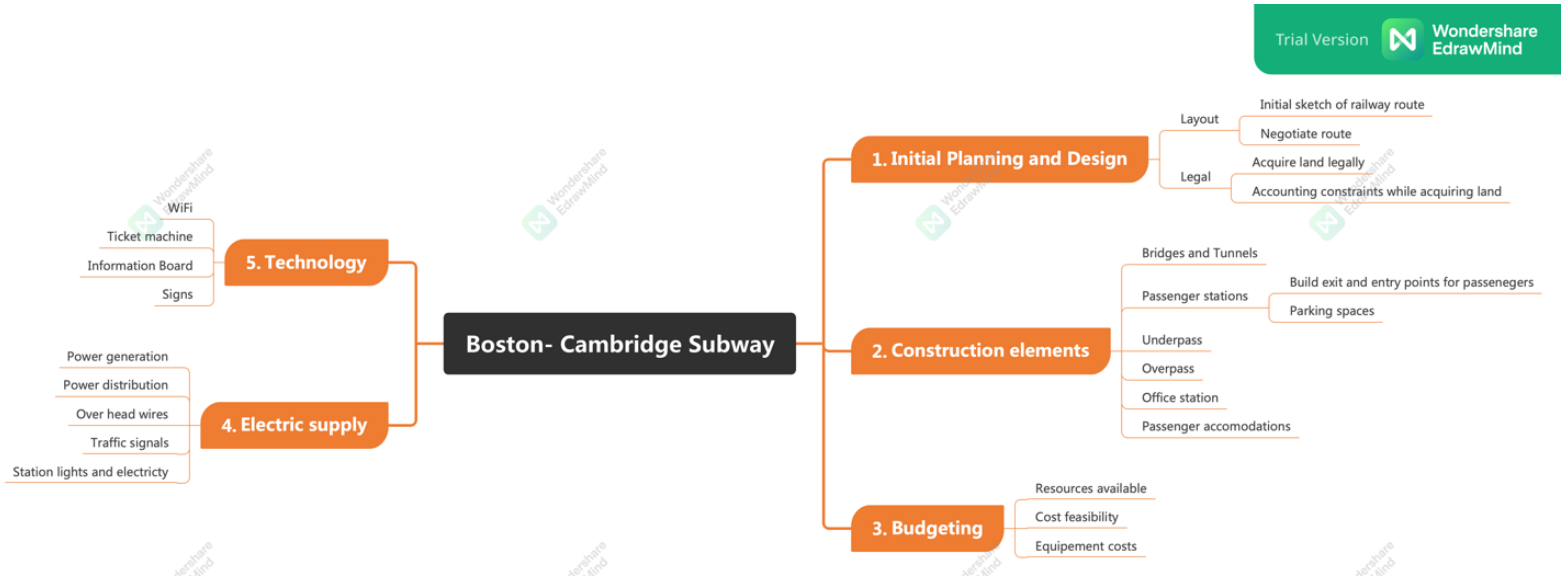


Figure 6 Mind Map

b. Activity Diagram

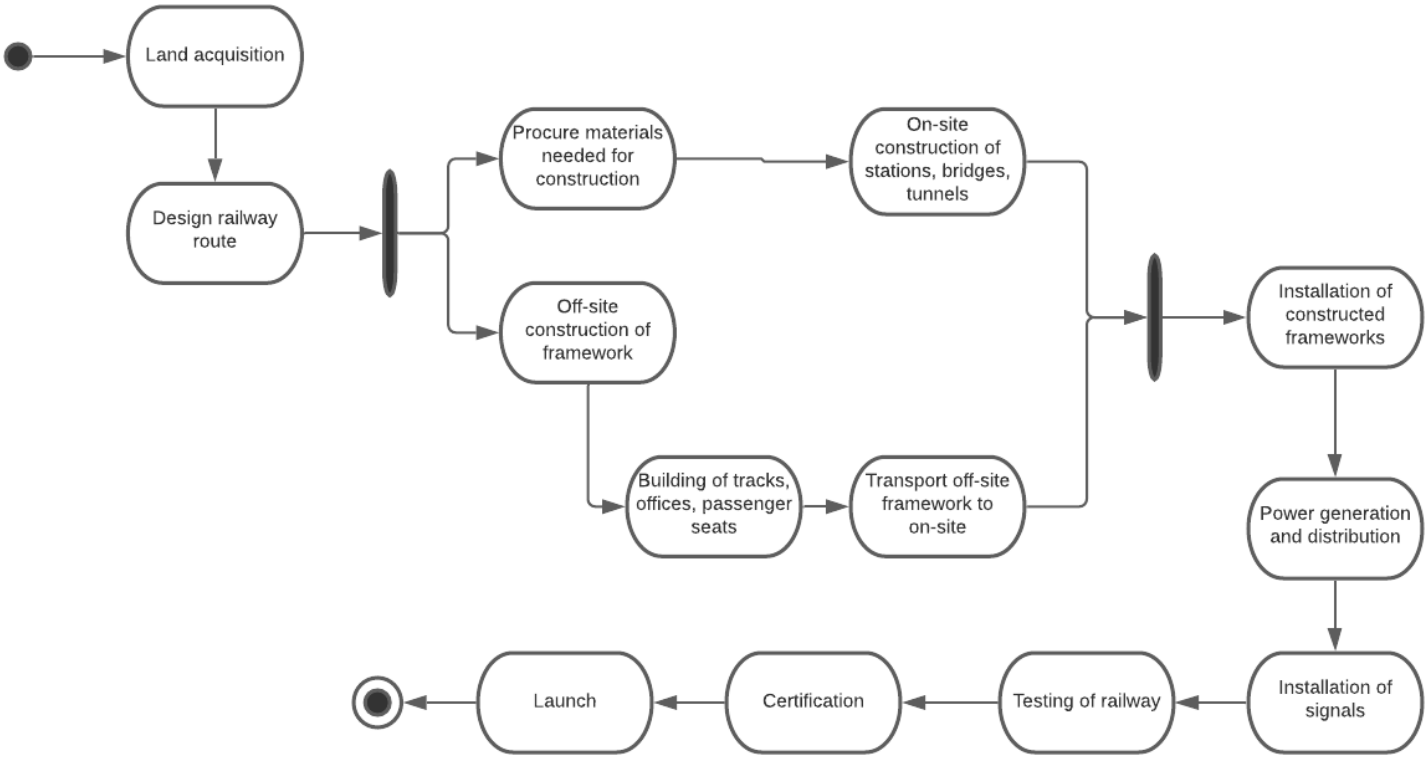


Figure 7 Activity Diagram