21 Minutes Flying on the Ground – Qatar – Bahrain MagLev-Link

No. 104
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ABSTRACT: The State of Qatar and the Kingdom of Bahrain, located in the hydrocarbon rich Middle East Region, have moved more and more in the focus of the public eye in the last years. Qatar's Pearl, and Lusail Developments or Bahrain's Financial Harbour are only some of the large and prestigious projects in the region.

However, the fast and tremendous economical growth also poses a big challenge for the transportation systems of both countries. By connecting Qatar and Bahrain via the 40 km long `Friendship Causeway` the basic conditions are provided for completing an integrated transportation system with inter-regional high-speed traffic.

The MagLev-Technology offers manifold advantages and additional economic synergy by beneficiary infrastructure for both cities and airports.

1 INTRODUCTION

Figure 1. Location of the State of Qatar and the Kingdom of Bahrain in the Arab Gulf. (Source: www. Middle east directory.com /images/qat-map.jpg)

According to Qatar's prospering economic growth, the upgrading of the existing transportation infrastructure is one of the big challenges of the local planning authorities.
Consequently the Urban Planning and Development Authority (UPDA) appointed in early 2006 the international Traffic Mobility Logistics Consultant PTV AG to carry out the Transportation Master Plan for Qatar (TMPQ) providing a layout and implementation scheme for a sustainable and integrated transportation system.
The decision to connect the Kingdom of Bahrain with the Emirate of Qatar via the 40 km long `Friendship Causeway` for the first time offered beneficial prerequisites for complementing Qatar's transportation system with a track-bound high-speed passenger transportation system.

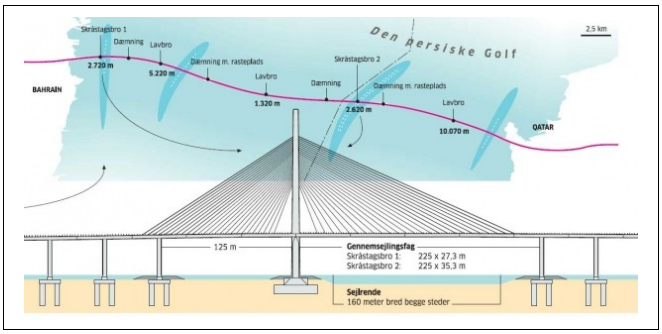

Figure 2. „Friendship Causeway" between Bahrain and Qatar. (source: www.ing.dk/artikel/88151)

Given the fact that there is currently no competing railway line and that there is a solid financial background in the oil and gas-rich region, both support a system using MagLev technology:

- Increased mobility with travel-times between 20 and 40 minutes by means of high acceleration to a maximum speed of 500km/h
- Additional economic synergy by beneficiary infrastructure for both cities and airports
- Positive contribution to the environment and climate protection by using energy saving and low-emission technology
- Increase of traffic safety
- Positive image by using most modern advanced transportation system in the world
- Creation of a tourist attraction

Considering all this, the local based Vössing Engineering Company, who have a long track-record in the MagLev-Technology, was appointed by (the former TRI) to study the technical and financial feasibility of a MagLev-link between Bahrain International Airport (BIA) and the New Doha International Airport (NDIA). The close cooperation with local authorities and state ministries as well as the TMPQ-Consultant was mandatory. This approach assured that the study results are compatible with the future long-term vision of the Qatar Transportation Masterplan.

2 ALIGNMENT

Finding the right alignment requires initially to determine the criteria and in particular the weight of those criteria within the value-benefit-analysis of possible variants.

Altogether we studied 6 variants and sub variants. The main objective was to find an alignment which combines low investment costs, short travel times and last but not least the strategically location of stops for interchange between other systems (feeder-systems) to assure best efficiency.

Final destinations in both countries should be the international airports, which function as hubs to collect and distribute inbound passengers.

In consideration of the fact that the development areas in Qatar are concentrated on the east coast a route along the coastline starting from Mesaieed in the south-east, Al Wakra, Doha, Lusail, Al Khor, Al Thakhira and finally Ras Laffan in the north-east was subject to several discussions with the TMPQ-Consultant and UPDA

At the cost of additional ridership potential this route option (variants 4, 5 and 6) was rejected in favour of the variants 1, 2 and 3 representing short links crossing the country diagonal.

Finally the preferred variant 1, which is shown in figure 5 was found to combine lowest cost with the most user potential. The cost drivers are mainly infrastructure costs for the guide way and the structures, such as tunnels and bridges.

Starting from NDIA the variant of choice describes an alignment following the Doha Bay Crossing with one stop in Doha North to collect direct passengers between Doha City and Bahrain. Passing diagonally across the flat country allows high-speed up to 500km/h till km 120. On the Bahrain side there is one stop planned in Ar Rifa completing the trip at Bahrain International Airport at km 181.

	Length (km)	Tunnel + bridges (km)	No. of stations	Travel time (min)	High speed (km/h)	System speed (km/h)
V1	181	6+49	4	40	500	273
V2	180	22+40	2(3)	30	500	360
V3	202	4+40	2(3)	30	500	404
V4	34	4+0	3	15	250	136
V5	196	23+40	7	60	500	196
V6	223	23+40	9	75	500	178

Figure 3. Parameter of variants

		V1	V2	V3	V4	V5	V6
Cost	Capital cost guideway (5)	5	5	6	*1*	6	7
	Capital cost structures (tunnel, bridges) (2)	7	9	5	*1*	9	9
	Other capital cost (2)	5	5	6	*4*	7	7
	Operation and maintenance cost (1)	5	5	7	*2*	7	8
	Total cost (10)	54	58	59	*17*	69	75
Return	Potential inhabitants (2)	7	5	5	*3*	8	8
	Potential workforce (2)	5	3	3	*3*	7	8
	Potential business (3)	8	5	5	*1*	2	3
	Potential tourism (3)	8	5	5	*1*	3	3
	Total potential (10)	74	46	46	*18*	45	50
	Return / Cost factor	1,37	0,79	0,78	*1,06*	0,65	0,67
Rank		**1**	**2**	**3**			

Figure 4. Value-Benefit-Analysis

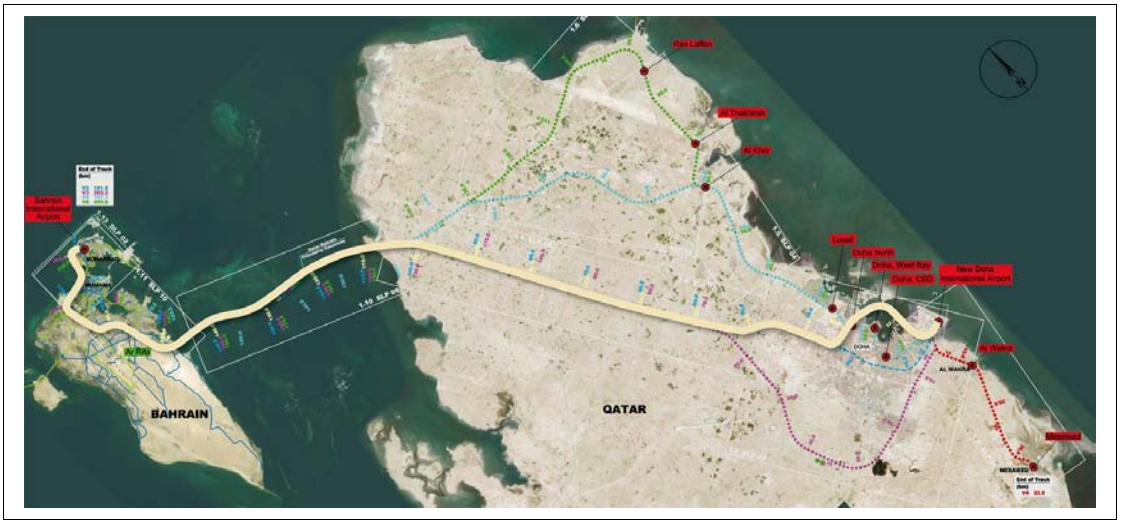

Figure 5. Preferred variant 1

3 OPERATIONAL CONCEPT

By assuming that the total demand of ride ship-prognosis is 8000 passengers per day the operational concept is based on a single track shuttle service between the two international airports of Bahrain and Doha.

The operation schedule (as shown in figure 6) is based on the ridership forecast and the trip times according to the speed profiles.

Based on the alignment and commonly used comfort limits of 1m/s² maximum speed profile was calculated that allows top speeds up to 500km/h over a distance of more than 100km.

Further increases in top speed were not recommended in this study due to the significant rise in energy consumption without corresponding advantages in overall tip times.

Figure 6 shows the speed limits and the speed profile resulting from the system layout for the three sections.

The operation schedule is determined by a simple pattern due to the existing passenger demand. Thus, operation with a 45 minutes headway between the two final destinations is planned.

Due to the remaining turn around time of more than 45 minutes, it is possible to establish an additional commuter service between NDIA and Doha North as well as between BIA and Ar Rifa with a 22,5 minutes headway seen in figure 7.

Route segment	Top speed (km/h)	Length (km)	Trip/Stop Time (min)	Average speed (km/h)	Energy consump-tion (GWh/year)
NDIA - Doha North	240	20	7	163	0.59
Doha North			2		
Doha North - Ar Rifa	500	137	21	392	2.23
Ar Rifa			2		
Ar Rifa - BIA	310	25	8	179	0.62
Total	500	182	40	268	3.36

Figure 6. Track performance

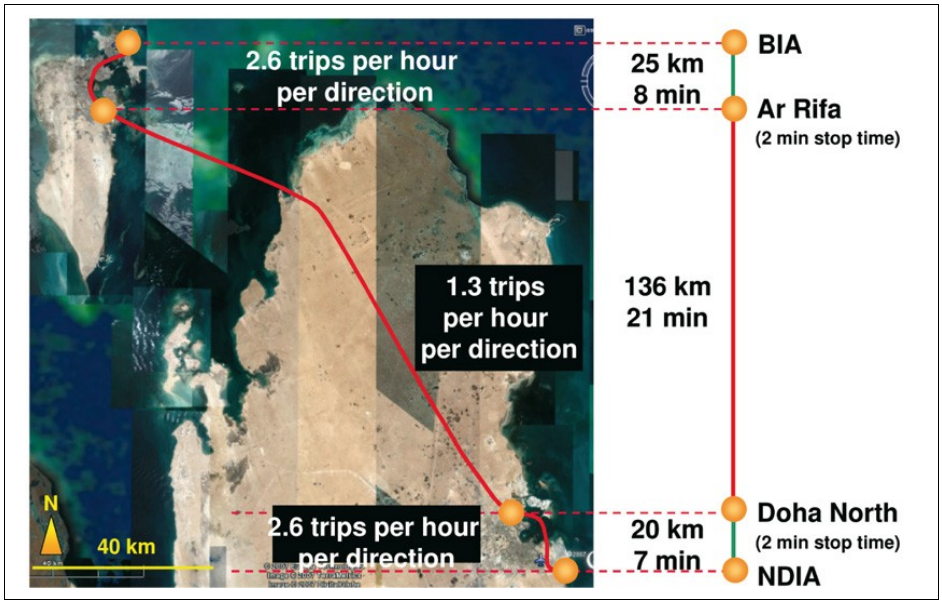

Figure 7. Operation schedule, trip, time and distance

The operation pattern for the complete link is shown in figure 8 over a 2.5 hours time period. Each coloured line represents a train and shows its movements over the route. The operational concepts require three 4-section trains in operation.

The operational concept offers interesting opportunities for a sustainable cooperation between both international airports, as not only short distance flights between NDIA and BIA become obsolete, but also long distance flights could be more efficiently balanced and linked.

Beyond the airport-to-airport connection the MagLev link also serves as a people mover, offering additional 450 seats per hour from NDIA to Doha North and equivalent on Bahrain side.

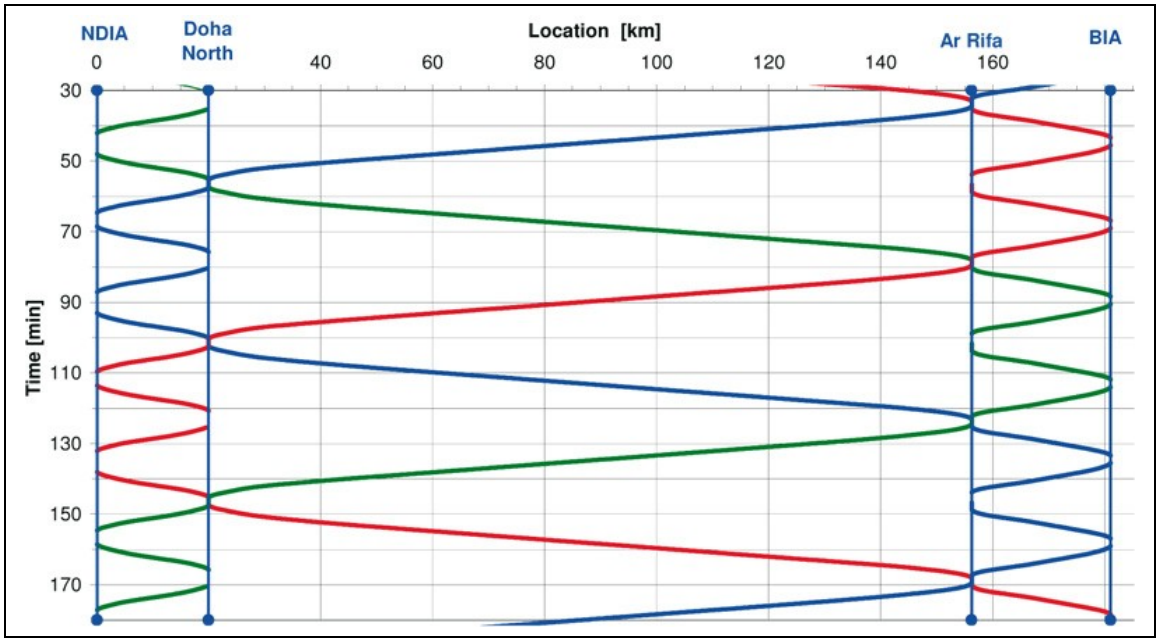

Figure 8. Operation pattern

4 ECONOMIC EVALUATION

The economic assessment was done on the macro- and microeconomic level. For the macroeconomic assessment three different scenarios were defined based on the ridership prognosis. Each scenario was compared with the base case without having a MagLev link.

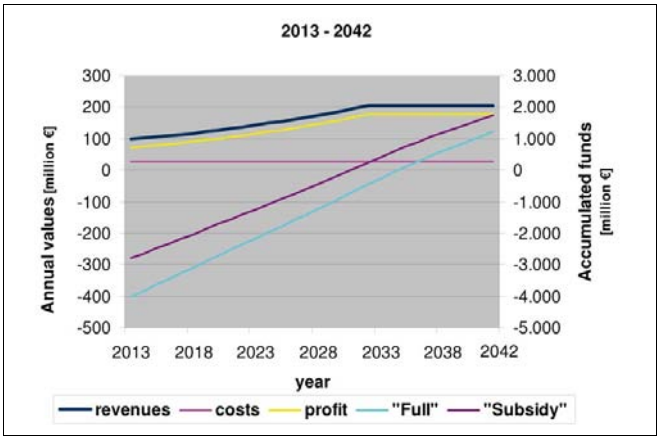

Figure 9. Return of invest

Capital costs were estimated at 3.3 Billion EUR, whereas operating costs amounts to 20.7 Million EUR/year. The cost estimations are based on the experience gained in similar projects with an allowance on local material and labour costs.

For the microeconomic assessment revenues and expenditures were computed for the main scenario and two different assumptions concerning the funding conditions of the project. The full case assumes an interest free credit scenario. The "Subsidy" case assumes an additional grant of 30% of the capital costs being provided.

According to the implementation programme it is assumed that the project will be finished within 4 years time and operation will start in year 5 (see figure 9).

Considering a rate of price increase of 3% per year the return on investment is expected after 22 years (Full case), and after 18 years (Subsidy case) of operation.

5 CONCLUSIONS

There is no doubt that the proposed MagLev connection will be a beneficial contribution to bring the two neighbouring Gulf States, Qatar and Bahrain, more closer together. Further more we are sure that the MagLev technology in comparison to conventional rail, especially in the Gulf Region, will attract travellers to prefer the high-speed train transportation, above car or airplane. Especially the unbeatable travel times of approximately 40 minutes between the two airports are convincing.

Nevertheless the local decision makers did not make any decision pro or contra the MagLev solution at the time of writing this paper. In order to understand this halting attitude of the decision makers we have to have a closer look to the region.

Currently a consortium consisting of France´s Systra, Canarail from Canada and the Lebanese consultant Khatib & Alami is doing a study on a GCC-wide railway network.

The project will facilitate and integrate transport links among all six GCC member states, improving co-operation between the GCC countries; socially, economically and also provide potential for political integration.

Since the third quarter of 2008 the German company Deutsche Bahn (DB) International GmbH was appointed by Qatari Diar Real Estate Investment Company (state owned) to carry out a conceptual design for integrating Qatar's various planned railways into a comprehensive and consolidated national railway system.

Obviously these studies are coming to the preliminary conclusion that the Maglev technology is not a sufficient solution within an integrated and standardized railway network.

This indecision may have their origin in the fact that this innovative technology is currently only operating in Shanghai and that the latest project in Munich has been cancelled. This, unfortunately, has affected confidence in the MagLev system.

Consequently it is important to clarify that this technology is not the key for solving all transportation issues in the Gulf Region (GCC), but in the right combination, the track on the Friendship Causeway between Qatar and Bahrain, could definitely be the most beneficial contribution to complete the GCC network.

Especially the niche of the passenger dominated high-speed traffic between Bahrain and Qatar, with a track length of almost 200km, is predestined for

MagLev, because any other system will increase travel times at the expense of attractiveness and acceptance of rider ship.

In a market where mainly iconic projects forming the countries image, the MagLev is the last missing piece!

1) General conditions	
Total track length:	184 km
Track A:	182 km
Track B:	1 km
Depot:	1 km
Number of stations:	4
Construction time:	4 years
2) Operation	
Operation concept:	Shuttle service
Operating speed:	500 km / h
Peak train headway: Intercity-Connection: Doha North - Ar Rifa Airport connectors: NDIA - Doha North; Ar Rifa - BIA	 45 min 22,5 minutes
Daily operation time:	18 hours ; from 05:30 to 23:30 o'clock
Peak capacity/ hour:	453 passengers
Trip time:	
Intercity-Connection: Doha North - Ar Rifa	21 minutes
Total Connection: NDIA - BIA	40 minutes
3) Propulsion & power supply	
Number of substations:	5
Number of segments:	3 main line; 1 maintenance area
Propulsion blocks:	7 high power (H2); 1 low power (L2)
4) Vehicle	
Train capacity:	340 passengers
Number of trains:	3
Number of sections:	4 per train, 12 in total
5) Guideway equipment	
Number of 2-way-switches:	3
Number of 3-way-switches:	2
6) Additional equipment	
Special vehicle:	1
Washing Facility:	1 (included in maintenance area)

Figure 10. Key Project Data