

Rebuilding the Transportation System in the City of Doha

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Abstract—This paper discusses the past and future of the transportation system in the city of Doha, Qatar. The city of Doha, the capitol of Qatar, is one of oldest cities in the gulf area and has witnessed a rapid change in its demographics over the past decades. Qatar has grown dramatically through the last 40 years from fishing and pearling based economy to a diverse economy. After the discovery of oil around three decades ago, the country witnessed a growth spurt in its economy. Doha has changed physically, economically, culturally, and demographically. The remarkable increase in Qatar's population from 750,000 in 2004 to 1,700,000 in 2010 had resulted in major changes to Doha's land use. The city has grown from a single core and expanded outwardly along main routes leaving Doha's downtown heavily congested. It was highly necessary to redevelop the transportation system in the city to accommodate the urban expansion in the heart of the city. Qatar plans to spend an estimated 100 billion USD over the next five years on infrastructure projects to expand and enhance the quality of road, water, air, and rail networks. Many projects were commissioned to improve the conditions of the transportation system and these projects were envisioned to have a holistic approach with the aim of integrating heritage, economic, sustainability, environment, and social enrichment of the country.

Index Terms—transportation system, city rebuild, urban expansion

I. INTRODUCTION

Qatar has witnessed an unprecedented growth that has affected the country's physical, economical, cultural, and demographical status through the past few decades; its economy has changed from fishing and pearling based economy to a diverse economy after the discovery of the oil in 1939. Qatar plans to spend an estimated 100 billion USD over the next five years on infrastructure projects including road, water, air, and rail networks to cater to the rising demands of the population [1]. This paper discusses the history of the development of the city of Doha. It provides some insights into the pre-oil era, post-oil era, rapid modernization phase till now, and the future transportation system in the city.

II. THE TRANSFORMATION OF DOHA, QATAR

Qatar covers an area of 11,437 square kilometers, with a coastline of 563 kilometers long. The country is a mostly low-lying, flat, and with a terrain stretching into the Arabian Gulf from the lands of Saudi Arabia. The Country's central location in geographical terms is politically supported by its position with the states of the Gulf Cooperation Council (GCC); Saudi Arabia, Kuwait, Bahrain, the United Arab Emirates, and Oman. Qatar's total population has reached 1.7 million people, compared to 1.5 million in 2008. It is forecasted to reach 2.0 million in 2015 with a constant annual growth rate of 3.97%, and about 3.2 million people, more than double, by 2030. The rapid increase in population over the last few years is attributed to the strong performance of the economy, which has resulted in a large number of projects, thereby leading to the influx of professionals, service and contracting sector staff and others [2]. The composition of the overall population of the country in 2010 was 76% males and 24% females. The total population has increased by 128% since 2004, GDP grew 210% at current prices from 2004 to 2009, and total government expenditures increased by 316% for the same period. [3]. Qatar's urban movement has gone through three significant phases; the traditional phase, the transition phase, and the modern-oil-related phase. Each phase, along with factors of a political nature and trade, has played key roles in the rise and fall of early towns of Qatar as shown in Fig. 1. The lower scale of the figure depicts the timeline of the country's vast growth in the transportation system development and it is evident that this mark coincides with the country globalization in the early 1990's [4].

Doha, the state's capital, is the largest city, the administrative and economic center of the country, and with over 80% of the nation's population residing in this city's core center and its suburbs. The capital is located on the Eastern Coast of the State of Qatar midway between the country's Northern Coast and its southern border that stretches around 190 kilometers, 98 kilometers north of Doha and 92 kilometers to the south of the city. According to Qatar Census [3], the city of

Doha is a house for 744,029 people who reside on a total area of 11,427 km². “Doha City” or “Ad-Doha” refers to the city’s circular shape that reflects the bay, which lies to the east of the city.

According to Al-Buainain [5], there are five factors that contributed to urban growth. First, factor is Doha’s geographical location at the center of the settlements, which provides easy access to people. In addition, Doha’s flat topography, lacking natural physical barriers aided the expansion. Second, Doha’s variety of transportation facilities such as motorways, airways -international airport, waterway, and seaport-was another aspect that enhanced urban growth. Third, the city’s national wide scale development plans have been highly invested and implemented such as construction of housing projects and providing good infrastructure. Fourth, Doha’s remarkable population growth promoted urban development and created new neighborhoods. Finally, the rapid economic activities that are centered in the capital city provided various employment opportunities, which attracted local citizens and international residents. The above factors contributed in changing the image of the city and the Doha’s skyline by the sea.

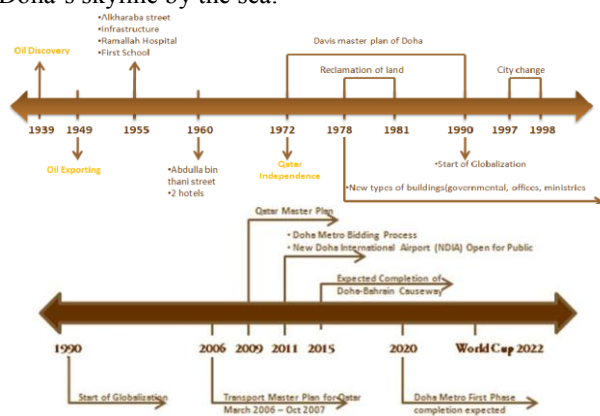


Figure 1. Qatar’s development time line since 1939 [4]

Doha’s Early Traditional Phase; Pre-Oil Era to 1950’s

Qatar’s ancient inhabitants were referred to as skilled seafarers and merchants. They were settled in the North-Western area of Qatar, Al Zubara, the oldest seaport in Qatar. In early 1800’s, Al Bida’a, the original site of Doha and other cities in Qatar, were developed at a distance from the tribal conflicts that took place at Al Zubara territory in the north of the peninsula. Moreover, it was considered as partially secure from the conflicts between Abu Dhabi Emirate and Bahrain. In addition to these reasons, Doha’s deep-sea water and its circular shape were the major attractive factors to fishermen and other inhabitants at that time [3]. During the early twentieth century, people migrated to Doha and continued their pearl-diving, fishing, and nomadic herding activities. In fact, pearling was the major source of living in addition to some other trading activities like importing commodities from Iran, India, and other adjacent countries. Limited water sources, and poor soil conditions affected the early distribution of the population in Qatar. However, as the pearling industry

developed, seaports were established which later made the city as a main trade center. Politically, Doha has emerged as the head quarter of the ruling tribes, which hosted the new governmental foundation and, therefore, became the main capital of the state. Fig. 2 shows for the city’s development since.

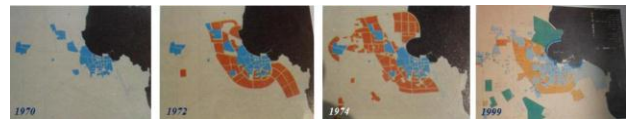


Figure 2. Llewellyn Davies master plan [6]

Doha’s Transitional Phase; Post-Oil Era (1960’s)

Oil was discovered in 1939, but its exploitation was halted between 1942 and 1947 because of World War II and the Bahrain embargo. Accordingly, the oil wealth acted as a catalyst for the urban development and the true sense of development in the country began at 1955 when the need to accommodate expatriates emerged. The period between 1949 and 1969 witnessed an increase in the population by 600 inhabitants and new administrative centers sprang up to manage the vast revenues.

Doha’s Rapid Modernization Phase; (1970’s till today)

Following the withdrawal of the British, the State of Qatar declared its independence on September 3, 1971. Doha as the capital of the new state attracted thousands of foreign experts and workers, employed in the construction and engineering industries. During early seventies Qatar witnessed an extreme increase in the construction of its infrastructure and transportation system. Between 1978 until 1981, the reclamation of land from the sea started to empty out the downtown (what do you mean by this statement? You mean the downtown expanded?). The reclamation project formed a symbolic and functional tool for the future of Doha where the Cornish Road has become a symbol for the new city. Since then, Doha has seen the most extraordinary expansion in international banking, sports and tourism activities, as evidenced by the many modern towers, malls, hotels and seats of power scattered throughout the city, and through massive housing developments like the Pearl, a commercial, residential, tourist and leisure complex. This unprecedented rapid urban growth experienced by the State of Qatar for the last few decades made effective and coordinated planning difficult which in turn resulted in several problems such as urban sprawl, traffic congestion, and improper spatial allocation and distribution of public facilities and infrastructure.

III. PLANNING OF DOHA AND THE DEVELOPMENT OF THE OLD CENTER

Planning in Qatar was essentially seen as a practical process that mainly aimed at the distribution of electricity, water and sewer systems around Doha and the smaller towns within the peninsula, based on a hierarchical road system. To accommodate the population growth and the vast change in Doha’s urban life, the government of Qatar appointed several foreign planning consultants to

plan for the future of the city. Among them was Llewellyn Davies who was hired between 1972 and 1999. Along this period, Davis planning consultant produced a new master plan for Doha and several planning progressive changes took place, as shown in Fig. 3. The government was advised to buy back the traditional residential quarters in central Doha and clear them for higher density commercial and governmental land-uses. This single-act approach was the reason behind the migration of large numbers of local Qatari residents from the heart of the city to its suburbs, resulting in the death of the old Doha center. The city center was then occupied by workers that accepted the overcrowded conditions of the city center transferring the old memorial Doha downtown into a native deserted city center.



Figure 3. (a) City of Doha development zones; (b) Elements of Doha Cornish area

Davis' master plan focused on the heart of Doha as the main goal of development. It mainly focused on preserving the Souk area as the traditional trade area, providing mixed-use residential apartments above the retail shops to accommodate the increased number of expatriates, providing the needed educational facilities for this population, while locating the governmental establishments at the northern side opposing the Cornish.

Within the New National master Plan for Qatar, a new district to the north of the heart of old Doha was conceived to be reclaimed and developed as a modern globalized area. In 1977, William Pereira, an American based architectural and planning consultancy firm, was appointed by the local government to develop the new district. Land reclamation work was done through this period, shaping the semicircular Cornish of Doha and announcing the west bay or "Dafnah" area with its national projects including, the regional park, the central business district, the Diplomatic area, Qatar University and several five-star hotels.

The new Cornish represented a great tool for functional and symbolic development, as it opened the space for new areas to grow and reflect the symbol of the new city of Doha. Within the process of transforming the Doha Cornish into an international culture and arts center for the gulf, the government of Qatar announced the project as a competition where the Agha Khan Trust for Culture (AKTC) instigated a process to gather the innovative ideas and projects. In their report, the AKTC divided Doha into three parts; Doha North, Doha South, and Doha Cornish (Center), as provided in Fig. 3. The report stated that the integration of Doha North with the central city by means of other than private car

transportation must be considered. Provision of pedestrian and bicycle routes as well as marine connections would enhance the value of the Doha Cornish.

IV. EXISTING TRANSPORTATION SYSTEM

A. Highway Network

Five main highways and five ring roads connect Doha from within and to its neighboring cities. The five main highways connecting Doha to its neighboring cities include the Dukhan highway to the west of the city, the Al-Shamal Road, connecting Doha to the north of the country, the Al- Khor Expressway, connecting Doha to the northern town of Al- Khor, and the Wakrah/Messaid Road, connecting Doha to the south of the country. Finally, the Salwa Road runs through south Doha and connects the city to the Saudi border to the south of the country. The five ring roads named A-ring road, B-ring road, C-ring road, D-ring road, and E-ring road control the traffic circulation inside the city. All five ring roads currently suffer from heavy congestion and traffic volumes during peak hours. The Public Works Authority has undertaken many developments in the last few years including the installation of traffic signals at vital points instead of roundabouts.

The Al Shamal-Road has traditionally been connected to the D Ring Road in Doha, a three-lane dual carriageway that connects the city on a north-south axis. However, as a result of congestion, the D Ring Road is being converted into a major highway through the city, and its name has been changed to the Doha Expressway, connecting Doha as a whole and connecting Doha with the north of Qatar. The road is being expanded into a four-lane highway (a total of eight lanes) with major interchanges which will better serve the country than the existing two-lane dual carriageway. Furthermore, the new Doha Expressway will connect Doha with the planned Qatar-Bahrain Friendship Bridge connecting the two Persian Gulf states as Bahrain and Saudi Arabia are currently connected. The existing Dukhan highway has been undergoing a reconstruction project for several years, with new interchanges having been constructed and the road being significantly expanded. In the future, it is planned to expand the highway so that it connects directly into Doha through a system of underpasses and overpasses. The existing Dukhan highway has been undergoing a reconstruction project for several years, with new interchanges having been constructed and the road being significantly expanded. In the future, it is planned to expand the highway so that it connects directly into Doha through a system of underpasses and overpasses, with plans to replace the Tilted Roundabout, the Markhiya Roundabout, and the TV Roundabout, all major roundabouts in Doha, with underpasses and overpasses.

B. Public Transportation

By the early seventies, the beginnings of the Qatar's modern engineering had put in place a radial ring road

pattern in Doha to accommodate the increasing numbers, character and requirements of motor vehicles [7]. As the city developed, the distances to be travelled and the numbers of people who travelled increased. However, development brought the constraints associated with time and convenience. The construction industry resolved its transportation problems by using lorries and pick-ups for moving their workers around, while smaller numbers of people were taken in taxis. Public transportation in Doha, Qatar, emerged in 2004 [8] when the company Mowasalat introduced the beginnings of the national bus system for use by the public. Originally operated on restricted routes, the system slowly expanded in an attempt to reduce the number of vehicles moving in Doha [9].

Major improvement to the bus system occurred during the preparations of the Asian Games in 2006. The public bus system became the official transportation mode for the major event. A major Central Bus station (Old Al Ghanim) was introduced. The station had 8,000 Square meters involving shaded waiting areas, water coolers and refreshment stalls. In 2007, the Mowasalat introduced the main plan for the bus service. It was initially decided that all buses routes would serve a minimum walking distance of 700 to 800 meters long from each serving location. Area's demand was taken into consideration regarding bus stops allocations. However, several planned services were neither implemented nor utilized [10].

To ensure a high quality service, bus technical maintenance is routinely done after the bus has run for at least 5000 kilometers. Mowasalat has its own driving training center to train drivers and use sophisticated software to provide live coverage of the bus movement, location, and schedule. In addition, the software can track the drivers' performance including speeding, aggressive driving. The system is also linked to the new ticketing system known as Karwa Smart Card that was introduced in the market in August 2012 [11].

C. Aviation

Doha International Airport is Qatar's only international airport. It is the hub of the local airway (Qatar Airways) and many other international airlines. Because of the rapid growth in Qatar, the airport is now considered too small and unable to properly handle all of the traffic at the airport. This problem was recently addressed with a large expansion that was made in anticipation of the 15th Asian Games event in 2006. In order to accommodate increased traffic, the airport's facilities were expanded significantly, including the construction of a separate terminal dedicated to first- and business-class passengers, and expansion of the current terminal. Furthermore, new stands have been constructed on the opposite side of the runway to handle additional air traffic. These changes have temporarily eased the problem, but because of the airport's small size and limited space for expansion, this has not been enough to permanently solve the problem of the airport crowding. The current capacity stands at 12 million passengers per year [12]. It should be noted that the 14,993 feet (4,570 m) runway is one of the longest at

a civil airport. As of 2010, the Doha International Airport was the world's 27th busiest airport in term cargo traffic.

V. FUTURE TRANSPORTATION SYSTEM

Doha Metropolitan area is currently in a continuous growth. Not only is the development of the urban fabric increasing to the west and along the road leading to the north of the peninsula, the extent of developments to the shore line is evident with new development sandwiched between the islands of Al-Safliya and Al-A'aliya. In January 2010, the government announced a crucial stage in its preparation of the Qatar National Master Plan 2032. Establishing long-term goals and objectives, the plan has created a framework in which shorter term strategies might be set and met. In brief, the plan appeared to accept the continuing balance between national and expatriate populations, itself a reflection of a variety of strategic and commercial strategies, seeking to redistribute the population both geographically and nationally, and attempted to reorganize traffic models to reduce existing congestion. According to the Ministry of Municipality and Urban Planning (MMUP), all mega projects in Doha are estimated to be completed by 2026. A sample of these projects is listed below [13].

A. Highway Projects

Some of the projects listed below are part of the country's road building program, which is designed to reduce congestion, journey times and environmental impacts, and improve the flow of traffic.

1) Sharq crossing

Sharq Crossing is one of the essential steps towards Qatar's ambitious development plans for the 2022 FIFA World Cup run-up. Formerly known as the Doha Bay Crossing, the project is scheduled to cross through Doha Bay and will include bridge intersections and a submersed tube tunnel that connects beneath the waters of Doha Bay. The Public Works Authority has recently awarded Fluor Corporation, a US based firm, a contract worth 185 million USD for the management and construction services of this mega project. The estimated cost of the project is 5 billion USD.

2) Orbital highway and truck road

Designed to be Qatar's longest road, this project stretches from the Northern industrial city of RasLaffan to Mesaieed in the South. The project will serve the purpose of transporting freight between the two ports mainly. The highway will have a total of 107 km long road with 4 lanes of dual carriageway. In addition, interchanges, fly-overs, side roads, footways, cycle ways, ramps and additional utilities such as storm water, surface water drainage and temporary diversion roads are also under construction. The project also has a provision to accommodate the future long distance rail tracks. The estimated cost of the project is 700 million USD.

3) Dukhan highway project

The Dukhan Highway project is set to reconstruct the 6.5 km highway to Dukhan from Gharaffa to provide dual three lane roads. The project, divided into three phases, has now begun with Phase 1. Phase 1 includes the

construction of the first kilometer of the Dukhan highway, Gharaffa Street and three interchanges. The estimated cost of the project is one billion USD. Phase 2 includes the design and construction of the major length of the Dukhan highway and the construction of two interchanges at Qatar Academy and BaniHajer roundabout, and Phase 3 includes the design and construction of the remaining ends of the Dukhan highway.

4) Lusail expressway project

The Lusail expressway is one crucial component of the main Expressway project, a national level mega-infrastructure project consisting of 30 highway projects. The Lusail expressway is expected to connect the new city of Lusail, currently being constructed north of Doha, to central Doha, as well as connecting the Pearl to the mainland. The expressway is expected to take the path along the former Istiqlal Road, now Lusail Street, and will be a four-lane dual carriageway passing through the city. The expressway will extend from Lusail City, through Rainbow roundabout, the Qatar Sports Club roundabout, and the fire department roundabout. The estimated cost of the project is 959 million USD.

5) Qatar-bahrain causeway

The project is one of the biggest cross-country infrastructure projects in the region. The causeway, which stretches for 40 kilometers will be the longest manmade bridge to be constructed. It was started in 2001 but has been delayed due to several reasons. At present, the causeway is scheduled to assist with the traffic flow during the FIFA World Cup, and therefore expected to be completed only by 2022. The estimated cost of the project is 3 billion USD. The Bahrain-Qatar Friendship Bridge is expected to link Qatar Western Coast near Al Zubara Castle with the Eastern Coast of the Kingdom of Bahrain at the south of Manama. It is estimated that the bridge will be 45 kilometers long. It will also be connected to King Fahd Bridge in Saudi Arabia. The construction of the project started in 2011 and is expected to be completed in 2015.

6) Doha expressway

The Doha Expressway is Qatar's first freeway that was undertaken by the Public Works Authority to provide a modern road network throughout the urban and rural parts of the city of Doha. The project is being carried out in 13 phases/packages. In order to ensure smooth traffic flow, several underpasses, flyovers and interchanges are being built. The Expressway is quite prominent as it connects the south of Doha with the north, and the east with the west through a free-flowing traffic. The project construction began in late 2007 and is expected to be completed in 2015.

7) F ring road

The F-Ring Road will be the sixth ring road in Doha, and is being constructed as part of the transportation network leading to the New Doha International Airport. The estimated cost of the project is 230 million USD. The project began in April 2011 and is expected to be completed by the third quarter of 2014. It is a full

package of development project that includes main roads (six to eight lanes), service roads, drainage and telecommunication networks as well electricity and water services.

8) G ring road

The new ring road is 19 kilometers, connecting Highway 55 to the airport and the port of Doha, and includes a project to create 3 to 4 lanes in each direction with service roads on both sides of the road and 4 intersections of multi-level addition to the development of network infrastructure and landscaping.

B. New Communities and Housing Developments with the Latest Transportation Facilities

The absence of the unique identification qualities of the city of Doha, in addition to the social and environmental problems of the globalized modern entities, were the main reasons behind the new cultural initiatives and the new projects proposed by the government planning sector in Doha. The local authorities focusing on creating a cultural unique Qatari architectural language initiated a number of regional city projects. Other mixed-use development cities were constructed along the urban growth corridor expanding northwards Doha city, such as Lusail City. Lusail, Qatar's Future City is currently described as a futuristic project, which will create a modern and ambitious society. It is planned to accommodate 200,000 residents and 170,000 employees; it will also welcome over 80,000 visitors. It is expected to cost 2.75 billion USD and will be completed in 2016[14]. The layout of the city is shown in Fig. 4.



Figure 4. Master plan of the Lusail City [14]

Transportation is a main element in the design of the new cities. Some transportation elements included in the design are listed below [14].

1) Light rail transit (LRT)

Lusail City has a comprehensive plan for establishing a network of light trains, which will connect the various districts. These trains will connect to train networks which Qatar and other Arab Gulf countries plan to build in the future. The network is composed of four main tramlines extending over 30.5 kilometers underground and over ground and 36 passenger stations.

2) Underground parking

Parking is a problem for even the most famous and modern of cities throughout the world. In view of this, the planners of Lusail City decided to create areas especially designated for cars. Parking lots will be assigned at every building for residents and visitors, and, in addition, there will be public underground car parks (7,000 places).

3) Water transport

Lusail City's 28 kilometers of waterfront development will make water taxi the preferred transportation for

many residents and visitors. It mentioned and planned for Water taxi to be one of the fastest and most enjoyable ways of getting to and around the city.

4) Bicycle routes

An extensive cycle route and pedestrian network are planned throughout the city. The paths will connect the different districts of the city to one another. Facilitating transportation even further, this network will also link to Lusail the public transportation system including the light rail station, the railway interchange as well as public car parking areas.

5) Bus stops

The level of design detail across the city will be staggering, from the litter bins to the railings to the bus stop throughout the city, each element will be treated as more an architectural masterpiece than an ordinary piece of street furniture.

Aviation

Due to the rapid growth in Qatar, the existing Doha International Airport is not capable of handling the rapidly growing passenger and cargo activities. A new airport, the New Doha International Airport (NDIA), is being constructed just to the east of the existing airport to overcome the current problems with the existing airport. When it opens, it will be the only commercial international airport serving Qatar's capital city of Doha since it will replace the old airport. NDIA will become one of the most advanced airports in the world. NDIA will be one of the first airports to take delivery of the biggest passenger plane ever built – the Airbus A380. Its terminal facilities, operational efficiency and reputation for passenger convenience will rival the world's best airports [15]. Upon completion, the airport is expected to have an annual capacity for 50 million passengers and 2 million tons of cargo, and will have parking position for 100 aircraft.[16] The new airport is located further away from the central areas of the city than the current airport, reducing noise and environmental pollution. The total cost of the new airport is approximately \$15.6 billion [17]. The layout of the airport is shown in Fig. 5.



Figure 5. Layout of the new Doha international airport [15]

C. Public Transportation

A major Qatar National Railway System and Doha Metro Network are currently being developed. The Qatar's national rail network is a project of about 350 kilometers and a budget of approximately 9.1 billion USD. The network will link Qatar's main industrial and residential hubs through high-speed passenger rail and

freight services in a travel time less than one hour by 2019 and reaching speeds up to 350 km/hr. The long network, expected to be operational in 2017, will be connected to the common Gulf Cooperation Council (GCC) rail network to provide mobility for passengers and freight with links to the neighboring countries of Bahrain and Saudi Arabia through three planned lines;

- 180-km long high-speed line to Bahrain with a top speed of 350 km/h,
- 100 km passenger transport line to Saudi Arabia, speeds of up to 200 km/h, and
- 325 km freight transport network – 270 km of which will also be used by passenger services – and link to the planned (GCC) network.

The Doha Metro network, one of the five railways systems planned across Qatar, is designed to link all major Olympic venues, villages and hotels district. It will also be linked to the New Doha International Airport and the Doha Port. Doha Metro Network is made up of 4 lines and 98 stations with a total length of approximately 300 kilometers. The lines will run through tunnels, at ground level and at overhead railway. The lines will run as follows: line (1) will run from New Doha International Airport to West Bay, line (2) will run east-west route linking New Doha International Airport and Airport City with industrial areas in the west of the city, line (3) will run from the industrial areas in the south through the center of Doha and to the Education City, and line (4) will follow the coast road and run from New Doha International Airport to West Bay, the Pearl and Lusail city with a spur linking up to the Education City. The construction of the metro is expected to start in 2012; the red line is expected to be completed in 2012, while the rest of the phrases and lines are expected to be completed in 2020 [18]. The layout of both systems is shown in Fig. 6.

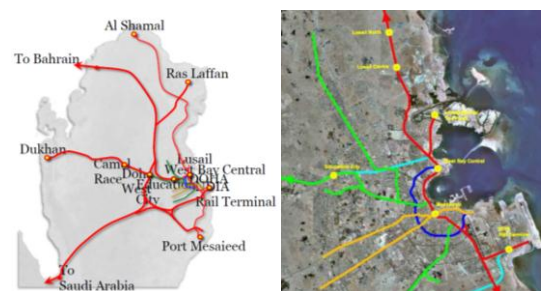


Figure 6. (a) Long distance passenger/freight railway system; (b) Doha metro network [19]

D. New Doha Port

The new Doha port project is currently the world's largest "Greenfield" port-development project. [20]. Strategically located south of Doha, the 7.4 billion USD megaproject, which includes a new port, a new base for the Qatar Emiri Naval Forces and the Qatar Economic Zone 3, will span a 26.5 square kilometer area. The project is intended to better position Qatar to benefit from the expected regional growth in container and vehicle carrier traffic as well as general cargo traffic [21]. The layout of the new Doha port is shown in Fig. 7.



Figure 7. Layout of the new Doha port [19]

The new port will include world-class cargo and container terminals, cargo handling systems and, in due course, rail facilities that will link the port to the neighboring countries. Developed as a modern, efficient and cost competitive commercial port and characterized by state-of-art technologies, high quality service and minimized vessel delays, the new port is envisioned to become a preferred destination for the international shipping and maritime industry. Once operational, the new port will offer a comprehensive range of services for both shipping lines and cargo owners and investment in the required capital equipment and technology will be made to ensure client needs are met. From infrastructure such as piers and warehouses to equipment such as cranes, careful consideration has been given to fleet expansion and to the capital equipment requirements necessary to build the new port and then to ensure the requirements for modern port operations are in place. For phase I of the port, eight ship-to-shore cranes will be delivered before the commencement of commercial operations in February 2016, and another four will be procured within 24 months of the first order. Twenty-six rubber-tired gantry cranes will also be in place by February 2016, with another 12 to follow [22].

VI. DISCUSSION

Qatar has grown dramatically through the last 40 years from fishing and pearling based economy to a diverse economy after the discovery of the oil especially in the past three decades. The capital, Doha, has changed physically, economically, culturally, and demographically. The city has grown from a single core and expanded outwardly along major routes leaving Doha's downtown heavily congested. It was very essential to redevelop the city of Doha especially the transportation system to accommodate the urban expansion in the heart of the city. Many projects had been proposed and completed with the purpose of improving the conditions of the transportation system in general. These projects were proposed to be a fresh and integrated approach where heritage, economic, sustainability, environment, and social enrichment are considered holistically. These projects aim at rebuilding

the city of Doha in a way that reinvigorates, modernizes, and revives the city.

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