DUBAI PUBLIC TRANSPORT BUS MASTER PLAN – A NEW ERA OF PUBLIC TRANSPORT SERVICES IN THE WORLD'S FASTEST DEVELOPING CITY

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INTRODUCTION

Along with the distinction of being one of the world's fastest-growing urban cities, Dubai faces a plethora of new opportunities and challenges. One result of Dubai's rapid growth is the decentralisation of its main activity centres, which currently consist of Bur Dubai and Deira. Further, the growing demand for land space, will lead to new developments outside the existing residential and commercial areas, especially in the southern parts of Dubai. As a result, the travel pattern is expected to change significantly over the next few years.

Today in Dubai, about 700 new vehicles are being registered on a daily and one out of two persons owns a vehicle. By 2020, when Dubai will have more than 5 million inhabitants, the five million car trips currently being generated daily is anticipated to increase to 20 million per day. Traffic congestion has become a part of every day life in Dubai and is a growing problem threatening the overall quality-of-life and economic prosperity of the region.

BACKGROUND AND OBJECTIVES

The Roads and Transport Authority (RTA) which coordinates, organizes and operates all form of transport in Dubai is well aware of the traffic situation and has established following guiding principles as stated in the Strategic Plan 2007-2009: 1

- Integrated land use and transportation plans.
- Optimal, integrated and balanced transportation system that meets the needs of all social sectors.
- World-class transportation service and safety levels which meets user expectations.
- High transportation awareness and education among Dubai residents.

Under these guidelines, RTA is working on upgrading and expanding the road network. To reduce and compensate for the rapid growth of private transport, RTA's aim is to ensure a world class, comprehensive public transport system that meets the needs of Dubai's travelling public.

This integrated public transport system will comprise Rail, Bus and Ferry services. Currently, much attention is being given to the prestigious, multi-billion Dirham Metro project which is targeted to begin operation in 2009. However, only 5% of Dubai's residents are living within

metro station catchment areas, and less than 10% of Dubai's work force is working within these areas. In order to maximize Metro's contribution towards solving Dubai's traffic problem, a road-based public transport service is needed to feed and, thereby complement rail service.

The cornerstone for an integrated transportation system is the Bus Master Plan (BMP) project, an integral component of the planning process for Dubai's public transport system. The BMP is being conducted under the guiding principle and vision that Dubai's public transport system will develop into a world-class transportation system by 2010. It includes the following objectives:

- Contribute to the overall urban transport system by providing safe and smooth transport for all;
- Increase the mode share of public transport services to 26% by 2010 (up from the current public transport mode share of 7%); and
- Ensure the bus and rail systems complement one another, rather than compete.
- This paper describes part of the comprehensive Dubai Public Transport Master Plan which has been elaborated by a Consultant Consortium [a] between August 2006 and May 2007[2]. It focuses on the following three components:
- Network Planning as the fundamental core of the Strategic Plan
- Organisation and Management as the base for succesfull implementation and operation
- Fare System as a major factor in attracting passengers and affecting financial conditions

The results and recommendations of the Master Plan have been submitted to the Public Transport Agency, but haven't been finally approved at the time of writing this paper.

NETWORK PLANNING

Meeting the above mentioned objectives requires significant changes and improvements to the current public transport services RTA provides. In this context, the main objective of the Bus Master Plan is to design an attractive, modern, comfortable, efficient, and well-dimensioned bus system that encourages people to use public transport. It will also have to complement the future rail- and water-bound systems and while also meeting passenger expectations. This chapter documents the activities conducted in carrying out bus network planning

Methodology

The bus network planning task was comprised of four key steps:

- Step 1: Review and compare world-class Transport system. Six international cities were selected as case studies of best practices and for a benchmark analysis of the performance of Dubai's public transit system: Berlin; Hong Kong; London; Germany's Ruhr area; Sao Paulo; and Singapore.
- Step 2: Develop the bus network planning and service-level guidelines. The international best practice case studies were used to craft Dubai-specific bus

[a] The Project has been carried out under the lead of PTV AG a by consortium of five firms comprising PTV, Hamburg-Consult GmbH, Rhein-Consult GmbH, BLIC GmbH and 'Zum goldenen Hirschen'.

network planning and service-level guidelines. These guidelines address many service and operational issues that drive ridership.

- Step 3: Determine the network planning process and strategic network approach. The strategic network planning approach was defined and detailed passenger demand analyses were carried out.
- Step 4: Review adherence to the guidelines and perform cost benefit analyses. The network concepts were developed and optimised by comparing the actual network performance against service level guidelines.

Situation Analysis

Overview of Existing Bus System

Dubai's current bus system can be regarded as a stand-alone system that has to capture the complete urban public transport demand within the entire Dubai Emirate and provide access to public transport for the population.

RTA currently operates 70 bus routes using a fleet size of around 500 buses. Of these, 5 are Nightliner services that began operations at the end of 2006, 5 are express services, mainly plying between the Central Business District (CBD) and bus stations in the south (Jebel Ali, Al Quoz) and Al Qusais, and 2 are airport routes providing a 24-hour service between the existing Dubai International Airport and the CBD at a headway of 30 minutes.

Public transport represents an extremely low share of transportation modes in Dubai, compared to that of other cities around the world. A benchmarking analysis3 shows that only about 7% of the population in Dubai uses public transport, compared to 19% in London, 25% in Berlin, and 41% in Singapore.

The results of the benchmarking analysis, together with findings from a network evaluation, 4reveal the following main service deficiencies in the existing bus system:

- high travel duration ratio of public to private transport,
- low level of service,
- insufficient capacity, and
- unrealistic design speeds.

Service Deficiencies

The following figures display a sample of benchmark results.

High Travel Duration Ratio

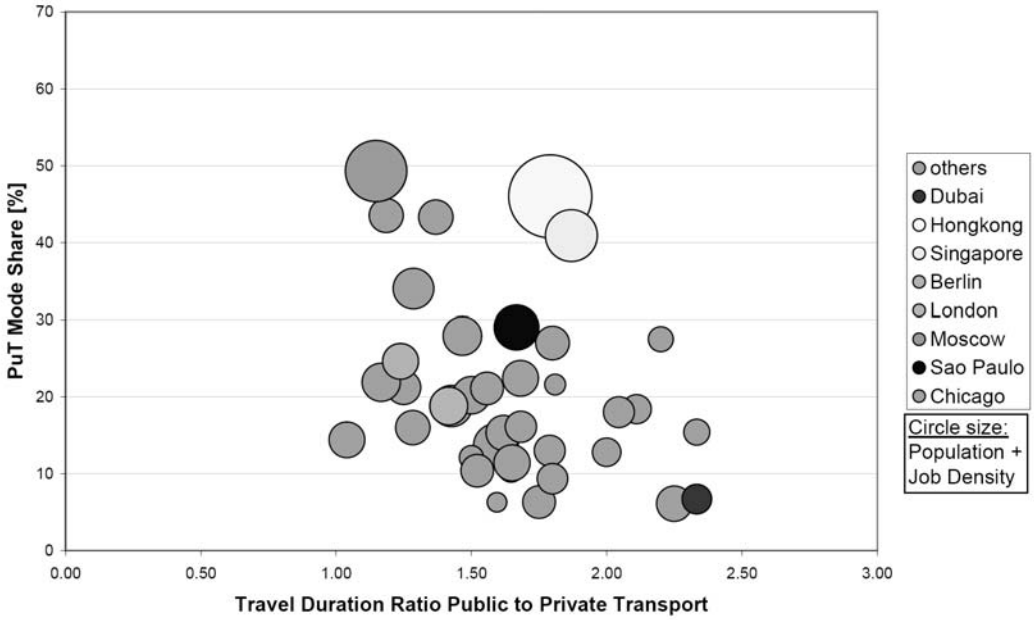


Figure 1: Travel Duration Ratio Public to Private Transport

The journey time ratio for public to private transport in Dubai is around 2.4—i.e., a journey that normally takes 1 hour by car would take 2.4 hours by bus. This is much higher than the observed values of 1.8 in Singapore and 1.3 in Berlin (Figure 4). It implies the need for more high-speed services, like express buses and metro, as well as more right-of-ways for buses that share the same road space as private vehicles.

Half of the routes in the present bus network have a journey time of more than 60 minutes. Part of this time is attributable to the fact that functional separation of bus routes regarding area coverage and long distance connections is not applied consistently, which resulted in long-distance bus routes being too slow to provide attractive journey times.

A long bus journey also presents an operational problem, whereby the downstream section of the route is susceptible to service delays. These delays (caused by congested roads in the CBD among other things) in turn, result in services arriving late, rendering them unreliable to passengers.

Low Level of Service

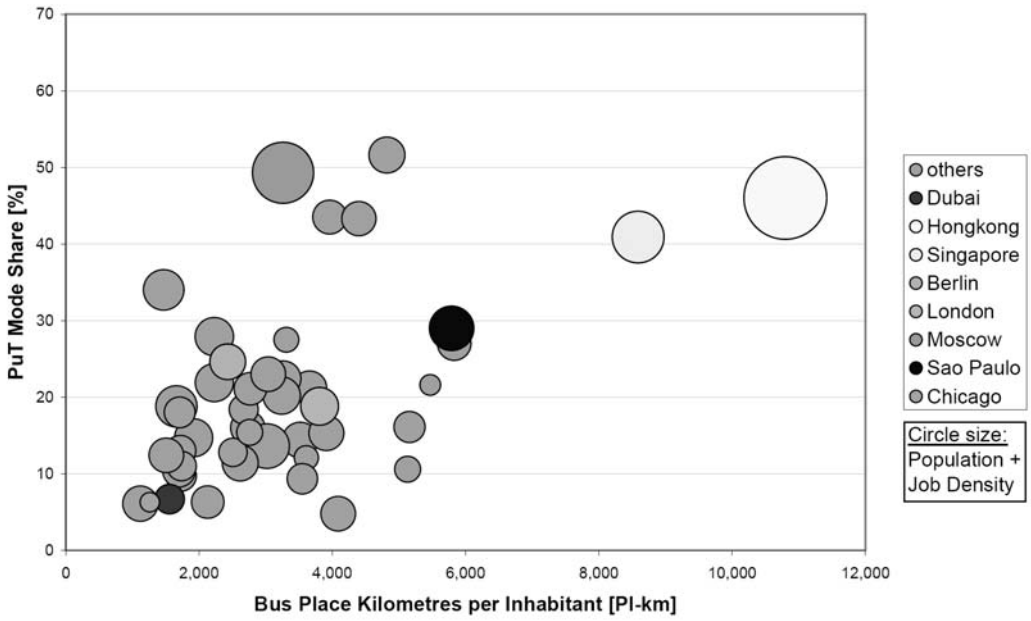


Figure 2: Bus-Place-Kilometres per Inhabitant

Bus-place-kilometre is a measure of the level of service provided by public buses. The benchmark study revealed low bus-place-kilometres offered per inhabitant in Dubai. In fact, as shown in Figure 5, the number of bus-place-kilometres for Dubai was one of the lowest worldwide, at around 1,800 per inhabitant.

An evaluation of the present network presents the following findings about bus route headway:

- A small proportion of bus routes operate at “high headways” of 10 minutes.
- About 25 routes operate at “acceptable headways” of 15 to 20 minutes.
- The majority of bus routes operate at “low headways” of 30 minutes or more.

This finding is significant because international research shows that service frequency is a primary factor influencing public transport ridership – low-frequency services have lower patronage compared to high-frequency services. As service frequency is one of the main drivers for bus patronage, it is essential that more bus routes and higher service frequencies be provided to make Dubai’s public transport more attractive.

Insufficient Capacity

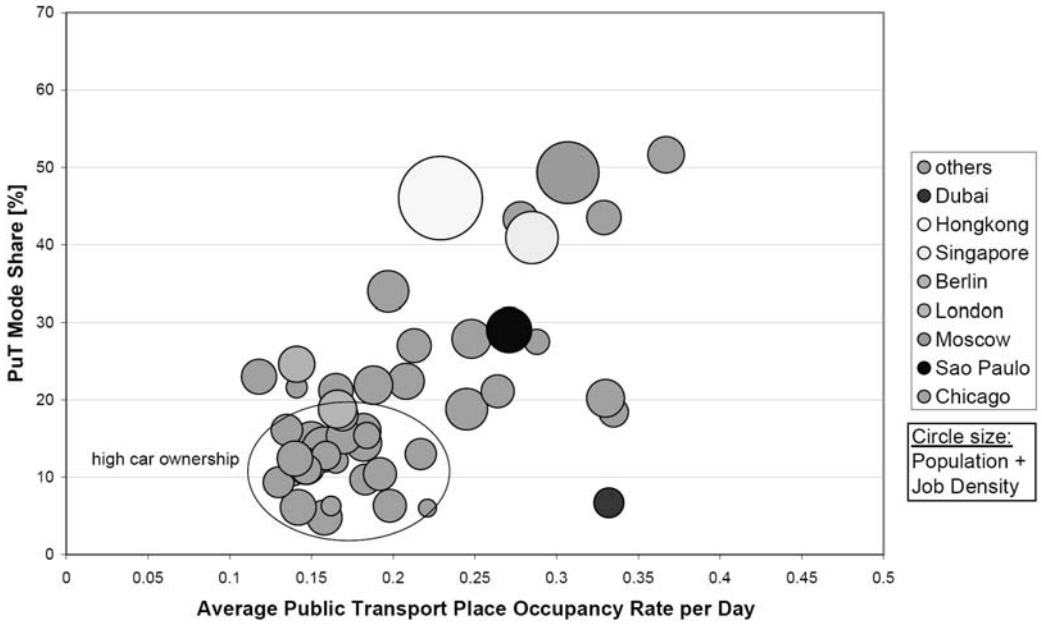


Figure 3: Place Occupancy Rate per Day

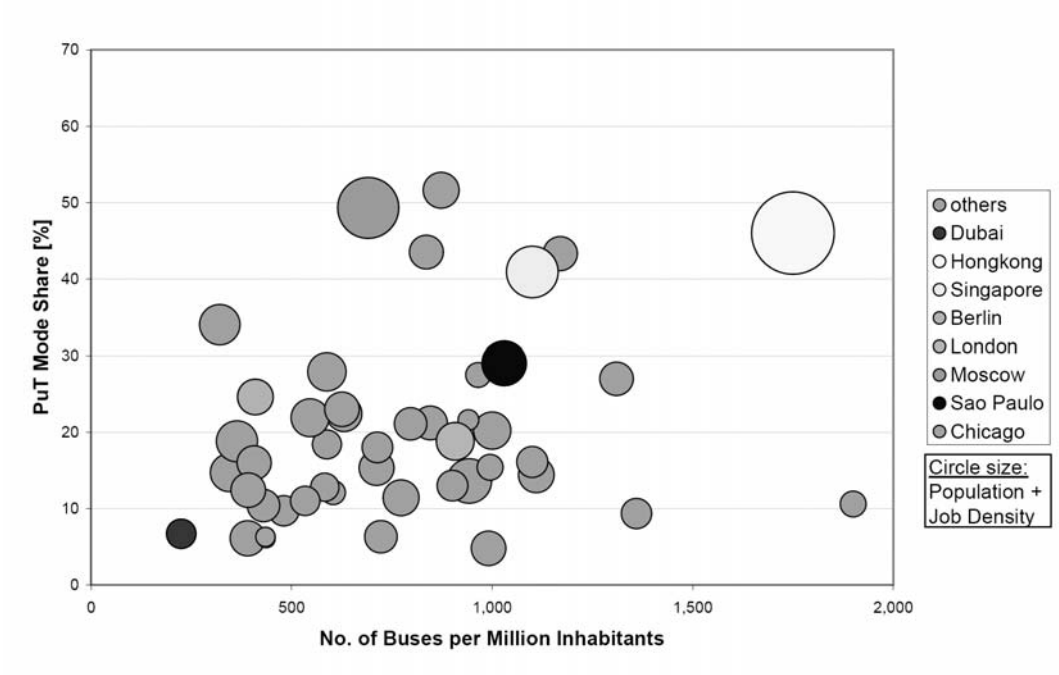


Figure 4: Number of Buses Provided per Million Inhabitants

The average public transport place occupancy rate and the number of buses provided per million inhabitants in Figures 3 and 4 show that Dubai's buses are highly utilised, but the fleet size is insufficient to cater to the demand. Being the city with the lowest bus-to-inhabitant ratio, Dubai needs to significantly increase its existing bus fleet to meet to the current demand.

Framework for Future Public Transport Network

Dubai is currently developing at a rapid pace, and its population is expected to grow significantly over the next few years. Based on official forecasts, around 2.3 million people will be living in Dubai by 2010, and about 5.2 million by 2020.

The next Figure provides an overview of the population development from year 2000 to 2020.

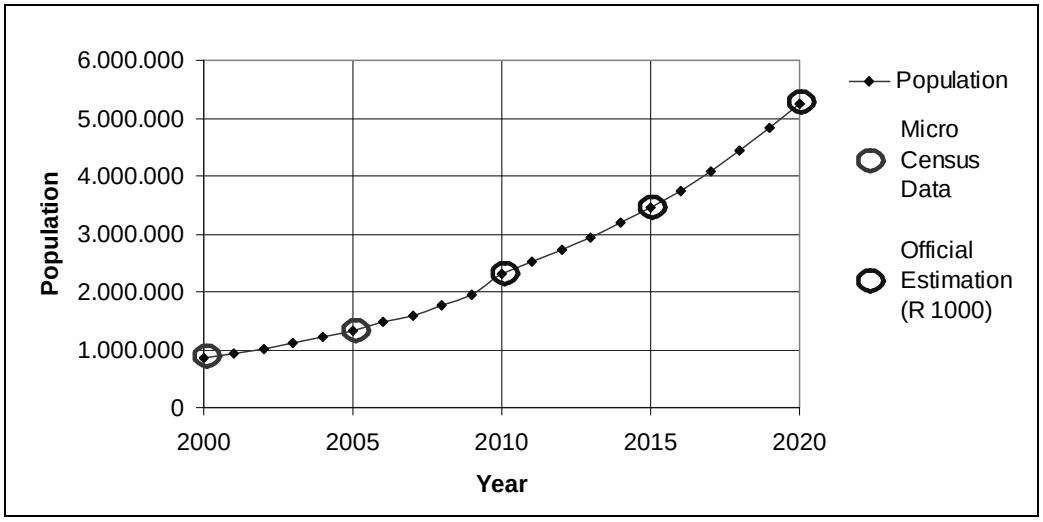


Figure 5: Dubai Population: 2000 to 2020

One result of this rapid growth is the decentralisation of the main activity centres, which currently consist of Bur Dubai and Deira. Because of the demand for more land space, new developments will take place outside the existing residential and commercial areas, especially in the southern parts of Dubai.

A comparison of the existing land use (Figure 6) and forecast for 2020 (Figure 7) reveals that Bur Dubai and Deira will no longer be the main activity centres in the future. New developments in the south, like World Central, Dubai Land, and Jebel Ali, will become areas of high population and employment densities.

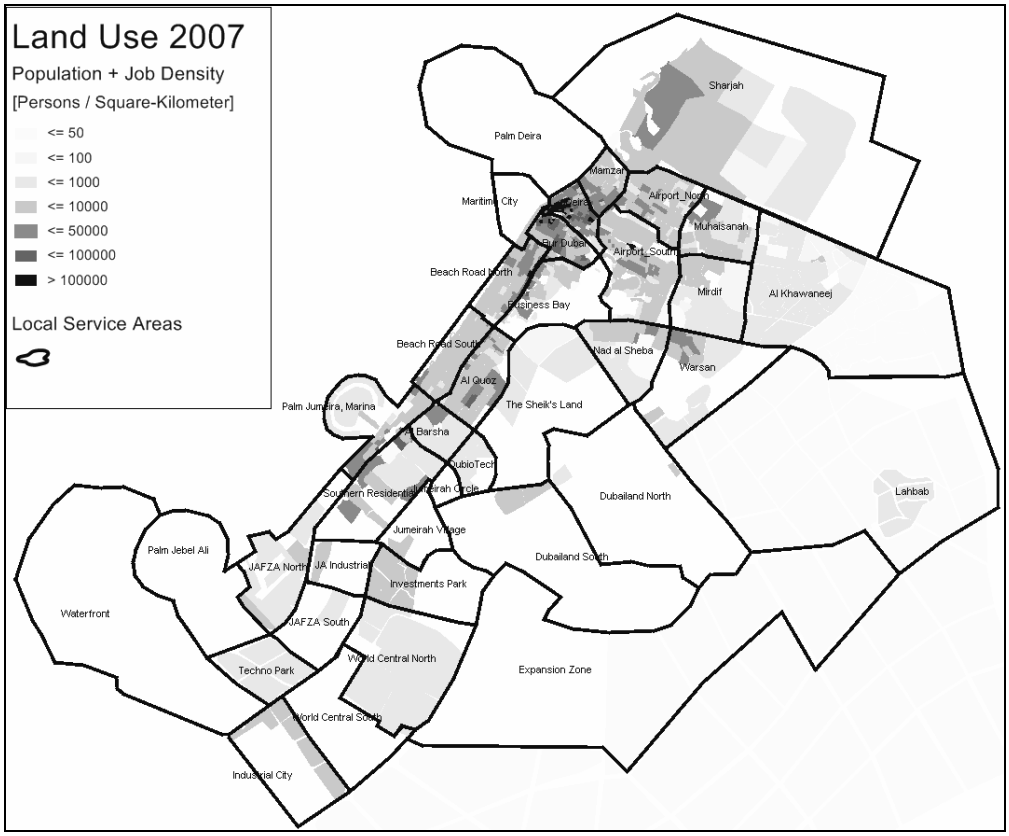


Figure 6: Population and Employment Density – 2007

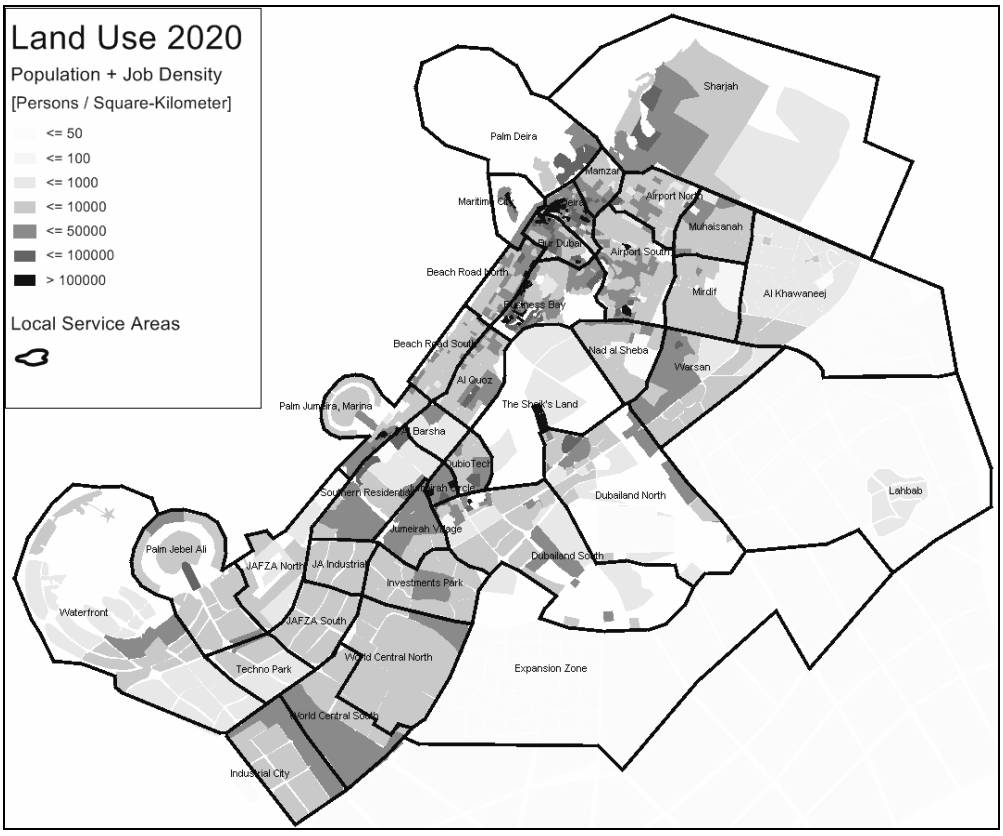


Figure 7: Population and Employment Density – 2020

Figure 8 shows the main travel trend for 2007 in the form of desire lines, where each line indicates a certain threshold of demand between two locations.

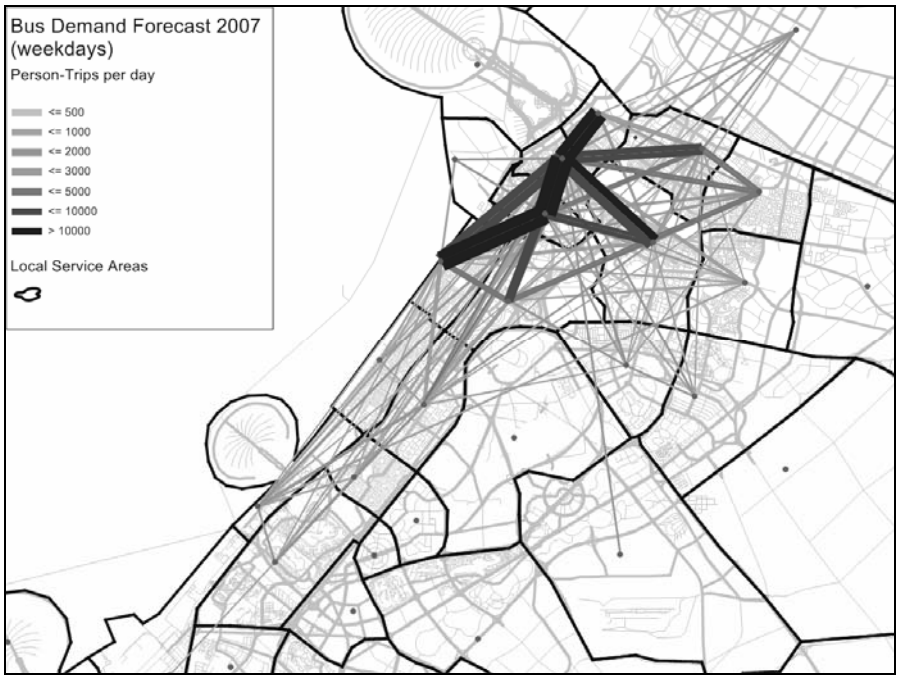


Figure 8: Public Transport Desire Lines – 2007

As seen in the figure, most of the existing travel demand involves the CBD area of Bur Dubai and Deira, with the neighbouring suburbs like Mamzar, Jumeirah, Al Quoz, and the airport.

By 2020, this travel trend will extend to a wider region, and high travel demand will also be expected between Dubai Land, Warsan, and Business Bay (Figure 9).

Figure 9: Public Transport Desire Lines – 2020

As a result of this development, the travel pattern for the next few years is expected to change significantly.

- The existing daily public transport ridership of around 250,000 trips is expected to increase to almost 1.4 million trips by 2009, 2.3 million by 2015 and 4 million by 2020.
- From the expected mobility patterns and forecasted demand volumes for the future years, the R1000 Integrated Transportation Plan5 contains a wide range of measures to improve the public transport system – including the construction of a mass transit rail-based system to serve as the backbone of Dubai's public transport network – to meet future travel needs.

The railway-based system for the year 2020 comprises of four metro routes and four tram routes, as shown in the Figure 10.

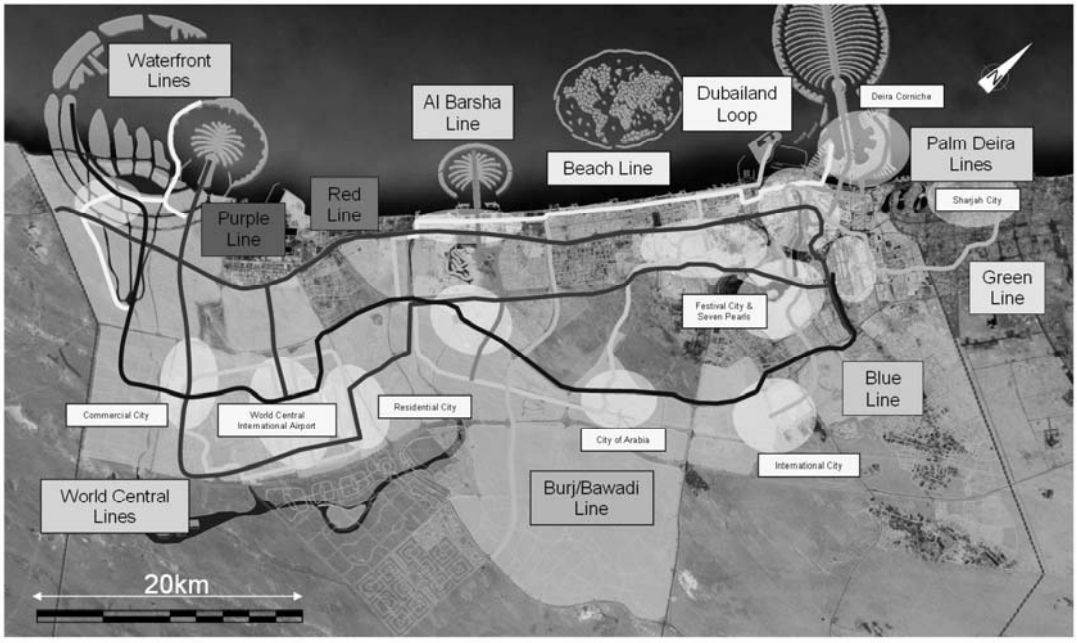


Figure 10: Vision for the Railway-Based Network (R1000)

With the advent of the first metro line in 2009, the rail network will develop into an extensive transportation system by itself with the Red, Purple, and Blue metro lines covering the north and south of Dubai Emirate, and the Green line and tram lines running between east and west.

Metro lines will serve the highest-demand corridors of Dubai Emirate and offer up to 1.5-minute headways in the peak hour in 2020 to cope with the forecasted passenger demand.

Besides the anticipated rail-based routes, water ferry routes have also been planned for as shown in Figure11.

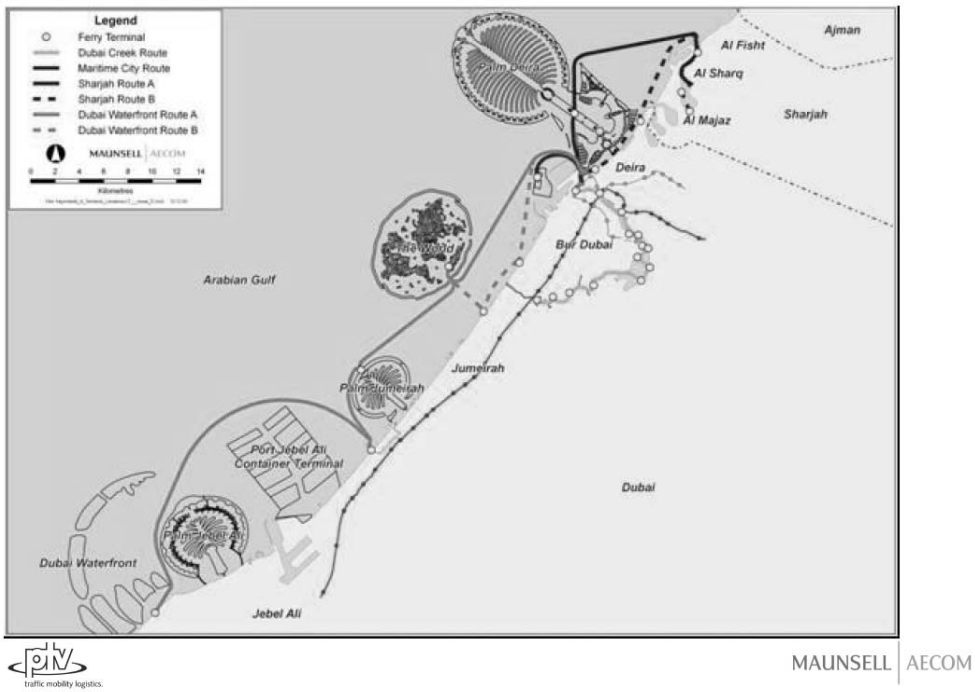


Figure 11: Vision for the Water Ferry Network (Water Ferry Dubai) [6]

The future metro and ferry networks in the R1000 study will form part of the input for the bus network planning work.

As highlighted earlier, various service deficiencies have been identified in the current bus network. Coupled with the fact that the existing network serves as a stand-alone system, revamping the way the bus network functions is necessary at this stage so that it will be ready for integration with the metro and ferry systems when they come on board in the near future.

Planning Guidelines

A set of planning guidelines have been established to be used by transport planners to design services that contribute towards the higher-level government policy objective. These guidelines enunciate, amongst other things, the types of services, service frequencies, hours of operation, passenger-loading standards. They also specify the types of situations these levels of service supply are applied, e.g. when increasing or decreasing patronage is observed.

Because service level guidelines have proven to be a practical and successful approach in many cities, this same approach is proposed for Dubai.

The following service-level planning guidelines are set up to address the main drivers of public transport usage:

- Passenger Wait Time (how long passengers have to wait for service) — directly influenced by service frequency.
- Passenger In-Vehicle Travel Time (how long passengers have to travel in a bus) — directly influenced by travel speed and route directness.
- Access/Egress Time (how long it takes a passenger to walk to/from a bus stop) — directly influenced by route density and bus stop spacing.

- Travel Comfort (how crowded bus services are and how long and often passengers have to stand) — directly influenced by service capacity, as a function of service frequency and vehicle capacity.
- Productivity (how to allocate resources to where they are most needed) — directly influenced by service capacity and passenger demand.

Strategic Network

Hub-and-Spoke Principle

From the observed land use information in the R1000 study, Dubai will have developed into a polycentric city by 2020. High travel demand is also forecasted for the following:

- between local (residential) areas and neighbouring city centres;
- between different city centres; and
- between different local areas.

To cater to this travel demand in an efficient and effective manner, the hub-and-spoke network is proposed. The main features of such a system include:

- local services connecting to local passenger interchanges, typically operated by feeder buses; and
- trunk services connecting main passenger interchanges, operated by bus or rail.

An illustration of the hub-and-spoke principle is shown in Figure 12.

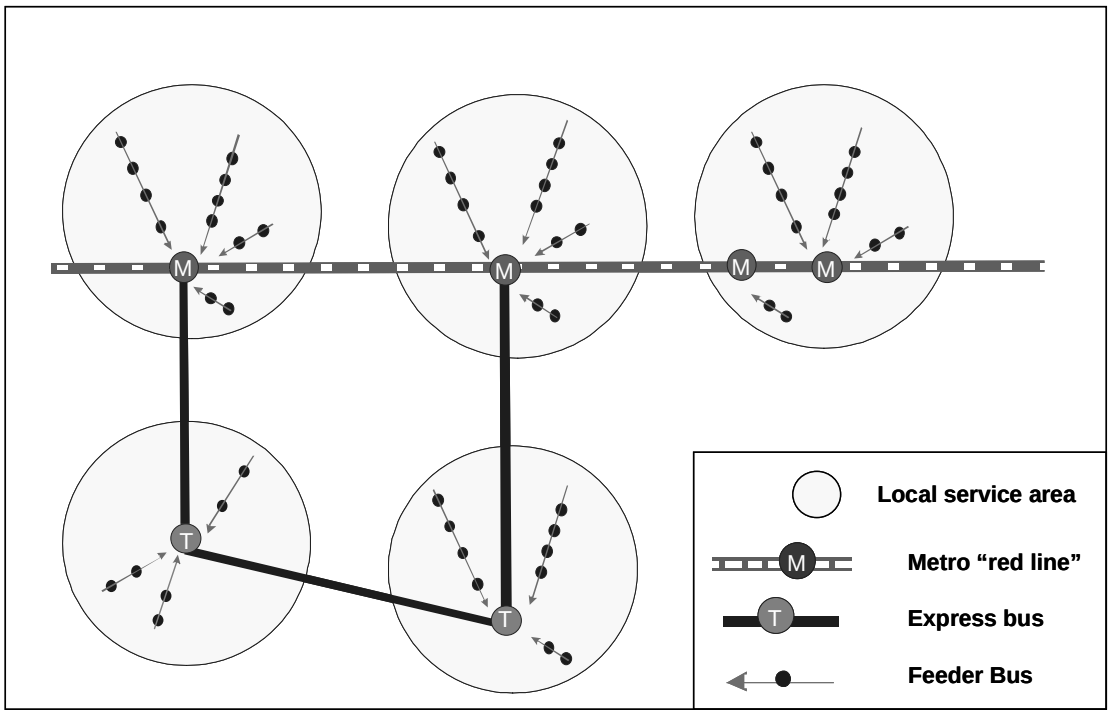


Figure 12: Hub-and-Spoke Principle

The benefits of such a system include:

- Passengers could travel throughout the network by transferring between services at designated transfer stations. Connecting services at these stations need to be coordinated so as to avoid long transfer delays.
- High passenger origin-destination travel speeds could be achieved, because the major section of a long journey would be made on fast trunk services.
- Hub-and-spoke systems provide high passenger origin-destination travel frequencies because of the efficient use of bus fleet.
- Passengers could travel through their own local service area with a maximum of one transfer from origin to destination.
- The hub-and-spoke system would allow the required service levels stipulated in the service level guidelines to be achieved more efficiently, e.g. service frequency, public transport travel times, travel speeds and service productivity.

Bus Network Hierarchy

To complement the proposed hub-and-spoke network principle, the bus network hierarchy will comprise of:

- a high-level system of direct express bus services; and
- a bus feeder system, connecting local service areas with the higher-level bus and metro systems.
- The main characteristics of these bus product types are as follows:
- Express bus:
- non-stop and fast connections between transfer stations;
- serve high-demand axis with high frequencies;
- complement the metro by reaching out to areas that are not served by rail; and
- operate with high-capacity vehicles.
- Feeder bus:
- operate in local service areas;
- serve as collector and distributor for the express bus and metro networks;
- ensure high accessibility to public transport with high route densities serving all bus stops; and
- operate typically with regular buses and in densely populated areas which require higher capacities, articulated buses.

Definition of Local Service Areas

The establishment of a hub-and-spoke system requires the definition of local service areas.

Local service areas have been demarcated by applying the following criteria:

- Area homogeneity, e.g. residential area versus industrial area;
- Natural and administrative borders or barriers, e.g. water, major roads; and
- A minimum area size (25 km2) with a minimum number of travel demand (origin trips) to justify a separate internal network.

Within the network model, local service areas have been generated by merging smaller traffic zones. As a result, 37 local service areas have been defined within Dubai Emirate as shown in Figure 13.

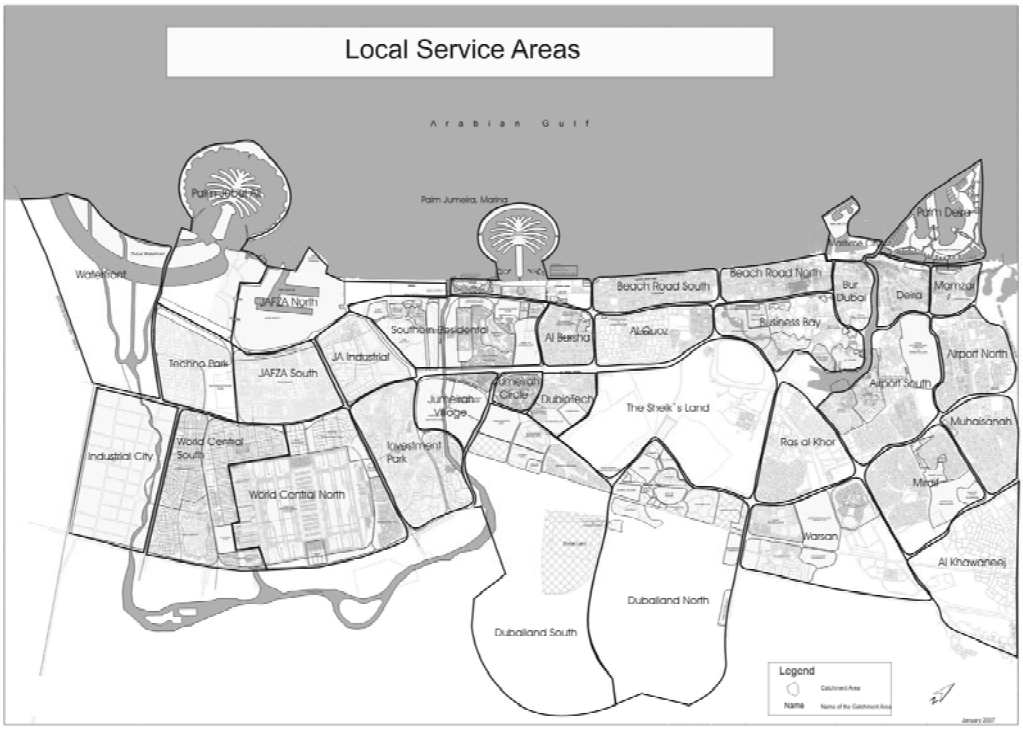


Figure 13: Local Service Areas

Following the hub-and-spoke principle, feeder buses will serve within these local service areas and connect them to a bus or metro transfer station nearby, to extend their reach to all communities of Dubai.

Definition of Transfer Stations

The general criteria pertaining to the locations of bus transfer stations are:

- bus transfer stations should be located strategically to facilitate the hub-and-spoke system;
- every local service area should be within reach of either a bus or metro transfer station, to which local feeder services would be aligned;
- transfer stations should be located as close to the main activity centre within the local service area as possible, where feeder routes will be aligned;
- locations earmarked as metro stations are preferred to ensure that the general structure of the public transport network can be applied up to 2020; and
- transfer stations should be linked to the higher-level road network easily.

According to these criteria, 27 bus-bus transfer stations have been determined. Existing bus transfer stations and new transfer stations approved by RTA were checked whether they fit into the overall hub-and-spoke network. Metro stations that will be in also serve as transfer stations.

Special Requirements within the Central Business District

Because of the high travel demand and congestions within the CBD, a separate bus system with a higher level of service which plies solely within this area is required.

A series of transfer stations around the CBD fringe will facilitate transfers between bus services coming from outside the CBD and the internal CBD bus system. The conceptual design (with the metro red line) is shown in Figure 14.

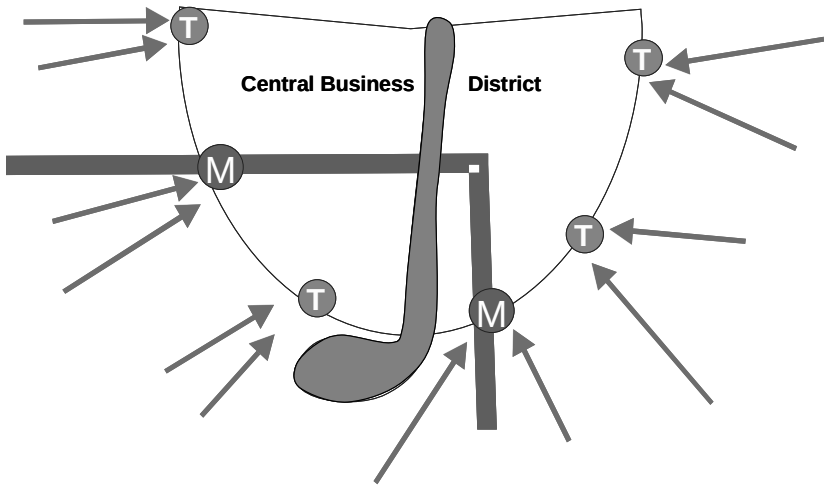


Figure 14: Conceptual CBD Network – External

Express bus routes coming from outside the CBD will be led to transfer stations located along the CBD fringe, where passengers can transfer to the metro or the CBD bus network. Feeder buses serving the areas around the CBD will also be led to these transfer stations on the fringe to allow passengers to transfer to the CBD bus or metro directly. Within the CBD, a network of CBD buses will connect all fringe transfer stations, and at the same time, ensure the required route density within the CBD

The recommended conceptual structure regarding the CBD network provides several advantages, in particular:

- The separation between an outer bus network and an inner CBD bus network follows the hub-and-spoke principle – the CBD bus network serves as a collector and distributor within the CBD and leads passengers to transfer stations where they can switch to the faster express bus network. This separation leads to an effective bundling of demand and facilitates capacity planning within the CBD as well as for the routes coming from outside the CBD.
- The separation between the express bus and CBD bus networks has important operational advantages, as service delays occurring within the CBD will not be extended to the widespread area covered by express buses.
- Transferring at stations on the fringe is easy and convenient for passengers, since CBD bus services and the metro will provide low headways (i.e., 5 minutes or lower during peak hours).

Strategic Bus Network 2007 – 2020

The service level guidelines reflect RTA's public transport objectives. Within a defined network planning process, these guidelines have been used:

- to derive the required strategic bus network, and
- for detailed bus network planning, to ensure that RTA's public transport objectives can be achieved best.

Based on the bus service level guidelines and the R1000 Transportation Master Plan, a bus network philosophy and rationale have been developed, which form the framework for detailed bus network planning up to 2020.

Main changes to the public transport network will come with the introduction of the metro Red Line in 2009. Therefore, restructuring of the bus network must be completed by then to ensure a full integration between the bus and metro systems. The bus network will also accommodate the future development of the rail- and water-based transportation systems according to the developments planned for in the R1000 Transportation Master Plan.

Following the network designed for 2009, short-term network planning (2007 to 2008) and long-term network planning (2015 and 2020) are carried out accordingly.

Bus Network 2009

Design Process:

The network design process is characterised by developing and testing options. Network testing was mainly carried out focusing on route alignments for 2009. Different options were considered regarding different network characteristics, in particular:

- design and dimension of express bus routes; and
- design of feeder bus connections to transfer stations.

The following conclusions were drawn from the various tests conducted:

Extensive express bus routes that run in parallel to the metro are counterproductive in 2009, since this would result in direct competition between the two systems. Passenger loadings and hence, productivity, on the Red Line and relevant express buses would decrease significantly. Instead, route alignments for express buses should complement the metro alignment and feed passengers to the metro especially for long-distance trips.

In general, the guidelines on travel time ratio and number of transfers can be better achieved if more express bus routes offer direct connections between local service areas. In order to balance the public transport offer regarding service-level requirements and productivity, options testing varying the design, dimension and extent of express bus routes were carried out. The preferred option comprises of 10 express bus routes on major demand corridors, operating with high frequencies and connecting all transfer stations and this has proven to be the most effective express bus option. The introduction of additional express routes led to a decline of productivity without significant benefits in the travel time ratio.

Extending express bus routes into the CBD showed that the average number of transfers per passenger would decrease slightly (by 2%). However, operating costs increased substantially without significant savings in passenger travel times. The original network design to truncate all express bus routes outside the CBD was thus adopted, since this leads to effective bundling of demand and facilitates capacity planning within the CBD, as well as for the routes operating outside the CBD.

More benefits were observed when additional connections to surrounding transfer stations are provided, rather than having all feeder buses within a local service area be led to one main transfer station only. With the extension of feeder routes to more transfer stations, additional express bus routes operating further away from the local service areas can be connected directly and concomitantly, reduce the number of network-wide transfers. Another advantage is connections between neighbouring local service areas can be made.

The preferred network option for 2009 has taken into consideration all these findings and the recommended services of this option are outlined in the next section.

Recommended Services:

The basic bus services comprise the definition of bus routes for the following bus network elements:

- express bus network,
- feeder bus network, and
- city bus network.

Figure15 gives an overview of all recommended services for 2009.

Figure 15: Transport Systems 2009 Overview

Express Bus Network:

The proposed express bus system in 2009 consists of 10 express bus routes carrying nearly 60,000 passengers, solely in the a.m. peak. Figure 25 shows the designed express bus route alignments.

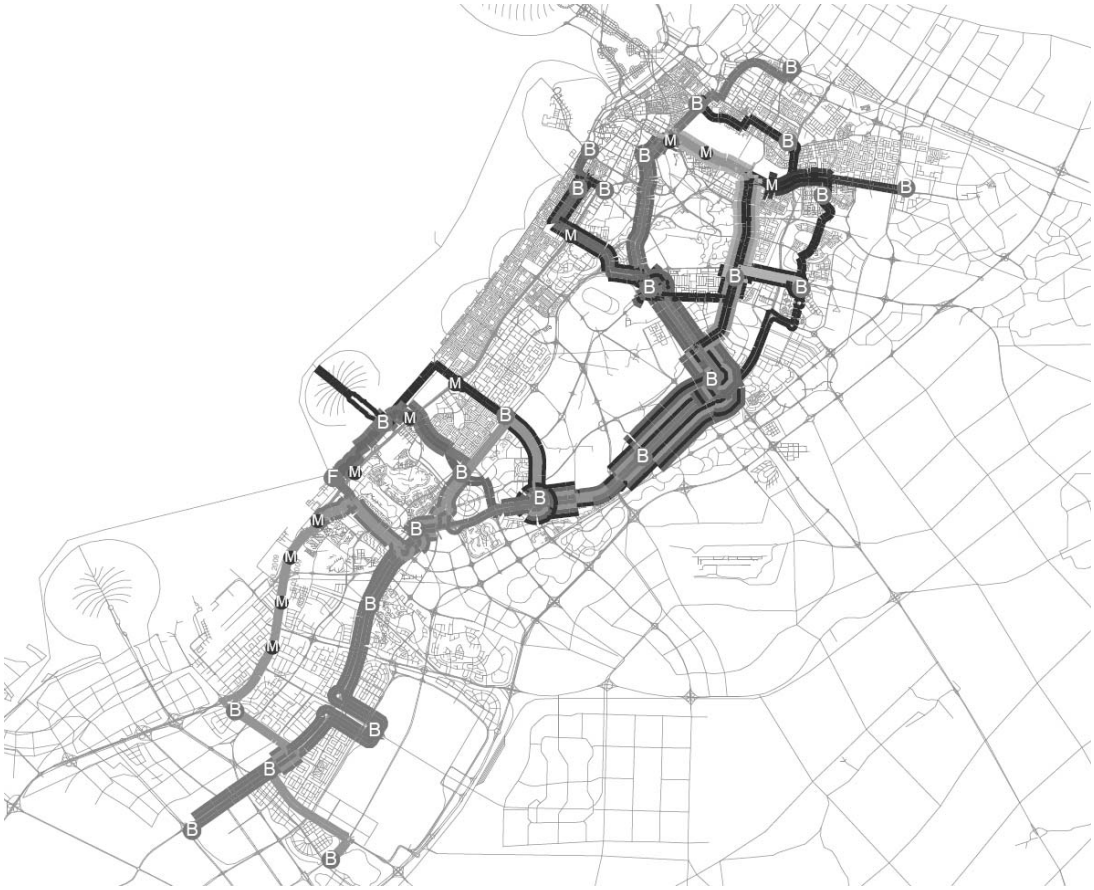


Figure 16: Express Bus Routes, 2009

In 2009, the metro Red Line will form the backbone of the public transport system. The express bus system will complement the Red Line and takes into account locations of the transfer stations and the forecasted demand.

Express bus routes will connect all transfer stations and cater to the highest demand adequately. This network ensures that all major demand flows (> 600 passengers per direction in the a.m. peak) will be covered by direct express bus routes.

Feeder Bus Network:

Feeder bus routes have been determined for all local service areas, except the "Future Dubai" areas and Deira and Bur Dubai, where the CBD bus network would be provided.

Altogether, 103 feeder bus routes have been created for 21 local service areas, transporting 100,000 passengers solely in the a.m. peak.

The feeder bus route network is shown in Figure 17.

Figure 17: Feeder Bus Network, 2009

The proposed feeder bus network will have the following characteristics:

- ensures required route density / area coverage;
- ensures required service levels such as minimum service frequencies and avoids crowding;
- connects each local service area with the higher-level express bus system and/or the metro system as well as with local city centres; and
- ensures that all main demand flows between local service areas are covered. For long-distance travel, connections are offered by metro or express bus routes. Direct local feeder buses are offered between local service areas in cases of exceptionally high demand flows.

In addition, recommendations of demand-responsive services are made when passenger flows are low. It is proposed to introduce demand-responsive services at night (between 11 pm to 5 am).

City Bus Network:

The city bus network has been designed as a separate network that operates with a high level of service within Dubai's CBD.

A total of 11 city bus routes connect all bus transfer stations located on the CBD fringe. This strategic approach has predetermined the alignments of CBD routes to a wide extent. The proposed CBD bus network is shown in Figure18.

Figure 18: City Bus Network, 2009

The proposed bus network has adopted the hub-and-spoke principle and adhered to the planning guidelines, with a full integration between the bus and metro systems. It is recommended to implement all bus network elements discussed here by 2009 the metro Red Line begins operations.

Short-Term Bus Network Planning

The preferred network option for 2009 provides the basis for the short-term (2007/08) and long-term (2015/20) planning tasks.

Bus Network 2007/2008

The recommended changes for the planning year 2007 can be regarded as first steps towards a comprehensive, attractive public transport supply in Dubai's future. Limited by constraints resulting from the existing fare system and the available bus fleet in 2007, the proposed measures for the 2007 bus network focus on meeting the most urgent deficiencies and the introduction of two pilot measures

Bus network planning for 2008 assumes that by the end of 2008:

- A new fare system will be implemented, which would allow the truncation of routes. Passengers would have to pay for their entire o-d trip, rather than paying an additional fare for each transfer.
- All transfer stations on the CBD fringe are in place.
- A total of about 1,000 buses (operational fleet) would be available.

Still, a full restructuring of the bus network cannot be achieved by the end of 2008 because the Metro Red Line will not be in place, bus transfer stations, required for the hub-and-spoke system would not be built before the end of 2009.

Given these constraints, analyses focused on which parts of the anticipated bus network for 2009 can be implemented in 2008. They include:

- Full implementation of the CBD bus network, comprising 11 bus routes operating as a separate high service level system within the CBD according to the network structure for 2009.
- Truncate the current bus routes that run into the CBD today, at the bus transfer stations on the CBD fringe.

Introduce pilot internal feeder bus networks in service areas, according to the suggestions for 2009:

- Introduce 2 express bus routes to bring bundled passenger demand out of the four local service areas previously identified.

Long-term Bus Network Planning

Long-term bus network planning is based on the following assumptions:

- The hub and spoke system approach has been defined in order to fulfil the needs of a polycentric city and is applied in 2009 as well as in 2015 and 2020.

Therefore, the rationale of the bus network and the locations of transfer stations remain the same up to 2020. Some of the bus transfer stations will evolve into metro stations.

- The CBD bus network, which is recommended for implementation in 2008, connects all fringe transfer stations and assures full area coverage in the CBD. Since all anticipated metro stations within the CBD are integrated into the bus network, there is no need to alter CBD bus route alignments.
- The designed feeder bus system assures full area coverage within the considered local service areas in 2009. Analysis has shown that this holds also true for 2020, so there is no need for route alterations within the designed feeder bus network.

Bus Network 2015 and 2020

In 2015, CBD and feeder bus route alignments will remain the same as for 2009. However changes will be made to express bus route alignments due to the introduction and operation of Metro lines. Headways will be adapted according to passenger demand in 2015 and 2020. Local service areas will be adapted due to land use and developments.

Main Network Indicators

This chapter compares international benchmarks with the results of the designed and suggested 2009 and 2020 network.2

The travel duration ratio between public and private transport in Figure 19 shows a considerable improvement from a ratio of 2.33 in 2001 to 1.54 in 2009, which is competitive with many systems in the world and very near the guideline of 1.5. By 2020, this ratio does further improve to 1.35 because of the introduction of new metro and tram services.

[2] Statistics mentioned in this chapter are based on Database Mobility in Cities, International Association of Public Transport UITP, 2005.

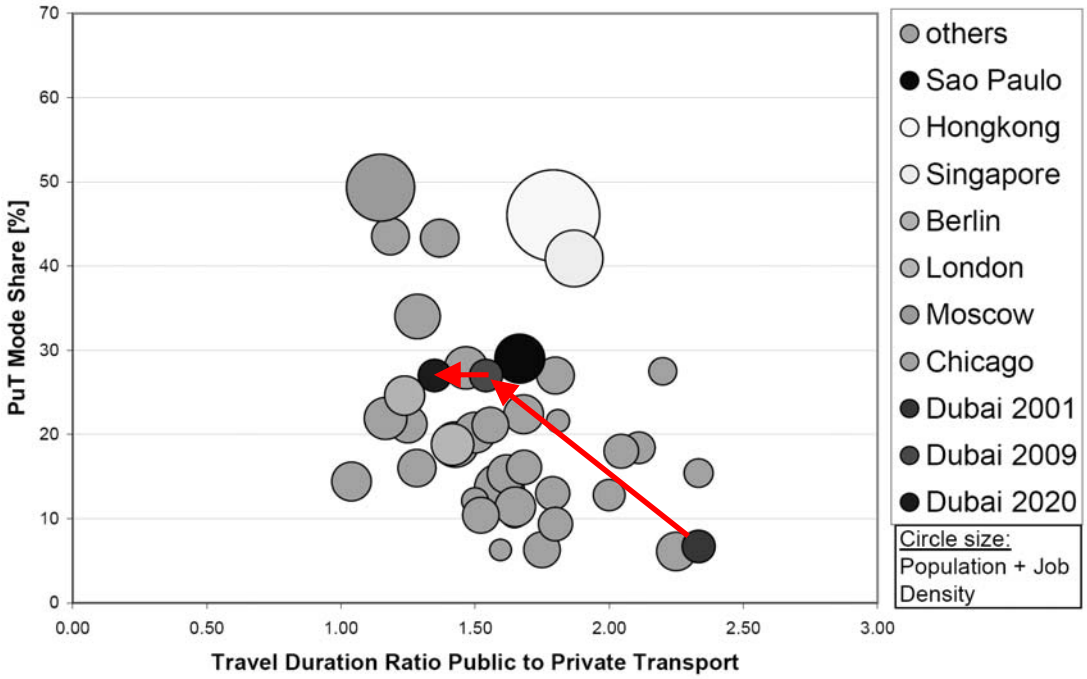


Figure 19: Benchmark: Travel Duration Ratio Public to Private Transport

The average place-occupancy rate drops from 0.33 in 2001 to 0.26 in 2009 (Figure 20). With the much higher number of public transport vehicles in 2009, the average occupancy rate will be lower than today. In 2020 the place-occupancy rate will reach 0.29 due to the significantly higher demand on the feeder bus network. With a much denser land use in the covered areas, the number of unlinked trips on the feeder bus network will more than double between 2009 and 2020. The efficiency on these routes will be significantly higher than in 2009.

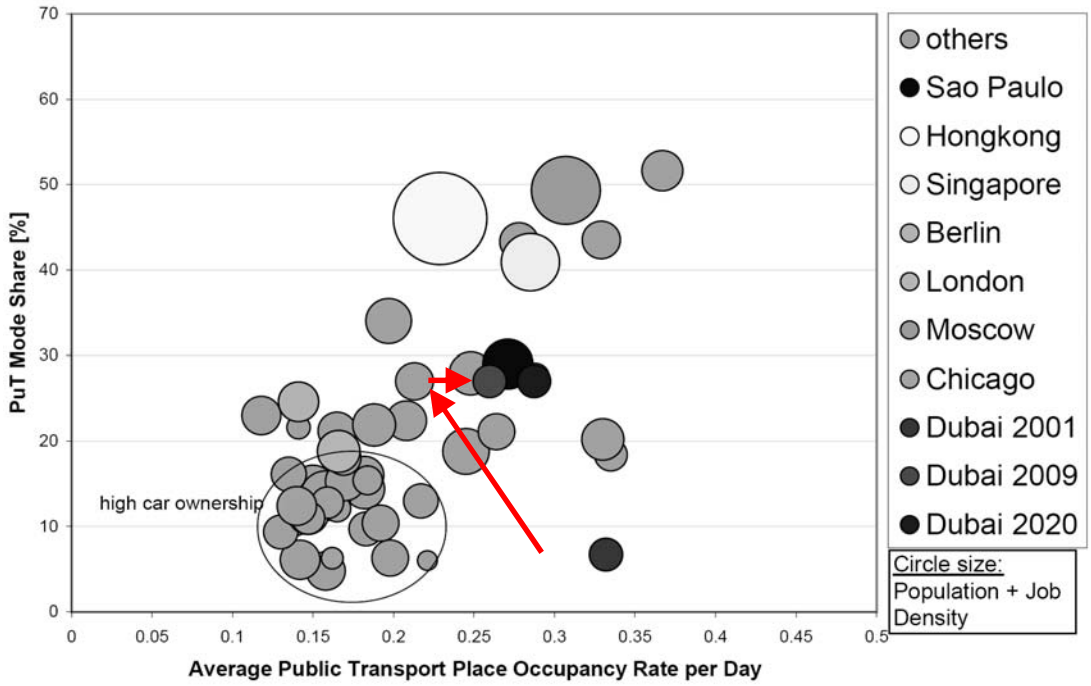


Figure 20: Benchmark: Average Public Transport Place Occupancy Rate

The number of buses will grow to about 1,300 per million inhabitants in 2009 (including a fleet estimation for "Future Dubai"), which is higher than the average of the other cities (Figure 21). But like in Hong Kong today, buses will be still the most common mode of public transport in Dubai by 2009. With the opening of new metro and tram services in 2020, the number of buses per inhabitant will drop to a level that is comparable to major cities around the world.

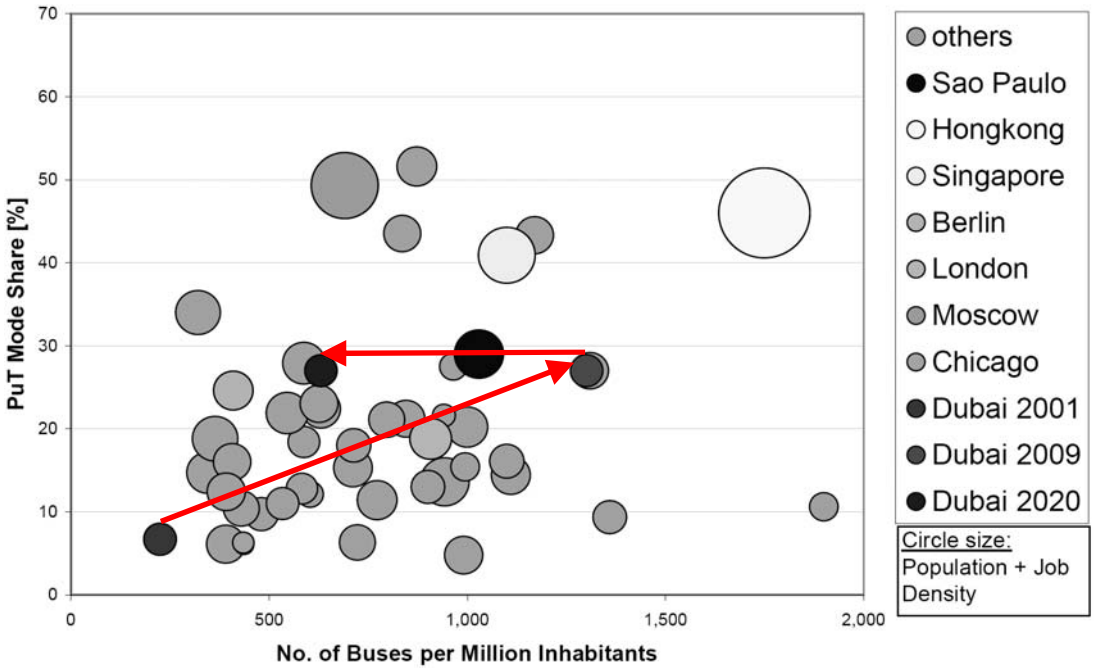


Figure 21: Benchmark: Number of Buses

The operating costs per passenger kilometre are highly competitive with those of the other cities analysed: they are slightly higher than Singapore and slightly lower than Hong Kong, but significantly lower than Berlin or London (Figure22). Compared to 2001, the operating costs in 2009 will rise from 0.17 AED/passenger-km (UITP statistics) to 0.27 AED/passenger-km. Due to a better place-occupancy rate in 2020, the operating costs will drop to 0.22 AED/passenger km. Thus, beginning in 2009, the bus network will be competitive with the public transport systems of many major cities around the world.

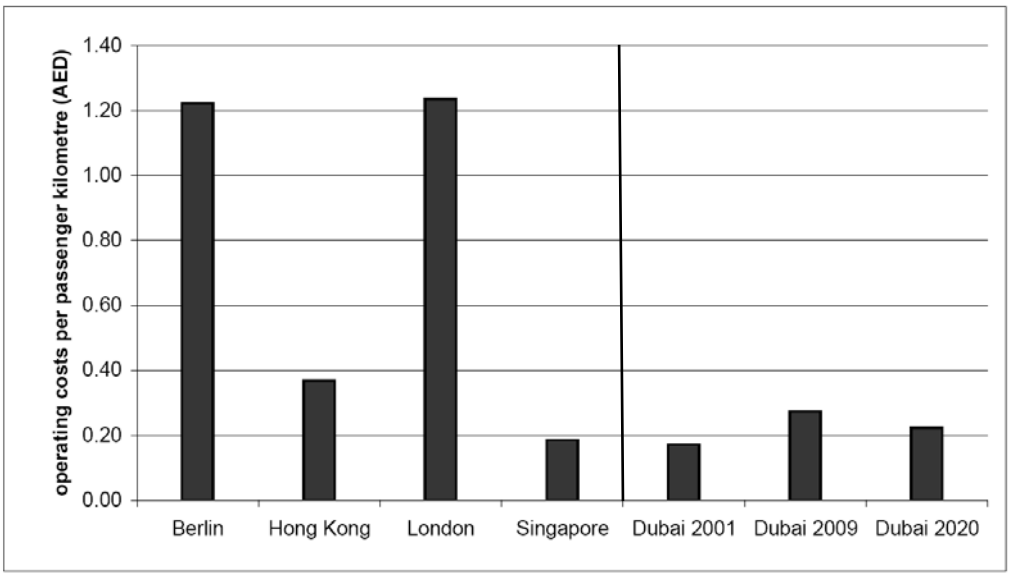


Figure 22: Benchmark: Operating Costs per Passenger Kilometre

Financial Indicators

By 2009 the annual costs will have reached more than 600% of the costs in 2004, between 2009 and 2020, they will level out. Though the rise in annual revenues will be slower between 2004 and 2009, it will nevertheless be significant, reaching about 470% of 2004 revenues. However, in contrast to projections for annual costs between 2009 and 2020, annual revenues will dramatically increase, almost as much as the rise in annual costs between 2004 and 2020. The following figure shows the development of the financial indicators from 2004 to 2020 at a glance.

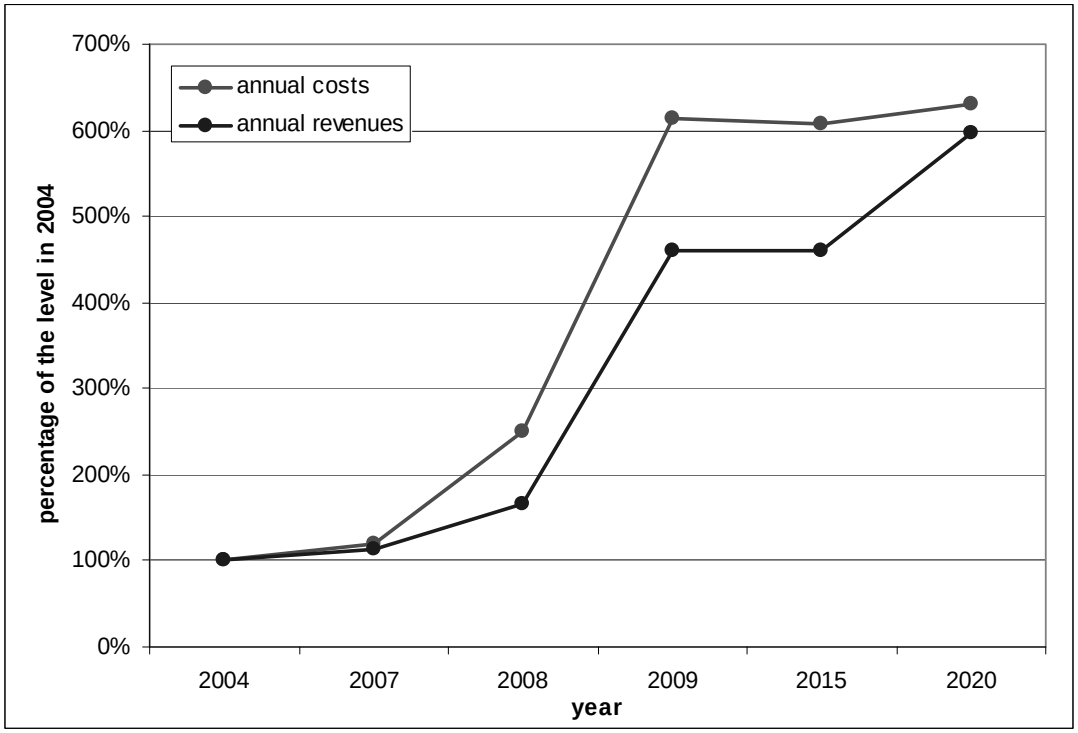


Figure 23: Comparison on the development of annual costs and revenues

Starting in 2009, service level guideline compliance will be ensured, and cost coverage will be in line with international benchmarks. So overall, the RTA objective of providing efficient, productive public transport is ensured.

ORGANISATION AND MANAGEMENT

Dubai's success story will continue as long as it has a fully operational, smooth transport system in place. Therefore, guidance by an effectively organized and managed governmental agent, responsible for transportation, is indispensable. The Road and Transport Authority (RTA), created in 2005, currently fulfills this role. RTA is comprised of the agencies for Bus Transport, Maritime and Rail with responsible for dual functions in planning and regulation and operations. This dual function oversight creates conflicts of interests and hinders any single agency's focus on its core-function. A review of best practices suggests separating these functions.

The Organisation and Management task of the Bus Master Plan focuses on the development of the most suitable regulatory regime, to meet the needs of urban bus transport in Dubai. The

following section presents the organizational structure recommended in the Bus Master plan. It is the result of the consultants work and has not yet been approved by the RTA. vii

Organisational Structure of present and future Public Transport Agency, PTA

The Public Transport Agency, PTA is responsible for al matters of public transport within RTA. The assessment of the current organisational structure of PTA began with a review of best practices among reputable regulatory regimes for public transportation world-wide. This review identified the most important functions required for a future planning and regulatory authority: Legislation and Policy; Planning and Regulations; and Operations.

Best practice suggests separating three overall functions to eliminate any conflicts of interest and to enable the organisations to focus on their core functions. The following briefly describes these three levels of organizational function:

Legislation and Policy: Responsibilities cover oversight of public transport legislative initiatives and setting policy to guide the development of a world class system and to ensure they are in line with the other policies of Dubai and the U.A.E., e.g. Socio-Economic, Environmental Policies, etc. These functions are currently executed by RTA.

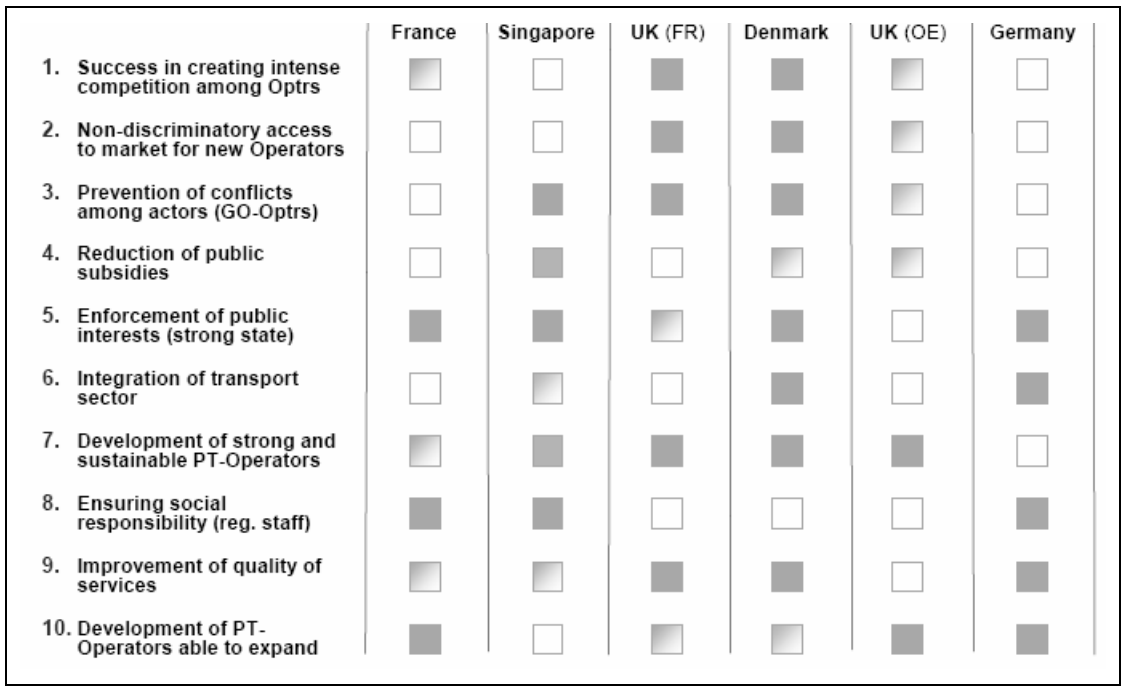
Planning and Regulations: Responsibilities include carrying out the public transport policy to ensure public transportation in Dubai by setting, and ensuring compliance with, quality and safety guidelines of a fully integrated system. These functions are to be fulfilled by the future Planning and Regulation Authority PTA for bus transport.

Operations:Responsibilities include oversight of daily operations. This function can be partly or fully fulfilled by the private sector.

There are several options for the allocation of these three functions within a single organization. Because it is best suited to deliver an integrated high quality transport system, the option recommended in the Bus Master Plan is to opt for a strong regulatory body.

Identification of best practice and selection of a suitable model for Dubai

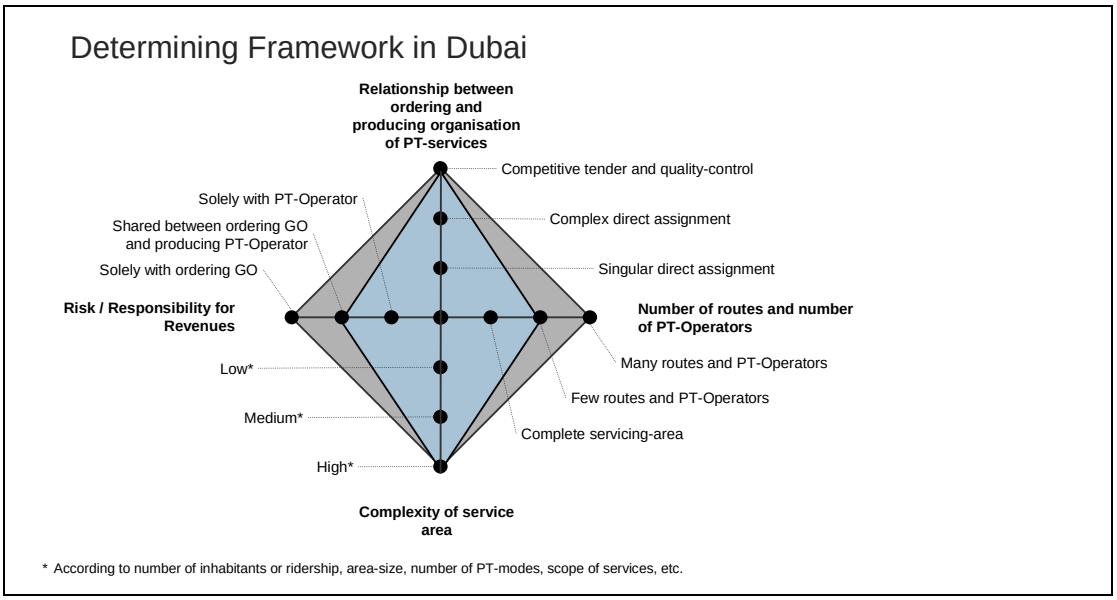
The review of international public transportaion regulatory regimes contributed to the development of a tailor-made organisational structure to meet Dubai‘s specific requirements.
These regimes were evaluated using a comprehensive set of criteria and led to the identification of advantages and drawbacks of the diverse models in place in the various countries and cities.



Comparison of Regulatory Regimes world-wide (FR = Franchise; OE = open entry; GO = Government Organisation; UK = United Kingdom; the more coloured the square , the greater the respective criterion is fulfilled by the model; the ranking of the evaluation-criteria does not imply any greater or lesser importance in this table).[viii]

Figure 24: Comparison of Regulatory Regimes world-wide.

The evaluation-criteria were ranked according to their relevance in the Dubai-setting; the order is different to that of Figure 24. Determining the framework for Dubai's future transport system requires a complete understanding and assessment of the complexities comprising the Dubai "setting" or "environment." Best practice dictates the services of a planning and regulating authority directly correlates with the complexity of this "setting." The process of "determining framework" in Dubai is illustrated in Figure 25.

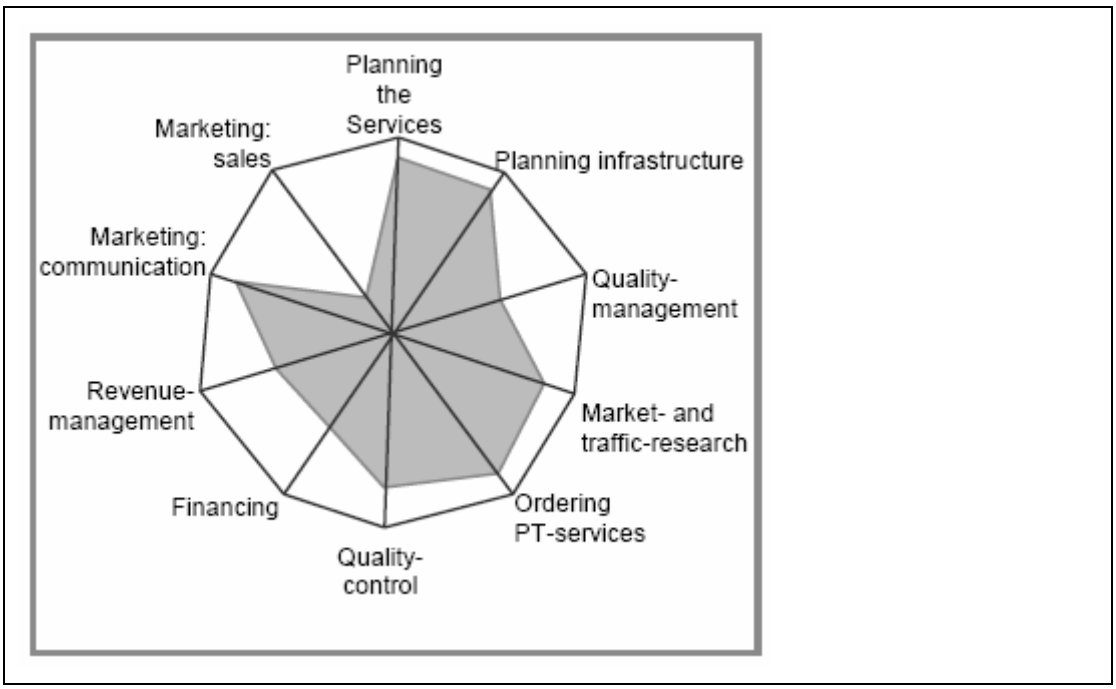


Determining framework for Dubai's future public transport system. The four parameters along the axis of the graph have a determining impact on the regulatory agency's scope of services. These four parameters and the regulator's scope of services are interdependent. The outer boundary represents the highest complexity, the centre the lowest complexity. The blue-shaded area is the degree of complexity anticipated for Dubai's transport system. It should be noted that, in the future, the "Number of routes and number of PT-Operators" in Dubai might be either in the middle ("Few routes and PT-Operators") as shown, or on the very right end ("Many routes and PT-Operators").

Figure 25: Determining Framework for Dubai's Future Public Transport System.[ix]

Figure 25 illustrates that Dubai's future public transport system will be highly complex. Using this graph, it was possible to define the scope of a future regulatory authority, which ideally should be in line with the determining framework. Since the scope of services for a planning and regulatory authority interacts with the determining framework, a strong and comprehensive regulator is required for such a complex public transport system.

A proposed scope of services for the future planning and regulating authority in Dubai – that meets the requirements of the complex determining framework – could be characterised as shown in the following graph. The different functions are each described along one axis. The blue-shaded area stands for the degree to which the regulating authority fulfils this function whereas the white area means that the operator is fulfilling this task. For example, the closer the blue area is to the outer boundary along an axis, the greater the degree the regulator is fulfilling the function. Conversely, the closer the blue area is to the centre, the greater the degree to which the operator is in charge of the function.



The scope of services for a future planning and regulating authority in Dubai that adequately meets the requirements of the complex determining framework is depicted as a spider-web on this graph. Each axis represents a set of functions and the degree to which the future planning and regulating authority will execute these functions. The outer edge symbolises the maximum scope of services or functions fulfilled by the future regulator. The centre of the graph stands for the minimum scope of responsibility of the regulator. The same is true in reverse: the white stands for the scope of services and functions executed by the operator. The reason for the involvement of the regulator in quality management is the Service-Level-Agreement (when e.g. tendering out services), defined by the regulator and agreed upon by all parties.

Figure 26: The Envisaged Scope of Services for a Future Planning and Regulating Authority in Dubai.[x]

Translation of present organisation into future form

The organisation of public transportation in Dubai is currently undergoing major changes at a fast pace. The Public Transport Agency is currently fulfilling multi-functional roles including planning and regulating and operations.

Most of the planning and regulatory functions necessary for the future regulatory authority currently are the responsbility of the PTA-Directorate Planning & Business Development. The most feasible process for establishing an effective planning and regulating authority, is to more fully develop those functions within the directorate by complementing them with those currently missing. This will enable the present PTA-Directorate Planning & Business Development to evolve into the future regulatory authority.

In contrast to the functions carried out by the PTA-Directorate Planning & Business Development, the functions of the other directorates of PTA namely human competenties, public bus, school bus, inter-city transport, and maintenance and fleet services are operational. Therefore, the other directorates of PTA are well positioned to soley focus on the operational functions and to possibly become private legal enterprises in the near or mid-term future. For instance, the private sector can provide bus operation service in lieu of the public authority.

Public Bus Operations and Depots:

It is recommended to connecting the depots with bundles of routes so they can be operated independently. Furthermore, they can be potentially be privatized in a few years and depots

services may be tendered out in a staggered way. However, the ownership of the depots would remain with the public sector.

Operations Control Centre:

A company with a private legal form may operate the Operations Control Centre (OCC) but the public sector should retain a majority share to guarantee that the public transport system is non-discriminatory and remains attractive for private investors. Alternatively, a private company could operate the OCC, provided the company is not linked to competing public transport operating companies, and its OCC-operations adheres to precisely defined non-biased rules.

Maintenance and Fleet Management:

Vehicle and fleet maintenance can be outsourced completely and provide services on a competitive basis. It is also possible, that the supplier of buses will be maintain the new buses.
Human Competencies:

PTA currently provides training for drivers and operates an academy for high skilled transport staff. These training functions can be outsourced completely. Only the regulatory functions associated with definiing human competencies should remain with PTA-Regulation. For example, defining and ensuring compliance with the definition of minimum-standards for drivers and the development of driver curriculum.

Taxi & Demand Response Services:

Taxi and demand response services could be offered out to private sector with strong entrepreneurial experience. The same is true for School Bus Operation, Inter City Transport, and Infrastructure Management Companies. Infrastructure management companies would be responsible for managing transit-related facilities.

Card distribution:

RTA‘s Central Clearing House should manage card distribution and related functions.

Separating the planning & regulating functions from daily operations will achieve a functional structure that is in line with the three levels (1) Legislation & Policy, (2) Planning & Regulation, and (3) Operations.

The proposed functional structure will allow the current separate agencies (PTA, Marine, and Rail) to fulfil their regulatory functions independently while opening up the possibility of creating an integrated public transport regulator for bus, rail and maritime services in the future. At a later time in the future, RTA might have determined how and where corporate support services are best allocated to be optimally functional.

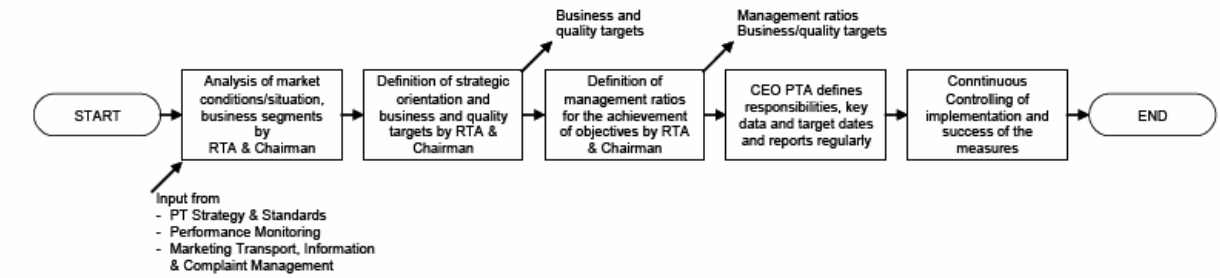
RTA must ensure that, in the near future, the structures remain consistent across all agencies to allow for the eventual merging of all regulatory roles.

Workflows

The essential workflows for the new planning and regulating authority have been defined and are compatible with the future vision of the organisational function. The focus is on the central planning processes as follows:

- Network planning
- Timetable planning
- Economic planning
- Procurement
- Investment planning
- Staff planning
- Education and training planning
- Quality management

The new workflow describes the general procedures for a responsible division and staff position. The example below details the interfaces between PTA-RTA and required information, and data.



Example for workflows: Definition of business and quality targets including the interfaces between PTA-RTA and required information and data.

Figure 27: Example for Workflows.

FARE

Public transport fare is a major factor in attracting passengers and is a basic element of the system operations which affects the financial condition of the operators. The relationship of fare levels to the quality of service provided, the means and convenience of payment as well as the simplicity of the fare structure have a significant influence on the ridership of the public transport system.

Integrated Fare Solution

In view of the impracticality of a fare-free system, further studies were conducted to obtain an integrated fare solution across the different modes of public transport. Three main fare structure types were analysed to find out their appropriateness to Dubai's setting – flat fare, zonal fare and sectional fare.

The main period used for this study is year 2010 where the public transport network would consist of a new bus system and the Metro Red Line. The Automated Fare Collection (AFC)

system will be ready by this period as well and with the central clearing house in place, a fully integrated fare structure can be implemented. Besides 2010, the other study periods include:

Years 2007 to 2010: Transition period from the existing fare system to the full AFC system, before the new bus network, Metro Red Line and central clearing house are ready.

Years 2015 and 2020: Future Dubai with a more rail-based public transport network comprising of more metro lines and tram on top of the 2010 network.

The data used in the analysis mainly comes from the travel demand from the R1000 Transportation Study model, as well as forecasted demand from the Network Planning Task for the other periods not included in R1000. The modes of transport include the existing and future modes operating within Dubai for the above study periods, namely – bus, abra, waterbus, ferry, metro, and tram.

Fare Structures

Flat Fare

Flat fare is the simplest form of fare possible, whereby a constant fare is charged regardless of distance travelled. The strengths and weaknesses of a flat fare structure include:

\+ very easy for passengers to understand and use
\+ easy supervision of payment hence faster boarding
– no reflection on passenger's trip length
Examples: New York, City of Tokyo

Zonal Fare

In a zonal fare structure, the charged area will be divided into different fare zones and the fares charged will increase with the number of zone boundaries crossed.

The strengths and weaknesses of a zonal fare structure include:

\+ uniform base fare for trips made within a small geographical area, e.g. CBD
\+ increasing fare for longer trip length (fare equity)
\+ fairly easy to understand and use for passengers
– fare collection and fare payment more complicated compared to flat fare
Examples: London, Berlin, Rhine Ruhr Area, Hong Kong

Sectional Fare

Sectional fares are set up based on point-to-point travel distances according to the paths undertaken by transit vehicles on each single transit line. It usually includes a boarding charge and fares will increase according to the additional sections travelled.

The strengths and weaknesses of a sectional fare structure include:

+ closer relation to travel distances since sections are usually shorter than zone diameters for zonal fares
– fares are based on transit's travel distance, which includes detours along the route
– fares are not transparent and difficult to calculate prior to travel, especially for transit passengers
Examples: Singapore, Bangkok Metro, German Rail

Besides the fare structure type also fare differentiation – e.g. number of tiers / price levels, premium on different service levels, higher prices on certain areas, peak/off-peak pricing, various ticket types for targeting user groups, etc. – is decisive for an effective and appropriate fare system.

Development of Fare Options

A preliminary analysis including the following test variations was carried out:

- flat fare – low, medium, high rates;
- sectional fare – fixed and non-fixed distances, high/low rates; and
- zonal fare – different number of zones and tiers, higher CBD fares.

An evaluation focusing on the distribution of trips across the different fare tiers, ridership and revenue was conducted and as a result, the following three options were selected for further analysis:

Option 1: Sectional based fare with 11 fare tiers and a degressive fare increment.
Option 2: Zonal fare with 5 fare zones and 3 fare tiers (plus a short-trip tier).
Option 3: Zonal fare with 12 fare zones and 5 fare tiers (plus a short-trip tier).

The three options were used for further analysis through a fare model.

Fare Model Analysis

The fare model was developed to provide a robust means to assess the impact on ridership, revenue and average fare for the different study years for the three selected fare options. It takes into consideration forecasted trip activities, different ticket types targeted at the different user groups and their take-up rates.

A range of ticket types commonly used worldwide and catering to the main trip activities was assumed in the analysis, which include work trips (trips made by locals and residents living in Dubai on a long-term basis), business trips (trips made by people coming to Dubai for short-term work purposes), tourists trip, senior citizen trips, student trips and others.

The types of tickets used and the assumptions undertaken are as follows:

Stored-value Ticket: a pre-paid ticket to provide users with the convenience of not having to buy a new ticket for every trip they make. Fares will be deducted from the ticket for every trip

the user makes; when the card value runs down to zero (or near zero), the user will need to top up the ticket again.

Cash: for passengers who do not wish to pay for their trips in advance through a pre-pay ticket. As it tends to exacerbate the efficiency of fare collection, a higher fare with increasing differential in future was assumed in the model for cash payments, as shown in Table 1.

Table 1: Cash Fare relative to Stored-Value Fare

2010	2015	2020
110%	120%	130%

Daily Network-wide Ticket: targeted at Business and Tourist trips, where these users will only be in Dubai on a short-term basis. It allows its users to make an unlimited number of trips across a 24-hour period.

Monthly 1-, 2- or 3-zone Pass: targeted at users for the zonal fare structures (Options 2 and 3) who make regular trips within the pre-defined number of fare zones only. Users of this pass can make unlimited number of trips within this constrain.

Monthly Network-wide Pass: allows its users to make unlimited number of trips across the whole network.

Monthly Senior Citizen / Student Pass: allows senior citizens / students to make unlimited number of trips across the whole network.

To determine the value of each monthly pass, the following formula was used in the fare model:

Monthly Pass Value = average daily trip rate × overall stored-value average fare[3] × discount × 30 days per month

The assumed daily trip rates, discounts, monthly pass values and average fare per trip for the different ticket types for 2010 (main study period) are shown in Table 2.

[3] For the 1-zone, 2-zone and 3-zone passes, the input fare for the respective fare tiers were used instead of the overall stored-value average fare.

Table 2: Daily Trip Rate, Percent of Stored-value Average Fare, Monthly Pass Value and Average Fare per Trip (2010)

Pass Type	Daily Trip Rate	% of Stored-Value Avg Fare	Monthly Pass Value (AED) / Average Fare per Trip (AED)
Daily Network-wide Ticket	5	90%	15 / 3.00
Monthly 1-zone Pass ***(for Options 2 and 3 only)***	2.5	60%*	100 / 1.33
Monthly 2-zone Pass ***(for Options 2 and 3 only)***	2.5	60%*	180 / 2.40 (Option 2) 140 / 1.87 (Option 3)
Monthly 3-zone Pass ***(for Option 3 only)***	2.5	60%*	190 / 2.53
Monthly Network-wide Pass	3.5	80%	270 / 2.57
Monthly Senior Citizen Pass	3	70%	210 / 2.33
Monthly Student Pass	3	60%	180 / 2.00

** denotes percent of input fare for respective fare tiers within each option*

Although the daily and monthly passes provide a cheaper and faster means of travel, their popularity is uncertain since such passes are not common in Dubai at the moment. High and low take-up rates were assumed in the analysis to reflect this uncertainty and this gave rise to a range of values for the final test results.

In the scenarios with low take-up rates for discounted passes, passengers would use the other mode of payment available, namely cash, and would result in higher revenues since cash fares are higher. Take-up rates were also assumed to increase over the years, as passengers grow accustomed to and learn the benefits of these passes. The increasing differential between cash fare and these passes would also support this assumption.

Applying these take-up rates, together with the elasticity figure of -0.374, the final results showing the estimated number of trips (trip chains), revenue and average fare for the different modes of payment across the different user groups were calculated. The mid-range values between the high and low ticket take-up rates for 2010 are shown in Table 3.

[4] Based on PTA's study following the last bus fare increase in 2003.

Table 3: Average Fare, 2010 Weekday

Test Option	Average Fare (AED)
Option 1	3.14
Option 2	2.91
Option 3	2.82

Comparing the average fares above against the forecasted average fare for major cities around the world in 2010 (see Figure 28), Dubai will have a fare level comparative to Amsterdam, Berlin, Madrid and Singapore.

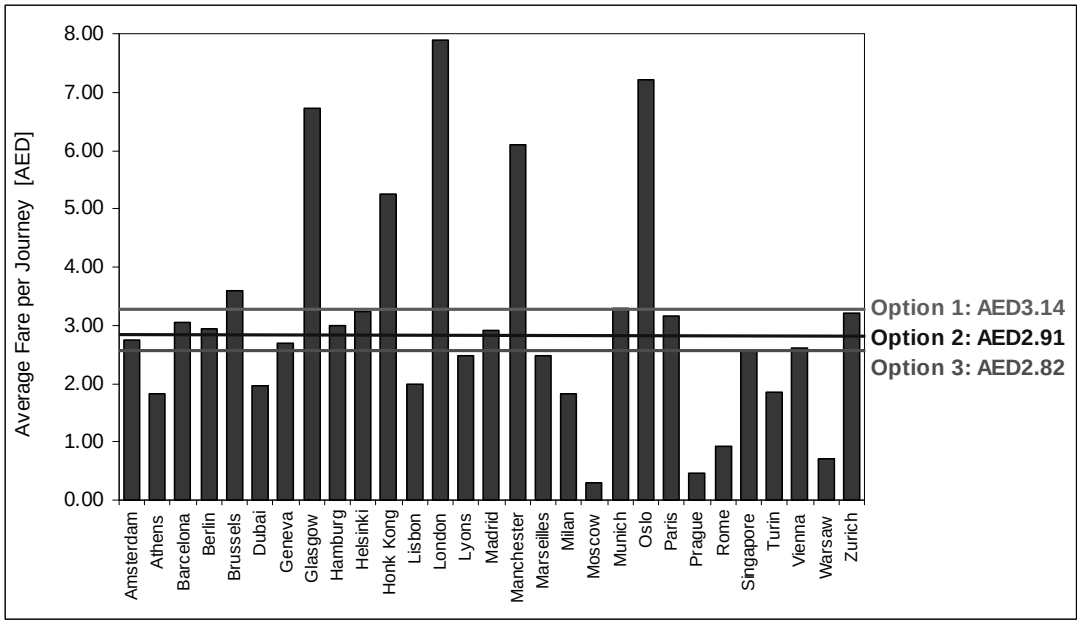


Figure 28: 2010 Fare Levels for Dubai and other Major Cities [5]

Compared to the cost of using private vehicles and taxis, public transport will always be the cheapest travel option (see Table 4).

[5] Average trip length as well as purchasing power can vary between the different cities.

Table 4: Ratio of Car and Taxi Costs relative to Public Transport Cost in 2010

Mode	Option 1	Option 2	Option 3
Car (excl. depreciation and insurance)	240%	260%	270%
Car (incl. depreciation and insurance)	450%	490%	500%
Taxi	890%	960%	990%

A cost recovery analysis was also conducted to find out the ratio of estimated revenue to operating costs; the latter includes vehicle running costs and manpower costs and excludes cost of assets and depreciation. Results show that the three fare options will produce a cost recovery of around 120%-130% in the year 2010.

Qualitative Evaluation of Fare Structure Options

Besides the analysis carried out in the previous chapters, a qualitative evaluation with regards to objectives of this study was carried out. In Table 5, an attempt to rank the characteristics of the three selected fare options on a scale of 1 (lowest) to 3 (highest) against the recognised key objectives was made. A weight of 1 to 3 is provided for each objective and the overall performance (number of points) of each option is shown at the end of the table.

As demonstrated in the fare model, fare levels could be adjusted to achieve the desired balance between ridership and revenue; therefore, albeit these are important aspects of any public transport system worldwide, a low weight has been used in this evaluation table.

Table 5: Evaluation of Fare Structure Options against Key Objectives

Objective	Weight	Option 1 – Sectional	Option 2 – Zonal (5 zones)	Option 3 – Zonal (12 zones)
Integration of Modes	**3**	2	3	3
Convenience and Simplicity	**3**	2	3	2
Future Expansion	**2**	3	3	2
Technical Flexibility	**2**	2	3	3
Affordability	**2**	3	3	3
Ease of Implementation	**2**	3	3	3
Ridership	**1**	3	3	3
Revenues	**1**	3	2	2
Total (weight x ranking)		**40**	**47**	**42**

Results show that Option 2 performs best when measured against the key objectives.

Comparing zonal against sectional fare structure, the former has greater merits in terms of convenience and simplicity for the passengers. In additional, a zonal fare structure would fit better into the hub-and-spoke public transport network structure proposed for Dubai, by charging passengers based on their zones of boarding and alighting without any fare penalties for travelling longer (in the absence of direct connections) to the transfer points along the journey. This would support the integration of the public transport system.

The other benefits of a zonal fare structure include:

Passenger Information and Marketing Options:

A zonal structure allows public transport agencies to present the fare system to the public in a neat and simple manner. Zone maps can be put up at stations and stops to help passengers understand the fare system at a glance. On the other hand, the marketing of sectional fares is fairly limited to fare tables and fare tiers which are not as eye-catching.

Fare Calculations:
In a zonal fare structure, passengers can easily calculate how much the trip would cost based on the zones where he boards and alights. However, sectional fares do not provide this convenience since they are distance-related and the amount charged would be dependent on the route taken.

Simplicity and Ticket Options:
Simplicity does not only refer to the understanding of the fare structure, but also to the transparency of the wide range of ticket options available. A sectional fare structure is indeed simple if the ticket types available are limited, e.g. one stored-value ticket and passes with a daily or monthly fare cap. However, in order to fully cater to the different travel patterns in the market, more ticketing options have to be made available.

In a zonal fare structure, a more diverse ticketing option can be provided to target user groups with specific travel patterns, e.g. regular commuters who only travel across two zones daily can purchase a 2-zone monthly pass instead of paying more for a more expensive network-wide pass, as for the case in sectional fare structure.

Flexibility:
A zonal fare structure provides more operations flexibility in terms of making refinements to the public transport network. Occasional changes to the network (e.g. route detours because of road constructions) would not affect the fares charged for the route.

In terms of the other study objectives, both the sectional and zonal fare structures do not differ much. Both fare structure types allow the adoption of social components like providing concession travel for students and senior citizens. They also facilitate future expansions where zones or sections could be added together with an increased number of fare tiers, albeit zonal structure has the additional flexibility of merging or splitting fare zones by changing the demarcation of zone boundaries.

Comparing the two zonal fare structure options (Option 2 with 5 fare zones and Option 3 with 12 fare zones), Option 2 would be more suitable for 2010 – when changing over from the existing fare system to a new fare structure, it is important for passengers to comprehend how the new structure works. Having fewer fare zones and fare tiers in Option 2 is easier to understand to begin with, and it also eliminates any contentious issues pertaining to the

number of fare zones traversed between the starting and ending points of the journey. Fewer (large) fare zones would also facilitate future refinements whereby the zones can be split into smaller ones depending on changes in travel patterns.

Recommended Fare Structure for Dubai

Recommendations on the fare structures will be made for the different study periods. They will first focus on the main study year of 2010, with general characteristics of the full fare structure. This will be followed by recommendations for future Dubai (2015 and 2020) and will end with recommendations on the transition from the existing fare system (2007 to 2010).

The full fare structure shall have the following characteristics:

No fare differentiation between CBD and suburbs:
Although profitable, higher fares for CBD would induce contra-productive effects on passenger attraction especially in the area with great congestion problems.

Fares regardless of the different modes of public transport:
The fare system needs to be in line and support the hub-and-spoke public transport network structure. Without any fare differentiation between the different modes, passengers will not be penalised for choosing one mode of transport over another and this will encourage multi-transfer trips and support the integration of the public transport system.

Premium fares at a rate double of regular fares for travelling on metro first class, and selected services like airport buses and ferries.

- An allowable transfer time of 1 hour; and
- Basic ticket types tested in the fare model.

A fully integrated fare structure can be applied when the AFC system is ready for the different modes of public transport and the central clearing house is fully functional. This period would likely arrive earlier for buses, ferry, waterbus and abra before the Metro Red Line comes onboard in September 2009.

From the evaluations carried out earlier, Option 2 has more merits compared to the other two options when measured against the key objectives.

It is therefore consultants recommendation that Option 2, which consists of a zonal fare structure with 5 fare zones (see
Figure 29) and 3 fare tiers, be adopted as the integrated fare solution for Dubai.

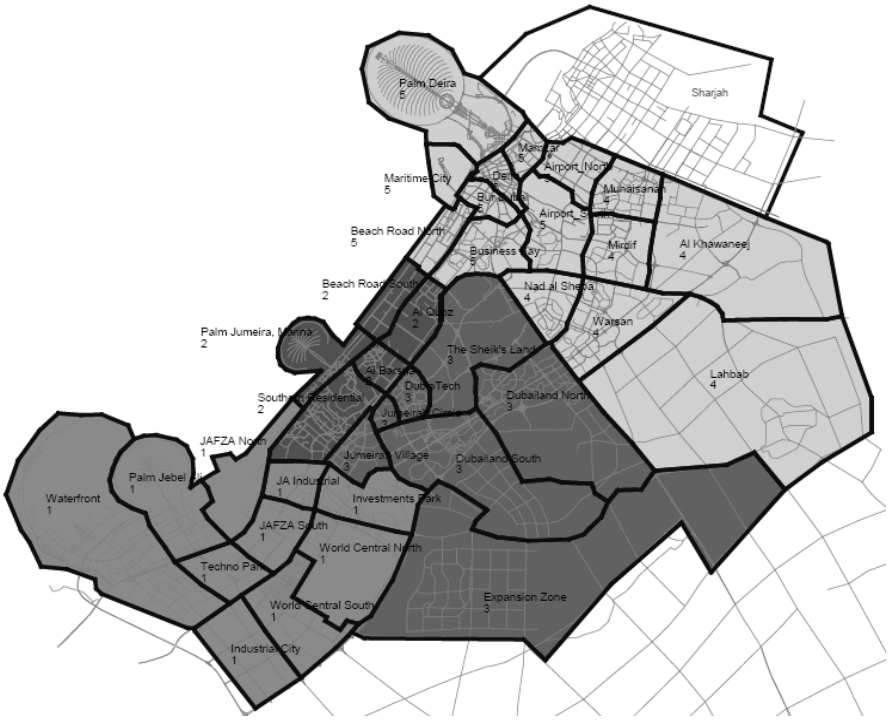


Figure 29: Zonal Fare Map

Note: All following shown details, especially fare levels, are suggestions and not approved or decided by RTA.

Details of the fare levels and basic ticket types recommended for 2010 are shown in Table 6.

Table 6: Recommended Fare Levels for 2010

[AED]	Single Trip		Daily Ticket *	Monthly Pass -		
	Stored-value	Cash		Adult	Senior Citizen *	Student *
Short Trip (≤ 3km)	1.80	2.00	-	-	-	-
Tier 01	2.30	2.50	-	100	-	-
Tier 02	4.10	4.50	-	180	-	-
Tier 03	5.80	6.50	14	270	200	170

** network-wide validity only*

There will be no differentiation between peak and off-peak fares.

After 2010, an on-going study on how the fare levels should be increased is recommended (e.g. small annual increments or big increase every five years) so that the fare adjustments will fall in line with the latest public policies.

Notwithstanding the absence of policy information at this stage, it is our recommendation however that fares be increased in small steps on a yearly basis for the first few years (after 2010) across all ticket types. By doing so, it will be possible to steer the market towards certain ticket types by increasing their attractiveness through higher fare differentials between tickets.

At a later stage, increment every alternate year for each ticket type is recommended, e.g. cash and stored-value tickets in the odd years and concession passes in the even years. This would provide the fare regulators a good understanding of market sensitivity within a short period of time.

Refinement of Fare Structure

With the advent of new metro and tram lines, coupled with the change in travel pattern, studies need to be carried out in the future to find out how the recommended fare structure could be refined. The areas of study, while not limited to, can be as follows:

- Refinement of Fare Zones
- Extension to Other Emirates and Increase of Fare Tiers
- Fare Differentiation

Depending on market needs, the demand potential can be tapped more fully beyond 2010, after passengers are accustomed to the new public transport network and the market has stabilised, by targeting certain user groups through the provision of more ticketing options such as:

Corporate Ticket

These are tickets providing discounted travel, sold in bulk to corporations for their employees. Usually, such tickets are most effective when provided based on a longer time period (e.g. yearly). The benefits of this ticket, for the corporations, include reducing the need to provide parking spaces for employees, reduce the number of company cars provided. For the public transport operator, these tickets allow the advance collection of fare revenue and provide a good basis for ridership forecast.

Park and Ride (P&R) Ticket

Depending on the availability of P&R facilities, P&R tickets which provide rebates for passengers who prefer to carry out part of their journeys using private vehicles could be implemented.

Tourist / Special Event Ticket

These tickets could combine travel fares with discounted entrance fees to places of interests or special events.

Because of the high value of the monthly passes, some regular passengers who would like to use them might not be able to afford paying for the card in one go. Depending on the popularity of these passes, further ticketing options whereby a monthly fare cap is attached to the stored-value ticket can be studied. As such, additional trips made after a certain amount of fares has been deducted within a month will be for free. Nonetheless, there might be technical implications as the smartcard might not have the capacity to record all the trips made within a one-month period.

CONCLUSION

The recommendations detailed in the Bus Master Plan cover a broad range of initiatives including:

- a constantly evolving network,
- infrastructure provision, reaching from bus stops, stations to depots,
- fleet improvements by means of purchasing new vehicles with state of the art propulsion,
- intelligent operation management systems,
- integrated ticketing applying cutting edge technology, and
- providing a framework for employee development and satisfaction.

Strong PTA leadership and effective management must address the following:

- Concentrate on PTA's role as regulator with a sophisticated, but not excessive quality control system.
- Outsource daily operation to the private sector, but keep operational skills in case the private sector provides unacceptable response to tenders. PTA must have the capability to do that alone.
- Continuously strive for a seamless integration of public transportation services, including metro, bus and water transport.

This paper highlights the building blocks of the comprehensive strategic bus networking study. With the Dubai Public Transport Bus Master Plan, RTA has the foundation necessary for creating a world class public transport system.

REFERENCES

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[1] Strategic Plan 2007-2009 Roads and Transport Authority, approved in the Board of Directors Meeting on December, 7, 2006, **5**.

[2] PTV AG et al (2007). Report « The Master Plan « . Dubai Public Transport Bus Master Plan, **5**.

[3] PTV AG (2007). Sub-Report "Bus Network Planning", Appendix B – Best Practice and Benchmarking Analysis –. Dubai Public Transport Bus Master Plan, **6**.

[4] PTV AG (2007). Sub-Report "Bus Network Planning", Appendix C – Present Network Analysis. Dubai Public Transport Bus Master Plan, **7.**

[5] Africon Ltd. Dubai (2006). Derivation of Updated 5-Year Transportation System Implementation Plans for Dubai, **14**.

[6] Maunsell Consultancy Services Ltd. (2007). Public Water Transport System for Dubai, **16**.

[vii] Hamburg-Consult GmbH (2007). Sub-Report "Organisation and Management", Dubai Public Transport Bus Master Plan, **34**.

also see: PTV AG et al (2007). Report « The Master Plan « . Dubai Public Transport Bus Master Plan, **34**.

[viii] PTV AG et al (2007). Report « The Master Plan « . Dubai Public Transport Bus Master Plan, **35**.

[ix] also see: Dr. Berlepsch, H.-J. v., Dr. Kretschmann, C. v. (2006) Structures of Public Transport Organisations. Der Nahverkehr, 11/2006, page14, **36**.

[x] also see: Dr. Berlepsch, H.-J. v., Dr. Kretschmann, C. v. (2006) Structures of Public Transport Organisations. Der Nahverkehr, 11/2006, page14, **37**.