

Mass public transportation system Riyadh, Saudi Arabia



SELP 695 – SE Integrative Project

Presented by

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Introduction

- The Kingdom of Saudi Arabia was established in 1932
- Riyadh, the capital city
- Riyadh has population of approximately 4 million
- Capital city center of commerce, social, and governmental affairs.
- The current mass transportation system is grossly inadequate
- This project will present solutions based on system engineering techniques integrating various aspects:
 - ⑩ Evaluation
 - ⑩ Designing
 - ⑩ Concept of operation
 - ⑩ Project management
 - ⑩ Quality assurance
 - ⑩ Ethical aspects

Problem Statement and Background Information

- Current mass public transportation system elements
 - ⑩ Ministry of transportation
 - ⑩ Saudi Arabia Public Transportation Company (SAPTCO)
 - ⑩ Privately owned bus transportation network
- Current system lacks capacity and needed facilities
 - ⑩ Inadequate fleet
 - ⑩ No city metro
 - ⑩ Limited stops
 - ⑩ Lack of staff
 - ⑩ All male buses
 - ⑩ Lack of air quality standards
 - ⑩ No public outreach

Current mode of public transportation





Project Objectives

- Analyze scope of the city's mass transportation needs
- Assess the size of public transportation system based on the needs
- Perform benchmarking with other cities around the world
- Design the administrative and operational systems
- Establish public out reach
- Design the fare structure
- Evaluate how to create the financial-sustainability for the system
- Improve air quality
- Create reliable and efficient all female buses and female compartments at city metro

System Requirements

■ Functional Requirements:

1. The system shall add adequate routes to reduce average wait time to 10 minutes
2. The system shall add adequate fleet capacity to support average wait time of 10 minutes
3. The system shall add adequate number of female-designated sections within the fleet
4. The system shall cover at least 80% of the city in the first 5 years
5. The system shall have adequate number of stops to support average wait time of 10 minutes
6. The system shall be able to secure all needed capital
7. The system shall have financial sustainability over the long term
8. The system shall have central administrative unit
9. The system shall have at least 2 maintenance yards
10. The system shall have adequate public outreach capabilities
11. The system shall have environmental friendly fleet

Operational Description

- Create a method to collect data regarding existing public mass transportation system by direct observation:
 - Travel times on the routes
 - Calculate the proportion of female passengers
 - Geographical survey as to the public gathering places such as universities, offices, industries, commerce centers, governmental offices, and the recreational centers
- Create a method to benchmark the scale of public mass transportation system with the similar size cities in the region that has modern mass public transportation system such as city of Dubai
- Create capabilities to perform regular financial analysis to justify:
 - ⑩ Cost and benefit

Cont 'd

- Investment requirement
- Financial sustainability
- Fare structure
- Create methods for public outreach:
 - Newspaper ads/articles
 - Magazine ads/articles
 - Public announcements
 - TV and radio ads
 - Onboard ads
 - Use of social media network
- Create capabilities to identify and implement environmental friendly/green solutions

Operational Needs

- Utilize data gathered from direct observational surveys to measure the need of:
 - Number of fleets
 - Number of routes
 - Number of stops
 - Number of fleet designated to female passengers
- Utilize the data calculated through benchmarking to support and adjust the number of fleets and routes assessed through direct observation
- Utilize the data calculated through geographical survey of the city to support and adjust the number of fleets and routes assessed through direct observation
- Utilize the data calculated through financial analysis to design fare structure

Analysis of Alternatives

Alternative-1

- Replace existing fleet with new fleet:
 - Advantages:
 - Improved service quality
 - Improve customer satisfaction
 - Disadvantages:
 - Increased fare for customers
 - Increased investment by government
 - Will not address shortage of fleets
 - Will not address shortage of routes
 - Will not address the need for designated female buses

Cont 'd

Alternative-2

- Add only bus fleet:
 - Advantages:
 - Reduced the existing shortage
 - Improved quality of service
 - Increased costumer satisfaction
 - Disadvantages:
 - Increased fare
 - Increased investment by the government
 - Will create complexity in the operation as new fleet will work alongside the old fleet
 - May lack desired capabilities without metro

Cont 'd

Alternative-3

- Add additional fleet using systems engineering approach:
- Number of additional fleet:
 - Advantages:
 - Fast and timely service
 - Improved service quality
 - Improve customer satisfaction
 - More stops
 - Reduce traffic congestion
 - Disadvantages:
 - Increased fare for customers
 - Increased investment by government

Cont 'd (alternative-3)

- Financial analysis:
 - Advantages:
 - Robust cost benefit analysis
 - Better decision making
 - Efficient fare structure
 - Financial sustainability over the long term
 - Disadvantages:
 - Initial investment cost

Cont 'd (alternative-3)

- Designated female fleet:
 - Advantages:
 - Reduced the existing shortage
 - Improved quality of service
 - Increased customer satisfaction
 - Disadvantages:
 - Increased fare
 - Increased investment by the government

Cont 'd (alternative-3)

- Environmental friendly/green solution :

- Advantages:

- Adoption of green fleet
- Increased health benefits

- Disadvantages:

- Initial investment cost

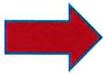
Cont'd (alternative-3)

- Public outreach:
 - Advantages:
 - Increased participation
 - Informing about the added convenience
 - Increased economic transactions
 - Improved quality of life
 - Disadvantages:
 - Initial investment cost

Measures of Effectiveness

- The table below summarize the differences between the three proposed alternatives:

	Cost	Meeting customer needs	Customer satisfaction	Environmental protection	Financial sustainability
Alternative-1	Low	Low	Low	High	Low
Alternative-2	Moderate to low	Moderate to low	Moderate to low	Moderate	Moderate
Alternative-3	high	high	High	high	high



Cont 'd

- Why Alternative-3 is the best solution:

- Planning under the system engineering approach will take a holistic view of the problem, possible solution, cost benefit analysis, and various stakeholders and their role.
- Will provide optimal solution
- Will provide modern day solution
- Adopt system architecting
- Can be expanded for future increase in demand

System Overview

- The system will have additional fleet
 - Allow to meet customer demand
- The system will have designated female fleet
 - Allow to meet customer demand based on religious and social values
- The system will have new routes based on strategic planning
 - Allow to meet various needs of residents such as social, educational, commerce, and recreation
- The system will have new environmental friendly fleet
 - ⑩ Allow to increase air quality and save precious resources
- The system will have in depth financial analysis
 - ⑩ Allow to set new fare structure for self sustainability

- The system will have centralized administration
 - ⑩ Allow better planning, implementation, monitoring, and control
- The system will have public outreach capabilities
 - ⑩ Allow to communicate with customers regarding new changes and services such as fare structure and availability of new routes and mater of public safety

Description of Stakeholders

- Ministry of transportation
 - Provides the overall administration and supervision of the system
- High Commission for the development of Arriyadh
 - Responsible for designing and construction of the project
- Passengers
 - The consumers of the service
- Employees
 - Work under the ministry of transportation and perform day-to-day operations
- Private sector
 - Business partners assisting to fulfill various program needs of system administrator such as new fleet, public outreach, advertising, and training
- Ministry of Finance

System Identification and Characterization

- The system will be composed of the following:
 - New fleet, additional employees, new bus stands, new rail tracks, new metro stations, public outreach material, new routes, street signage, designated lanes, centralized administrative offices, and maintenance & parking yards
- Main parameters and numerical data:
- **DISCLAIMER:** Most of the Numerical Data has to be obtained from survey of the citizens of Riyadh and will require extensive time-motion studies to support the System Requirements such as number of new routes, number of new fleet, and number of stops to obtain 10 minutes wait time. However, this will require massive amount of efforts and resources that are not at my disposal for the purpose of this project. Therefore, absence such resources, I have tried to research similar projects and borrowed the data for illustration purposes.

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- Bus fleet:
 - 22 new lines
 - 1,000 new buses
 - Total length of 1200 km
 - 6,765 new bus stops
 - Approximately \$2 billion project cost
 - Time horizon: approximately 3 years
 - Capacity: approximately 1 million passengers daily

Cont'd

- City Metro:
 - 190 new trains/470 carts
 - 176 km tracks
 - 85 stations
 - 42% underground tracks/47% elevated tracks/11% surface tracks
 - Approximately \$22 billion project cost
 - Time horizon: approximately 7 years
 - Capacity: approximately 2.6 million passengers daily



Cont'd

- Outside the system:
 - Private vehicles, pedestrians, traffic system, communication network, and inter-city trains & buses
- Internal processes:
 - Knowledgeable staff, software, planning, implementing, monitoring, and controlling
- Products/service:
 - Reliable and fast transportation



Cont'd

- Customer for the system:
 - Residents of the city
- Supplier for the system:
 - Government, and private sector
- The next bigger system containing this system:
 - Multi-city mass transportation system
- System satisfaction of a mission or capability need:
 - Create reliable and modern mass public transportation system and quality service focusing on customer service

The Plan/Design

- Number of fleet:
 - Survey of the city with respect to pockets of population
- New routes:
 - Survey of the city with respect to pockets of population and centers of activity
- Central control:
 - Coordination and scheduling
 - Operations and maintenance
 - Problem solving

Cont'd

- Central administration:

- Overall supervision during and after the construction
- Financial analysis (cost benefit analysis/fare structure)
- Human resource
- Public outreach
- Training

The Expected Data Result

- The expected results:
 - Adequate increase in numbers of fleet (reduction in wait time for passengers)
 - No underserved areas within the city
 - Fast and timely service
 - Frequent schedules and stops
 - Increase in revenue
 - Reduction in air pollution
 - Less traffic congestion (people switch to public mass transportation)
 - Increase in employment
 - Overall increase in commerce activities (increase of business/recreation transaction)
 - Increase in customer satisfaction

Systems Architecting Process

■ The Heuristic Approach:

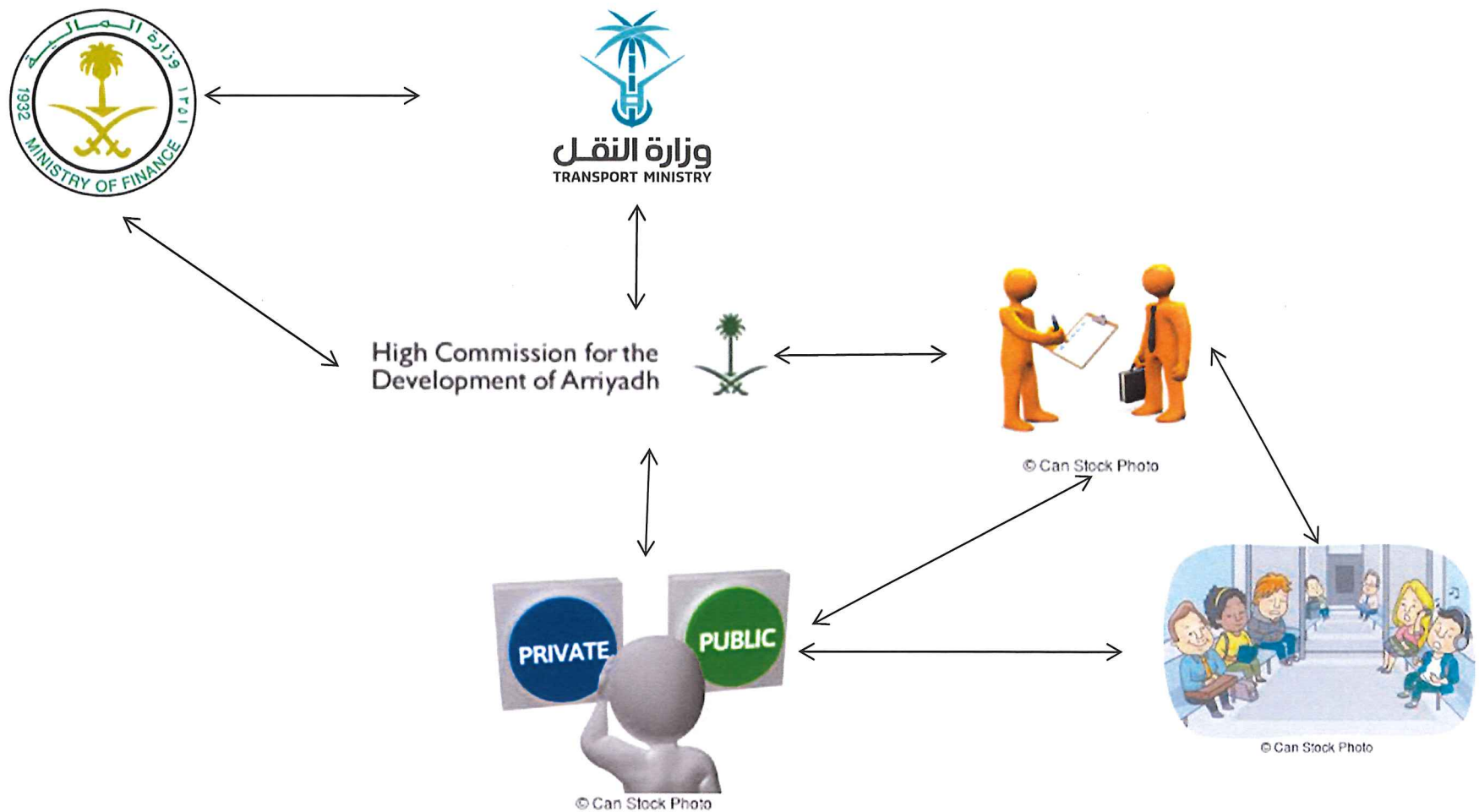
- The Heuristic approach is an architecting process that is used to find the optimum solution of a problem
- Heuristics is defined as statements of common sense that aid in problem-solving and decision-making process

■ The selected Heuristics:

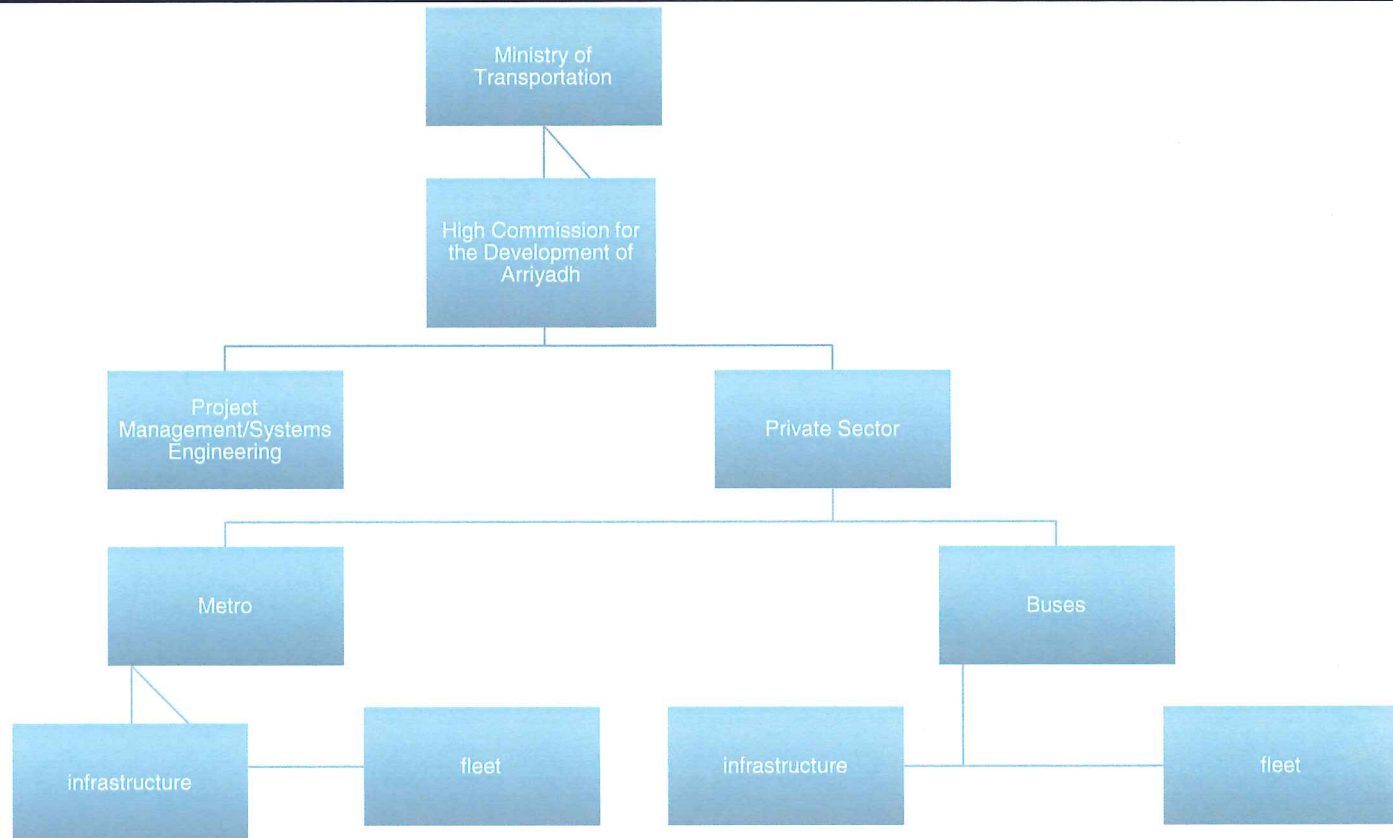
- “Systems need to be built to tolerate change and expansion beyond current stakeholder needs”
 - The system need to have built-in flexibility for the future expansion of the city and the associated need of mass public transportation
- “You cannot economically satisfy all critical stakeholder needs, so the job is to increase value-to-cost ratios in the long term, over current systems”
 - The system is capital intensive and cannot be self-sustaining from the beginning
 - The system needs to be self-sustaining over the long-term

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Operational View (OV-1)



Block Diagram



Risk Management(before mitigation)

No.	Risk	Likelihood	Impact	Action
1.	The government might not have needed capital to support the proposed system	Moderate	High	The government needs to bring in private investors by issuing special infrastructure bonds
2.	Lack of human resources and technical knowledge	High	High	The government needs to hire a general contractor of international repute
3.	System is complex and may create implementation and adaptation problems	Moderate	Low	The system should be completed in phases and with necessary training and public outreach
4.	The system may require relocation of certain residential and commercial properties	moderate	moderate	The government has to negotiate reasonable price and accommodation for relocation
5.	The system will increase existing fare structure	High	moderate	The government needs to highlight the benefit of the system and gain support through public outreach

Cont'd

likelihood	5			(5)		(2)
	4					
	3	(3)		(4)		(1)
	2					
	1					
		1	2	3	4	5
		impact				

Risk management(after mitigation)

No.	Risk	Likelihood	Impact	Action
1.	The government might not have needed capital to support the proposed system	Low	High	The government needs to bring in private investors by issuing special infrastructure bonds
2.	Lack of human resources and technical knowledge	Low	High	The government needs to hire a general contractor of international repete
3.	System is complex and may create implementation and adaptation problems	Moderate	Low	The system should be completed in phases and with necessary training and public outreach
4.	The system may require relocation of certain residential and commercial properties	Low	Low	The government has to negotiate reasonable price and accommodation for relocation and make necessary changes in the routes
5.	The system will increase existing fare structure	High	moderate	The government needs to highlight the benefit of the system and gain support through public outreach

Cont'd

likelihood	5			(5)		
	4					
	3	(3)				
	2					(2)
	1	(4)				(1)
		1	2	3	4	5
		impact				

Verification Methods

Requirements

The system shall add adequate routes to reduce average wait time to 10 minutes

The system shall add adequate fleet capacity to support average wait time of 10 minutes

The system shall add adequate number of female-designated sections within the fleet

The system shall cover at least 80% of the city in the first 5 years

The system shall have adequate number of stops to support average wait time of 10 minutes

Verifications

Analysis: by survey of the operations under the system to determine the adequacy of routes

Analysis: by survey of the operations under the project and use of computer models to verify that the wait time is achieved

Analysis: by survey of the operations under the project and the use of data to establish whether female-designated sections are adequate

Analysis: by survey of the operations under the project to determine the service area of the city

Analysis: by survey of the operations under the project to determine the adequacy of number of stops to maintain average wait time of 10 minutes

Cont'd

Requirements

The system shall be able to secure all needed capital

The system shall have financial sustainability over the long term

The system shall have central administrative unit

The system shall have at least 2 maintenance yards

The system shall have environmental friendly fleet

Verifications

Analysis: by computer base modeling to evaluate the cost of the project and the methods of raising capital

Analysis: by computer base modeling to evaluate the financial sustainability of the system based on fare structure, number of users, and capital investment by the government

Inspection: by visual examination that central administration is established and operating

Inspection: by visual examination that the 2 maintenance yards are established and operating

Inspection: by visual examination that the system has environmental friendly fleet

Ethical Issues

- Some of the ethical issues that may impact this project are:
 - **Kickbacks**
 - kickbacks play a big role in delaying projects in Saudi Arabia and it may affect this project negatively which may result in the poor quality of the material and fleet
 - **Lost of business for existing small transportation companies**
 - The project will result in eliminating local privately owned small transportation companies
 - **Affordability**
 - The increased fare may not be affordable by low-income segment of the population

Conclusion

- Current mass public transportation system in city of Riyadh, Saudi Arabia is grossly inadequate and lacks needed capacity and quality of modern mass public transportation system
- The proposed solution provides the means to efficiently address the growing needs of the city's mass public transportation system.
- The proposed solution will have built-in means to expand for future expansion.

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