INTEGRATION OF PUBLIC TRANSPORT SERVICES: THE CASE OF ISTANBUL

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ABSTRACT

INTEGRATION OF PUBLIC TRANSPORT SERVICES: THE CASE OF ISTANBUL

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One of the most important policy and action areas in urban transport planning is the improvement of public transport with a view to increase its usage. Public transport is the most effective way of meeting increasing mobility needs in urban areas. It can provide long-distance journeys that may be difficult to travel via walking and biking. In the face of increasing car usage, it also ensures the most efficient use of space (i.e. transport infrastructure) and hence can help relieve congestion, which is a consequence of increased car usage. Transporting people with public transport, as opposed to cars, also results in lower levels of energy consumption and emissions; and consequently public transport also plays an important role in climate action plans and in achieving such policies as environmentally-friendly, clean, green, energy-efficient, and lower-cost (in terms of space and energy consumption) urban transport systems. Public transport is also a means of providing equal access opportunities to the society, since not everyone can be expected to travel with the car. As a result, for environmentally, economically and socially sustainable urban transport systems, public transport is a fundamental component.

Public transport often constitutes a variety of different systems and services; and policies to improve public transport systems bring along a multi-modal system, which consists of various different public transport modes. This improvement also brings

along the need for integrated systems. Public transport integration is both a necessity and a key for attracting travelers.

Public transport integration has various levels and perspectives that are line/route integration, tariff/ticketing integration, information integration and schedule/headway integration. Integration criteria that are examined in the study are based on literature and three best practice cases from the world. These cases are Singapore, London and Toronto. As a case study, this study assesses public transportation integration in Istanbul, Turkey.

Istanbul has a diversity of transit modes, high daily passenger numbers, high population and a high level of mobility. Moreover, maritime transport and diversity of rail transportation (metro, tramway, funicular, streetcar, Marmaray etc.) make Istanbul a good case to investigate the integration of public transportation to compare it with good practice cases. Five transfer stations (Şişli-Mecidiyeköy, Zeytinburnu, Yenikapı, Aksaray-Yusufpaşa, Kadıköy) in Istanbul are investigated in-depth in terms of public transport integration.

The aim of the study is to present Istanbul's situation regarding public transport integration. By doing so, both inadequacies/weaknesses and potentials/possibilities to achieve an integrated public transport system in Istanbul could be investigated and assessed.

The findings of the study enlighten the framework of an integrated public transport system, but by taking the locality into account. The study investigates integration components specific to Istanbul and also some transfer stations in Istanbul are analysed in depth. The study can provide recommendations for future system map, information tools, fare policies and schedule arrangements as well as for achieving the whole system integration.

Keywords: Public Transport, Integration, Istanbul

ÖZ

TOPLU TAŞIMA HİZMETLERİNDE ENTEGRASYON: İSTANBUL ÖRNEĞİ

Gür, Aslıhan
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Toplu taşımanın geliştirilmesi ve kullanımının artması, kentsel ulaşım planlamasında en önemli politika ve eylem alanlarından biridir. Toplu taşıma, kentsel alanlarda sürekli artan hareketliliği karşılamadaki en etkili yöntemdir. Kent içinde, yaya ve bisikletli olarak gerçekleştirilmesi zor olan uzun mesafeli yolculuk ihtiyacının karşılanmasına olanak sağlar. Toplu taşıma ayrıca mekânın en verimli şekilde kullanılmasını (örneğin ulaşım altyapısı bakımından) sağlayarak artan araç kullanımının bir sonucu olan trafik yoğunluğunu ve sıkışıklığını hafifletmektedir. İnsanların özel araç kullanımı yerine, toplu taşıma sistemlerini kullanarak ulaşım ihtiyaçlarını karşılaması, daha az düzeyde enerji tüketimi ve salınımı ile de sonuçlanmaktadır. Böylece, iklim eylem planları ile çevre-dostu, temiz, yeşil, enerji tasarruflu, düşük maliyetli (mekân ve enerji tüketimi açısından) kentsel ulaşım sistemleri ve politikalarının gerçekleştirilmesinde de önemli bir rol oynamaktadır. Toplum içindeki her bireyin özel araç ile yolculuk yapmasının beklenemeyeceği düşünüldüğünde, toplu taşımanın toplumun fırsat erişimindeki eşitliği sağlaması bakımından da önemli olduğu görülmektedir. Sonuç olarak toplu taşıma; çevresel, ekonomik ve sosyal sürdürülebilir kentsel ulaşım sistemleri için son derece önemli bir bileşendir.

Toplu taşıma sistemleri genellikle birçok farklı sistem ve türden oluşmaktadır. Toplu taşıma sistemlerindeki gelişmeler ve politikalar, çeşitli toplu taşıma türünden oluşan çoklu sistemleri beraberinde getirmiştir. Bu gelişmeler ayrıca entegre sistemlere olan ihtiyacı da ortaya çıkarmıştır. Bu bakımdan, toplu taşıma entegrasyonu hem bir gereklilik hem de yolcu sayısının arttırılmasında asli bir unsurdur.
Toplu taşıma entegrasyonunun çeşitli unsur ve bileşeni olup bunlar hat/güzergâh entegrasyonu, bilgi entegrasyonu, tarife/biletlendirme entegrasyonu ve zaman çizelgesi/sefer aralığı entegrasyonudur. Bu çalışmada incelenen entegrasyon kriterlerinde, önceki literatür ve üç başarılı dünya örneği temel alınmıştır. Bu örnekler Singapur, Londra ve Toronto'dur. Bu çalışma, örnek alan incelemesi olarak İstanbul'da toplu taşıma entegrasyonunun durumunu değerlendirmektedir.

İstanbul toplu taşıma sistemi, birçok farklı ulaşım türüne, yüksek oranda günlük yolcu sayısına, nüfusa ve hareketlilik düzeyine sahiptir. Ayrıca, deniz ulaşımının varlığı ve raylı ulaşımın çeşitliliği (metro, tramvay, nostaljik tramvay, füniküler, Marmaray vb.) de İstanbul'u başarılı dünya örnekleri ile karşılaştırma yaparak değerlendirebilmek adına toplu taşıma entegrasyonunun incelenmesi adına iyi bir inceleme alanı haline getirmiştir. İstanbul'da beş transfer istasyonu (Şişli-Mecidiyeköy, Zeytinburnu, Yenikapı, Aksaray-Yusufpaşa, Kadıköy) toplu taşıma entegrasyonu açısından incelenmiştir.

Çalışmanın amacı, toplu taşıma entegrasyonu ile ilgili İstanbul'un durumunu ortaya koymaktır. Bunu yaparak, toplu taşıma entegrasyonunu gerçekleştirmek için İstanbul'daki hem yetersizlikler/zayıflıklar hem de potansiyeller/olanaklar araştırılıp değerlendirilebilir. Çalışma bulguları, yerellik hususu dikkate alınmak suretiyle entegre bir toplu taşıma sisteminin çerçevesine ışık tutmaktadır. Ayrıca İstanbul örneği özelinde incelenen transfer istasyonları ve entegrasyon bileşenleri üzerinden gelecekteki sistem haritası, bilgi araçları, ücret politikaları ve zaman çizelgesi düzenlemeleri hakkında entegrasyonun sağlanması için çıkarım ve tavsiyeler sunmaktadır.

Anahtar Kelimeler: Toplu Taşıma, Entegrasyon, İstanbul

To my family and myself.

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ABBREVIATIONS

App.	Application
a.m.	Ante Meridiem (before midday)
A.Ş.	Incorporated Company
BRT	Bus Rapid Transit
CO_2	Carbon Dioxide
e.g.	Exempli Gratia (for example)
etc.	Et Cetera (and the rest)
ERT	Electronic Road Pricing
EU	European Union
GPS	Global Positioning System
GTA	Greater Toronto Area
GTHA	Greater Toronto and Hamilton Area
h	Hour
i.e.	Id Est (in other words)
IBB	Istanbul Metropolitan Municipality
IDO	Istanbul Sea Bus
IETT	Istanbul Electric Tramway and Tunnel Establishments
Km	Kilometer
Km^2	Square Kilometer

LTA	Singapore Land Transport Authority
LRT	Light Rail Transit
MRT	Mass Rapid Transit
NOx	Nitrogen Oxides
Nr.	Number
OECD	Organization for Economic Co-operation and Development
p.m.	Post Meridiem (after noon)
TCDD	General Directorate of Turkish State Railways
TDI	Turkish Maritime Organization
TfL	Transport for London
TTC	Toronto Transit Commission
TUIK	Turkish Statistical Institute
UITP	International Association of Public Transport
UKOME	Municipality Transportation Coordination Center
UNCED	The United Nations Conference on Environment and Development
VOCs	Volatile Organic Compounds

CHAPTER 1

INTRODUCTION

Public transport is an integral part of urban transport. In the face of ever-increasing mobility needs and travel demand, public transport is the most effective way of transporting people in urban areas. It can effectively meet the needs for long-distance journeys that may be difficult with walking and biking. It also meets the increasing mobility needs across urban areas. In addition, when compared with journeys made with the car, public transport ensures the most efficient use of space (i.e. transport infrastructure), and hence can help relieve traffic congestion, which is a negative outcome of increased car usage in cities. Transporting people with public transport, as opposed to cars, also results in lower levels of energy consumption and emissions; and consequently, public transport also plays an important role in climate change action plans and in creating environmentally-friendly, clean, green, energy-efficient, and lower-cost (in terms of space and energy consumption) urban transport systems. Public transport is also a means of providing equal access opportunities to the society, since not everyone can be expected to travel with the car. In short, public transport systems can play an important role in order to create environmentally, economically, and socially sustainable transport systems.

Consequently, contemporary policies that aim at achieving sustainable development have urban transport and public transport policies at its core. To provide a better understanding of the role that urban transport policies, and public transport in particular can play in sustainable development, it is necessary to describe this term.

The presence of sustainable development term points out the underlying challenges the world faces. The most significant one is the climate change which refers to increases of the global temperature and to the causes of global warming. While people consume more for industrial and economic development since industrial revolution, consumption of natural resources results in significant problems like depletion of resources and increase of waste.

Sustainable transport is crucial to fight against climate change and achieve sustainable development. Many studies, researches, and discussions are carried out to cope with urban transportation problem and to achieve a sustainable urban transportation. As urban areas have some unavoidable problems originating from increased level of traffic, and particularly car traffic, tools to cope with those problems are created across the world.

Sustainable transport is a system that provides accessibility and mobility for all of the urban areas and residents via safe, environmentally-friendly, and energy-efficient transportation modes. It can also be described as a system which considers energy/resource consumption, social impacts, emissions, design, infrastructure and economic efficiency. That's why it encourages walking, cycling, public transport improvements, integrated public transport systems and the reduction of the usage of privately-owned automobiles, i.e. cars.

Sustainable transport strategies include an efficient public transport system, walking and cycling. An efficient public transport system means an integrated system. That is because, in most urban areas, public transport constitutes a multitude of different systems and services. Improvement of public transport systems bring along a multi-modal system, which consists of various different public transport modes. This improvement also brings along the need for integrated systems.

Public transport integration is the focus of this study. Integration contributes significantly to the public transport investment, service quality, mobility

improvement and ever-increasing population needs. Public transportation integration aspects in this study are line/route integration, information integration, tariff/ticketing integration and schedule/headway integration. These four components are investigated and discussed as the prerequisite factors for an integrated public transport system.

The two main research questions of this study are how to ensure integration in metropolitan cities' public transport systems which have multi-modal systems and whether or not Istanbul public transport system, based on the five transfer stations (Şişli-Mecidiyeköy, Zeytinburnu, Yenikapı, Aksaray-Yusufpaşa, Kadıköy) studied within the scope of this thesis, reveals a successful example of integration.

There are various reasons to investigate Istanbul as the chosen case of this study. It can be compared and evaluated with good practice cases in the world in terms of diversity of transit modes, daily passenger numbers, population and the level of mobility. Moreover, maritime transport and diversity of rail transportation (metro, tramway, funicular, streetcar, Marmaray etc.) make Istanbul a good case to investigate the integration of public transportation.

In order to assess success, the thesis developed an analysis framework based on a checklist, in other words a list of criteria. The aim of the thesis is to develop a framework, consisting of these items as a checklist, enriched and supported with the findings of the literature. Then the experience in the city of Istanbul will be analyzed with the help of this framework, i.e. checklist. This checklist aims to search for answering the research questions of this study.

Two main research questions are formulated within the scope of this thesis, as mentioned above. These research questions, as well as some sub-questions are as follows:

- Based on the literature and best-practice cases, how can a strong integration be ensured for public transportation systems in metropolitan

cities that generally have multi modal systems; in other words what are the indicators of a successfully integrated public transport system?

- Based on Istanbul's transfer stations that are studied in this thesis, how successful is Istanbul with regard to integrated public transport?
    - What are its strengths and weaknesses?
    - Based on its weaknesses, is there room for progress?

It is aimed to outline a general framework of an integrated public transport system in metropolitan cities and to assess, to what extent Istanbul achieves an integrated public transport system with these questions.

In the analysis, Istanbul is compared to good practice cases from around the world. The comparison will be made in four aspects: route/line integration, information integration, tariff/ticketing integration and schedule/headway integration.

Main data collection methods are collecting written documents and visual documents like photographs; field trips and observations on site; and interviews with major public transport service providers in Istanbul during the site surveys. Five transfer stations are investigated in terms of line/route integration. They are also investigated in terms of waiting times, walking times between the modes and information at stations. Hence, the other integration aspects are also observed at transfer stations. The aim is to describe the examples and draw some conclusions.

First of all, the study starts with a review of the definition and evolution of public transport and its classification; in other words, various public transport modes, in Chapter 2. In this regard, the role of public transport in contemporary transport policies, its relationship with efficient planning of transport and sustainable transportation are evaluated. In order to evaluate the dual relationship, the importance of public transport in contemporary transport policies is set forth. Efficient planning of transport has the main transport strategy upon a highly utilized and integrated public transport. By analyzing these, the importance of efficiency and hence integration of public transport systems are shown. Before analyzing public transport integration, history and classifications of public

transportation, in other words modes of public transport are analyzed. Then the literature review is presented about the increasing emphasis on integration as a necessity for an efficient planning and operation of transport. The literature on public transport integration is reviewed. By analysing the concept of integration in public transport within the literature, various levels and perspectives of public transport integration are revealed. Within the context of this study four aspects or components of public transport integration are assessed. They are line/route integration, tariff/ticketing integration, information integration and schedule/headway integration. Moreover, challenges for achieving integrated public transport systems are also discussed in Chapter 2. Even though there are multitude of challenges for achieving an integrated public transport system, such as institutional structures, fragmented operators and system deficiencies, successful cases exist across the world. Investigating the successful cities in spite of many challenges provides a basis for developing an analysis framework.

In this way, Chapter 3 includes good practice cases from different parts of the world. These cases are Singapore (Republic of Singapore), London (United Kingdom) and Toronto (Canada). These cities' transportation systems are generally accepted as featuring successful public transport systems, due to their high public transport ridership and efficient inter-modal interaction. They are also chosen due to some criteria like population of the city, diversity of public transport modes and level of mobility. Besides, these cities have easy access to their public transport documents and detailed English webpages of responsible institutions or associations. Namely, information access is also a factor in best-practice case selection. Analysis of the best practice cases are made by evaluating the cases in terms of the four integration components, which are, as mentioned previously, line/route integration, tariff/ticketing integration, information integration and schedule/headway integration.

After investigating the world cases, public transport policies in Turkey with a special emphasis on integrated public transport are discussed within Chapter 4.

The public transport policies at national level are described by summarising the five-year development plans, national transportation master plans, councils of urbanization (held in 2009 and 2017) and council of transportation, maritime and communications (held in 2013). Hence, public transport and integration issues from a perspective of national level is understood.

In Chapter 5, the research methodology of the study is presented. In order to reveal the method of research, the scope of the thesis is explained first. Secondly, previously mentioned research questions, aims and objectives are stated. Beside the main research questions, sub-questions are also produced in order to explore the case study, Istanbul in detail. These sub-questions are:

- How effective are the plan documents about public transport in delivering an integrated public transport service in Istanbul?
- Are there sufficient measures in plan documents to ensure an integrated public transport system?
- Is an integrated public transport system (route/line integration, information integration, tariff/ticketing integration and schedule/headway integration) achieved in Istanbul according to literature and when compared to best cases from the world?
- Do Istanbul's public transportation future plans involve emphasises on integration?
- Based on the analysis framework, how can Istanbul's public transport system be improved in terms of integration?
- Based on the research results, what policies and recommendations can be made for public transport integration in Turkish cities and cities worldwide?

In the rest of the methodology chapter, methods of analysis, case study selection and the checklist headings are presented. Selection of the chosen case study is described. In addition, a number of criteria are produced in the form of a checklist.

The checklist is composed of 31 questions that are derived from both literature review and the three best practice cases' experiences and implementations.

Chapter 6 is the analysis of the Istanbul case from Turkey. Istanbul is studied under three main headings in this chapter. Firstly, introduction section gives general information about Istanbul including demography, spatial planning and transportation of the city. Secondly, public transport systems in Istanbul are investigated. In order to find answers for sub-questions of the research, planning back-ground, public transport operators/institutions in Istanbul, public transport framework and policy documents in Istanbul and Istanbul's plans with an emphasis on integration of public transportation are evaluated. Thirdly, Istanbul public transport integration is evaluated in detail within the context of formerly-stated four integration levels. It is intended to analyse Istanbul case within the context of integration components and in comparison, with the three good-practice cases via the formulated checklist. This is the main analysis of the research. Istanbul public transport integration is thoroughly evaluated and compared with Singapore, London and Toronto in terms of the check-list questions, which are determined in Chapter 3.

As for Chapter 7, it is the Conclusion Chapter of this study. The main analysis of this thesis shows that Istanbul public transport system has inadequacies and weaknesses as well as potentials and possibilities. Although several achievements exist, there is also room for improvement in terms of system integration. Hence, findings of the analysis are provided in the last chapter. These findings of the study provide lessons and recommendations for future system map, information tools, fare policies and schedule arrangements, which are the components for achieving the whole system integration. So, the last chapter has three subtitles, and includes summary of the research, main findings and future research.

CHAPTER 2

CONTEMPORARY PLANNING POLICIES FOR PUBLIC TRANSPORT

2.1. Introduction

Public transport provides passengers access and mobility to all kinds of opportunities, e.g., employment, medical care and recreational opportunities. It benefits the people who choose it or must rely on it since they haven't got any other choice of transport. Public transportation reduces traffic congestion and travel times, air pollution and energy consumption. It is also a necessity for an efficient public transport system. Public transport is a crucial contributing factor to efficiency, mobility, environmentally-friendly systems and hence sustainable transportation.

In this chapter public transport's definition, history and classification as well as its importance in contemporary transport policies are explained. First of all, definition of public transportation and its historical development are explained. Following, classification of public transport systems, in other words the different modes of public transport systems are set forth. There is an increasing emphasis on integration within the literature since it meets the need for efficient planning of transport. So, it is important to state it's increasing importance. Contemporary policies for public transport and integration focus are emphasized by evaluating the different aspects of public transport integration. Literature on public transport integration is reviewed in this section. Lastly, possible challenges for achieving integrated public transport is evaluated.

This part of the research feeds fundamentally Chapter 3, which involve good practice cases from the world and the case study Istanbul. That is because this part constitutes a basis in order to determine criteria for integrated systems. It helps to assess the Istanbul case.

2.2. Definition, History and Classification of Public Transport

2.2.1. Public Transportation History and Public Transport Classification/Modes

Understanding the history of urban areas' development may help to understand history of transportation and public transport in particular. That is because location, size, structure, physical form and development direction of cities are designative features for public transport characteristics of that city.

Civilian transport is thought to have begun due to exchange of goods. Exchange of goods represent carriage of surplus of goods to another locations. The more the surplus of goods are generated, the more exchange and transport facilities they need. So, transportation accelerated itself (Vuchic, 2007, p.1). Some transportation modes dominated over a specific time periods in that available modes were limited. Horses or steam engines are the most distinct examples for those. Yet there are variety of options today after two centuries of technological development (Grava, 2002).

As stated earlier, the term sustainable development is given the status of a global mission by The United Nations Conference on Environment and Development (UNCED) in 1992 although it was introduced in the 1980s and popularized in the 1987 report of the World Commission on Environment and Development (the Brundtland Commission). The Brundtland Commission report defines it as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The two key concepts were limitations and needs. Then at the UNCED in 1992, national governments affirmed Agenda 21 that is the confirmation document of essentialness of human activities in various sectors to be developed in a sustainable manner (OECD, 1996).

Sustainable transport is related with sustainable development. Sustainable transportation implies sustainable development within the transportation sector. The OECD sets out six criteria for the attainment of environmentally sustainable transport in the target year 2030:

-Emissions of nitrogen oxides (NOx) caused by transportation will have been reduced for the objectives of ambient nitrogen dioxide and ozone levels.
-Emissions of volatile organic compounds (VOCs) that are caused by transportation will have been reduced to meet acceptable risk levels and to avoid excessive ozone levels.
-Per-capita carbon dioxide emissions caused by fossil fuel use of transportation will have been reduced consistent with global protection goals to prevent climate change.
-Emissions will have been reduced to an extent that harmful ambient air levels are avoided.
-The urban land will meet the need of motorized vehicles' movement, maintenance and storage; including public transport vehicles.
-The transportation noise shouldn't result in outdoor noise levels that present a health concern (OECD, 1996).

The three types of transportation system's sustainability are defined as follows:
-Social sustainability, that reduces poverty and involves equity issues.
-Environmental and ecological sustainability, that involves only acceptable levels of adverse external environmental effects and thus creates livable settlements.
-Economic and financial sustainability, that includes incentives for efficient response to needs while using the resources efficiently and maintaining assets (Akinyemi and Zuidgeest 2000, p.32).

Transport's share of global energy related CO_2 emissions is 23%. (https://www.iea.org/, last accessed: 12.11.2018, 16.42) To meet the objectives of sustainable transport in parallel with sustainable development, this rate is tried to be lowered by governments. Energy use per capita for transporting people is the least in public transportation. That's why public transportation usage in urban areas is crucial to meet the objectives of sustainable transportation and hence sustainable development.

Vuchic (2007, p.2) explains the public transportation before the 19th century as follows: Early public transport appeared via existence of boats and ferries as a public conveyance in trade cities like Venice and London. Coaches, sedan chairs, public

coaches pursue that. Grava (2002) indicates the industrialization, which emerges during the nineteenth century, to cause transportation, because urban revolution to metropolitan areas were defined by production and service zones. Nineteenth century's transportation modes were horse cars, street cars and finally underground metro lines in the later century. Twentieth century's transportation modes were wider. Various rail modes (heavy or light) and motor vehicles like buses and cars emerged (Grava, 2002, p.2). That could pave the way for scattered special-purpose centers. Movement of people varied according to their trip purposes. Many people could go to many distinct directions for various trip purposes.

Mobility and accessibility are significant features of a city. Mobility is the ability of people to go around the city by using private or public transportation vehicles. As for the accessibility; it is the possibility to go to a specific point of the city. Life in the urban areas are possible with these two significant features, because residences, working places, shopping centers, entertainment centers and green areas are located in different parts of the city. Not all of these are reachable on foot (Grava, 2002, p.1). Public transportation is one of the means which supply mobility and accessibility for the people living in urban settlements.

Public transportation is a public service which is generally provided by city governments. Babalık-Sutcliffe (2012, p.155) specifies six characteristic features to define a service as a public transport system:

-It is non-exclusive, i.e. everyone can make use of it (as long as they pay the fee).

-More than one person can make journeys on the system at the same time.

-Transport service is ensured according to preestablished routes.

-Transport service has a fee for it.

-Transport service has preestablished stops and stations which are the access points to the system.

-Transport service has time-tables or schedules even though these time-tables or schedules can sometimes be flexible.

In the light of Babalık-Sutcliffe's specification, it can be said that early public transport systems were not 'public' enough when compared to today's conditions.

Because those former public transport modes were not affordable for everyone or they were not systematically operated.

Figure 2.1 designates the urban transportation types including public transportation modes.

Characteristic/Usage Type	Private		For Hire		Public or Common Carrier
Common designation	Private transportation		Paratransit		Transit
Service Availability	Owner		Individuals, groups		Public
Service Supplier	User		Carrier		Carrier
Route Determination	User (flexible)		User (carrier)		Carrier (fixed)
Time schedule Determination	User (flexible)		User (carrier)		Carrier (fixed)
Cost-price	User absorbs		Fixed rate		Fixed rate
Carrier Type		Individual			Group
	Walking	Carpools	Rental car	Dial-a-ride	Street Transit (streetcar, bus, trolleybus)

Modes	Bicycle	Vanpools	Car sharing	Jitney	Semirapid transit (bus rapid transit, light rail transit)
	Motorcycle		Taxi	Charter bus	Rapid transit (rail and rubber-tired metros, regional rail)
	Automobile				Specialized modes
Optimum Domain of Operation					
Area Density	Low-Medium	Origin:Low, Destination:High	Any		High-Medium
Routing	Dispersed	Radial	Dispersed		Concentrated (radial) ubiquitous
Time	Off-peak	Peak only	All times		Peak, daily hours
Trip purposes	Recreation, shopping, business, other	Work only	Business, special services		Work, school, business, social, other emergency

Figure 2.1. Urban Transportation Types and Public Transport Modes

(Vuchic, 2007, p.46)

Urban transportation is classified according to various different aspects. (e.g., technology, physical system, operation) There are three transportation modes which are private, for-hire, public in regard to operation and usage. Private transportation represents a transportation mode which is provided by private vehicles like bicycle, motorcycle and automobile. Walking is also a private mode of transportation. For hire transportation, which is also called paratransit, refers to a carriage provided by an operator. Taxi, jitney and dial a ride are the most common examples of it. Public transportation consists of transport systems with fixed routes, predetermined schedules and fares. Anyone can use public transport under the condition that she/he pays the fee of usage. Bus, underground metro lines, light rail lines and rapid transit lines can be shown as the most common public transportation modes. Public transport is also named as mass transport, transit or common carrier (Vuchic, 2007, p.45).

Babalık-Sutcliffe (2012, p.155) indicates the five components of a public transport system as vehicle, route, parking/depot-area, station and the control unit. Vehicles are the carriages that transport and carry people. Bus, minibus, rail system vehicles, water bus (sometimes referred to as sea bus) and ferryboat are the examples for these vehicles. Routes are the corridors in which the transit service is provided (e.g. Traffic roads and rail roads). All those public transport corridors and routes represent the whole public transport network of a city. Stations are the plots in which the passengers get on or get off the vehicles. Parking/depot-areas are the storage areas where vehicles are parked and stored outside their timetables. Control units are the administration centers which control and follow the vehicles and services. The following sections describe different types of public transport systems and their service characteristics.

2.2.1.1. Street Transit (Streetcar, Bus, Trolleybus)

Bus is the most prevalent public transport mode within street transit. Buses are generally operated by using the same highway and road space with other motor vehicles or pedestrians. That's why it is controlled individually with a driver rather than an automated vehicle technology (Babalık-Sutcliffe, 2017, p.163). The history of bus service is traced back to the 1820s in France. After several cities in France developed public systems and named them as omnibuses with horses, London in United Kingdom and New York in United States follow that innovation (Grava, 2003, p. 305). When it is thought in today's context a bus is a vehicle accommodating many riders inside and using diesel engine and rubber tires. Buses are over-the-street vehicles and are generally utilized in mixed traffic. They have a fixed-route and pre-established schedules.

2.2.1.2. Semi rapid Transit (Bus Rapid Transit, Light Rail Transit)

Semi-rapid transit types are bus rapid transit and light rail transit in the general sense. Grava (2013, p.384) describes bus rapid transit as a systematically coordinated service at faster speeds when compared to the standard bus operations. Bus rapid transit contains adaptation with intelligent transportation systems and control methods. They

have improved design and preferential lines in contrast with standard bus service. The first bus rapid transit was served in Chicago in 1939. But actually, the major improvement of the service was within the following thirty years (Grava, 2013, p.385).

Light rail transit has its power from aerial lines rather than rails. That's why there is not an obstacle to serve it in the mixed traffic. However, it is also possible to operate in on an exclusive lane segregated from other traffic. In fact, preferential light rail transit is more common in order to increase service quality and speed. The reason to entitle light rail transit as "light" is because of the fact that light rail transit vehicles are usually smaller in size and have less passenger capacity. Light rail transit is operated generally in a transit unit of four cars (Babalık-Sutcliffe, 2017, p.165-166). The advantage of light rail transit is low investment cost compared to rapid rail transit, such as underground metro, and lower operating cost with high-volume passenger capacity compared to bus systems. Grava (2013, p.466-468) explains the logical reasons to advocate light rail transit as environmental characteristics, image and community acceptance, capacity and cost, flexibility in design and implementation, labor productivity, reliability and safety of operations, mechanical efficiency and power conservation, quality and attractiveness of ride.

2.2.1.3. Rapid Transit (Rail and Rubber-tired Metros, Regional Rail)

Rapid transit type is defined as the transit with high performance. This is because these transit systems have fully segregated routes, guided technologies, safety measures, and higher passenger capacity with up to10 cars per transit unit. The most dominant rapid transit types are rail rapid transit, i.e. heavy rail systems such as the metro and regional rail. Light rail rapid transit and automated guideway transit follows them at lower-capacity side (Vuchic, 2007, p.72).

2.2.1.4. Waterborne Modes/Ferry Service (Ferryboats with different classifications)

Waterborne systems in cities that are along sea, river, lake or bay are used for public transport services in such cities. Waterborne modes allow passengers drive even faster

than land based systems. They are classified by type of vessels and by type of service. Types of vessels are monohulls, catamarans, hydrofoils, hovercraft etc. Types of service are passenger ferries, automobile ferries and water taxis (Vuchic, 2007, p.493).

2.2.1.5. Special Modes (Funiculars, Inclines, Cog Railway, Cable Car, Aerial tramway, airborne modes)

There are considerable number of different public transportation systems in different cities. These systems are created according to topography or because of terrains and barriers. They can have a role to assist and integrate already built public transportation lines or routes. Vuchic (2007, p.73) defines specialized transit modes as pedestrians and pedestrian-assisting facilities (for instance paths, sidewalks, station areas, halls, stairways), terrain-specialized transit modes (for instance cog railways, cable cars, funiculars or inclined railways, aerial tramways), and water based transit modes (for instance ferry boats and hydrofoils).

Although there are various public transport systems, as listed above, automobile ownership and usage are considered as the single most significant reason for boosting mobility. On the other hand, it has various undesirable outcomes, such extreme energy consumption and emission per passenger, and hence city governments try to shift car users to public transport. However, there is not a single and simple way to make travelers use public transportation modes, particularly considering the variety of modes that may be required in making a single journey. The integration of public transportation in urban areas is the key to make public transport vehicles attractive for travelers. The automobile industry has a vision that the improvements for pollution control and cost effectiveness in the sector would make even the poorest people prefer private automobiles. The negative features of public transportation are expressed as being cumbersome and time-consuming (OECD, 1996, p.48); however, the improvements emphasized by the automobile industry cannot meet the requirement of OECD criteria or the definition of World Bank about sustainable transport. Besides, these improvements cannot be seen as solutions of noise and traffic congestion. Hence the direct and major way to meet the sustainable transportation objectives is public

transportation. Making travelers use public transportation is the recent challenge that public transit authorities are faced with. Public transportation should be integrated to increase the public transit usage rates. If a public transportation system is not integrated, the system cannot be convenient and attractive for users. That is why the following sections focus on the issue of integration in public transport in further detail.

2.3. The Concept of Integration in Public Transport

2.3.1. The Need for Efficient Planning of Public Transport: Increasing Emphasis on Sustainable Transport and an Integrated System

As described before, public transport improvement is a crucial action and policy area within urban transport planning. An increased usage of public transport is an effective way to meet mobility. It is also fundamental for the efficiency of the urban transport system and planning. In addition, it increases mobility choices and accessibility in urban areas with lower costs and less negative externalities compared to car usage. When the high car travel share is taken into account, it is important to keep in mind that public transport also relieves congestion, emissions and energy consumption. Hence public transport is also one of the main factors in climate action plans. In this context, public transport is also a fundamental component of sustainable transport policies.

Therefore, this section gives an outlook on the reasons behind the importance of increased share of public transport within the urban transportation systems and the increasing emphasis on integration of public transport systems.

There are various means of dealing with the global warming. All of the actions that are conducted to control the global warming aims to decrease carbon emissions. The relationship between sustainable transport policies and public transport lies right here. Because transport's share of global energy related CO_2 emissions is 23% and it has increased 2.5% annually between 2010 and 2015, while it was 20% in 1990 (https://www.iea.org/, last accessed: 12.11.2018, 16.42). There are many transport strategies upon public transport in that public transportation has less energy

consumption and carbon-dioxide emission per individual. In order to achieve sustainable urban development, one of the requirements is to have a high-quality public transportation system (Babalık-Sutcliffe, 2017, p.158).

Kennedy (2002) assesses public transportation and automobiles from economic, environmental and social perspectives. He finds out the certain feature of an overall sustainable transportation system; that is the flexibility, adaptability and combination (of mixture of modes). These features all exist in public transportation. In a general manner, journey demand is low in urban peripheries. The more public transport lines get to inner parts of the city center, the more journey demand will occur. Because people get on the public transport vehicles and these vehicles head forward to the city center. Hence, concentration of journey demand increases in the city center (Babalık-Sutcliffe, 2017, p.157). Urban transportation and expansion of cities are in a dual relationship with each other. Because accelerated urbanization and urban development is in one sense a result of urban transport improvements. On the other hand, population growth and urbanization require an advanced public transport system. That's why planning of public transport in an integrated manner is crucial to administrate the high levels of mobility. In this context, transfers gain importance.

Transfers within the public transport system offer users flexible travel choices and encourages intermodal travelling. A well-integrated system increases the public transport ridership. In this manner, public transport integration is a key for reversing the increased car usage.

Jeon and Amekudzi (2005, p.31-35) states that an increased use of public transit is a requirement for a sustainable transportation and integration of public transport is a certain way for an increased use of public transport. That's why it is significant to understand the public transport integration and how it has found a meaning and response within the literature.

Public transportation process is defined as the movement of passengers over a distance during an interval of time. The relationship between passengers, distance and time generate basic operating elements of transportation (Vuchic, 2005, p.7). Vuchic (2005) explains transit network as a set of transit lines that connect with or cross each

other. These lines are coordinated for effectiveness and to supply integration. Transfer stations are joint stations for minimum two lines. Transfer stations enable passengers to transfer between transit lines (Vuchic, 2005, p.4-6). Integration is physically ensured by these transfer stations where lines intersect or terminate at. A transit system with too few transfer stations presents a commuter transit which is used for journeys between home and work. Therefore, they may not present many types of journeys and serve only in the peak hours of the day generally. On the other hand, public transport systems which serve all-day and area-wide, are grounded on transfer points of lines and modes.

Inadequate transfer arrangements may stop potential passengers in catchment areas from using public transport. In the light of the explanations, it can be said that integration in a public transport system in general terms is a combination of two or more lines or modes in the same station/place to make public transport more effective. Integration at basic level refer to the integration of different elements in public transportation systems. It also focusses on interchange or in other words transfer. There are various recommendations about how integration should be achieved in the most effective way.

Even though integration of fares, services and information within public transport has been a concern at the operational level, there is a more strategic form of integration in practice. It is relevant to the integration of policy instruments for greater performance achievement from the overall strategy, i.e. integration between policy instruments involving: different modes, infrastructure provision, management, information, pricing, integration with other policy areas, integration between transport measures and spatial planning measures (May, et al., 2006, p.320-321). Hence some possible overlapping between these are shown to be inevitable. Besides horizontal integration between agencies, spatial integration between local authorities and vertical integration between local/regional/national/supranational administrations are also important aspects (May, et al., 2006, p.320-321).

Givoni and Banister (2010) considers integration in public transport as physical, operational or managerial integration. In this respect; it is stated that all consisting

elements of a network like sub-networks, large variety of users, operators and governing institutions should be integrated to provide an efficient system. Integration encompasses three levels which are integration of institutions, integration of supply of transport (integration of different modes), and integrating transport considerations into the decision making regarding the location with all its activities that create demand for transport.

Goodwin (1999) discusses in his work transport strategies which are mostly related with 'predict and provide' approach (e.g., British Government's white paper). As a matter of fact, interest in the development of integrated transport strategies is traced to this "predict and provide" realization (Goodwin, 1991). Policy shift from car-based to public transport-based strategies are emphasized and implementation problems are described. A well-integrated transport system is suggested to get over the negative impacts of traffic congestion and pollution.

Guihaire and Hao (2008, p.1270) indicates public transport's organizational changes over the last decades. The two crucial trends of today's public transport problem are also reviewed in the study. These trends are privatization and deregulation movement and the development of integrated intermodal transit systems.

Both public transport systems' integration within a mode and integration with other modes are essential to ensure an integrated public transportation. In this context, Babalık-Sutcliffe (2017) explains the necessary actions as follows:

- Integration should be provided between the different lines of a transit mode. Transfer stations should be designed for transition from one line to another.
- Integration should be provided between different transit modes. Railway systems in particular should be supported with feeder bus lines. Transfer stations should be designed for this kind of inter-modal transition.
- It is essential to plan public transport stops and stations in integration with pedestrian pathways and areas. Hence, pedestrians' access to stops and stations can be easy and secure.

- Public transport systems should be integrated with bicycle transport. Bicycle roads and lanes should access public transport stops and stations, which should have bicycle parks.
- Fleet of transit vehicles should include bicycle carriage arrangements.
- Park and ride facilities should be planned at stations in the urban fringe to allow drivers to reach the center by public transport. This way, park&ride should be encouraged.
- Design requirements should be met in transit stops and stations to allow taxies and private automobiles to drop-off or pick-up passengers (Babalık-Sutcliffe, 2017, p.189-190).

As it is understood, integration is about all transit modes as a transit system of a city rather than being about one kind of urban transit mode. Walking and cycling is also included in the system. The more the public transportation is integrated as a whole system, the more demand will occur for the public transport systems.

Eggenberger and Partidario (2000, p.204) suggest five forms of integration. They are substantive (physical and biophysical issues), methodological (integration of environmental, economic and social impact assessment approaches), procedural (environmental, social, economic assessment, spatial planning and environmental impact assessment), institutional (provision of capacities to cope with potential issues and duties) and policy (sustainable development as the guiding principle) integration. Public transport systems should serve an integrated service throughout the urban area to compete against car centered transport culture and to be attractive for passengers. Both intra-modal and inter-modal integration of different lines necessitate convenient and efficient transfers among lines to be guaranteed. Vuchic classifies the components of the aforecited integration as functional design of lines, optimal layout of transfer stations, coordinated scheduling, information and a joint tariff (Vuchic, 2005, p.215). Transport Studies Unit in the University of Oxford defines the levels of integration as integrated information of routes, timetables and fares, integrated ticketing, availability of tickets and integrated fares, integrated networks both in planning and operational

stages and wider integration, e.g. integration with nonpublic transit modes or some arrangements for private transportation like park and ride (Öncü, M.A., 2007, pp.18-20).

Sharaby and Shiftan (2012, pp.63-64) recommend three different levels which may refer to integration. They are informative integration, physical integration among different networks and fare integration.

It might not be possible to cover all of the perspectives regarding integration in this study. The literature also focusses on policy integration and institutional integration. From this point of view, these integration aspects might be discussed as one of the integration components. However, the main approach in this study is to try to cover the public transportation integration aspects which are related with the planning profession and hereby with the spatial dimension. That's why even though the challenges about the institutional structure are examined within the scope of this study, the main public transportation integration aspects investigated in this study are line/route integration, information integration, tariff/ticketing integration and schedule/headway integration. These integration components are investigated and discussed as the prerequisite factors for an integrated public transport system. They are expressed in following sections in this chapter.

2.3.2. Line/Route Integration

A transit line is a provided service on a predetermined schedule and on a fixed alignment by public transport vehicles. A transit route generally specifies street transit although it is often synonymous with transit line. A transit route is often overlapping lines rather than major rail lines (Vuchic, 2005, p.4). Route; in other words, is a defined road that a public transport vehicle follows regularly to make passengers get from one place/station to another place/station in the city.

Transit lines offer passengers opportunities of travel path selection with their integration. The more transferring opportunities there are, the more a network becomes efficient. But correctly planned transfer is a requirement for that. As for a

correctly planned transfer; well transfer design, convenient walking paths and station amenities are required (Vuchic, 2005, p.215).

Edwards (2011, p.1-20) emphasizes transport intherchanges which provides integration in public transport in detail while explaining integration of lines and routes. Transport interchanges or transfer stations are crucial in that the integration of lines/routes is achieved in these places. A shift from automobile use to public transport cannot be achieved unless interchanges are well designed. New public transport vehicles are not solely the key to lure travelers. The study also explains the importance of policies on different modes' connections rather than singular transport mode's line connection.

There are strategies in the Turkey's Council of Urbanization's (2009) Commission Report of Urban Technical Infrastructure and Transportation about integration of public transport. According to these strategies, paratransit services (dolmus, minibüs) which are usually conducted by private sector should feed the public transport system rather than compete with it. Three indicators are determined to achieve the strategy of integration. These indicators are increase in the number of feeding lines, increase in the number of passengers that use feeding lines and increase in the number of stations (The Council of Urbanization, Urban Technical Infrastructure and Transportation Commission Report, 2009, p.74).

Line/route integration is one of the components of public transport integration that encompasses integration both between one mode's lines' and between different modes' lines. It also encompasses pedestrians, bicycles and automobiles. Because a well-integrated system allows passengers to park their automobiles or bikes at stations, well designed and accessible pathways are needed for pedestrians and for bikers to carry their bicycles along their journey. That is why integration within one mode is not solely adequate. Different modes with all their lines/routes should be integrated with each other. On the other hand, integrating different modes' lines is not an easy issue to tackle, because every mode has its own design characters or specific features in spatial configurations. For example, buses are operated at street level. Many rail lines are below the surface. Some transit modes like bus rapid transit operate in the

middle of highways in a segregated manner. As for the maritime transit they need special corridors to access landward. Beside all of these, such factors as park and ride and bike and ride facilities are also crucial.

2.3.3. Tariff/Ticketing Integration

Transit fares and ticketing are also crucial to attract people to use public transport. It is also one component of public transportation agencies' operations. Fares also have an influence on shape and development of urban areas including suburbs and fringes. Sinha (2003, p.334-340) presents the challenge of captivating travelers to public transport unless economic measures are combined with dramatic improvement in the levels of transit service. Appropriate pricing policies is one of the ways, together with integrated planning of land use and transportation. Linking neighborhoods with regional rapid transit services can make public transportation economically viable. It is understood from the study that tariff/ticketing integration is a necessity to allure travelers. More importantly, it complements and strengthens line/route integration.

Various factors need to be considered in order to determine accurate public transportation tariffs. These are objectives, necessities and limitations that are related to fares, fare collection types, structure of fares with regards to zoning and/or timing, special fares with regards to user types, level of fares with regards to level of payment and its impact on ridership (Vuchic, 2005, p.374).

The word tariff expresses the list of prices while using public transport. As to ticketing; it is the production or selling of tickets. In respect to these meanings; tariffs are one of the final products of ticketing systems. Tariffs show fares to the passengers.

The process of determining appropriate tariff/ticketing system involves a number of factors as mentioned before. For example, although revenue maximization is a goal of ticketing, this should not be at the expense of attracting passengers to the system with affordable and convenient pricing policies. Having said that, covering operating costs is another factor in consideration. Contribution from public bodies, for example in the form of government subsidies, can also affect decisions regarding tariffs and ticketing.

Tariff/ticketing process is also affected by fares' collection types in that fare collection itself also has a cost. It can be noticed that there are different collection types in transport vehicles or at stations. Vuchic (2005, p.376-377) classifies fare collection methods as follows:

1-Pay-enter method, which refers to payment at the beginning of the trip,

2-Paying on board, by using ticket issuing machines, especially in specific public transport modes like bus and light transit,

3-Pay-leave method that is used with graduated fares in zoned systems. Those also vary according to the forms of payment (cash or pre-paid).

These methods are to be selected according to public transportation mode or operators. Various public transport modes operated by different operators may sometimes cause multiple ticketing systems in the same city, although this is not ideal for a fully integrated system.

Figure 2.2 is an illustration of possible consequences of an increase in the ticket fares. As it can be seen, if fares increase, passengers switch to private automobiles, and consequently service frequency and speed reduce. In that case, people living in urban fringes become disadvantaged. Because people in peripheries are most affected by delays, prices and congestions due to distance and zonal systems.

The second visual is about fare structures. The first (a) is flat fare structure. Flat fare is the simplest fare structure. It doesn't consider distances and the fares can be collected both at gates in a station and while boarding a vehicle. Although this structure can be appropriate for small sized cities, the more geographic size increases the more inequity for passengers occur in this structure. The second one (b) is zonal fare structure. Zonal fare is one of graduated fares. The urban area is divided into zones and the price is determined according to journey lengths. The possible negative aspect of zonal fare structure may be short trips crossing zone boundaries more than once. The last visual (c) illustrates sectional fare structure. Sectional fare structure is also a type of graduated fare. The difference of sectional fare from zonal fare is that, sections are often shorter than zones and sectional fare is more complicated to compute. That's why sectional fare structure is not much dependent on distances.

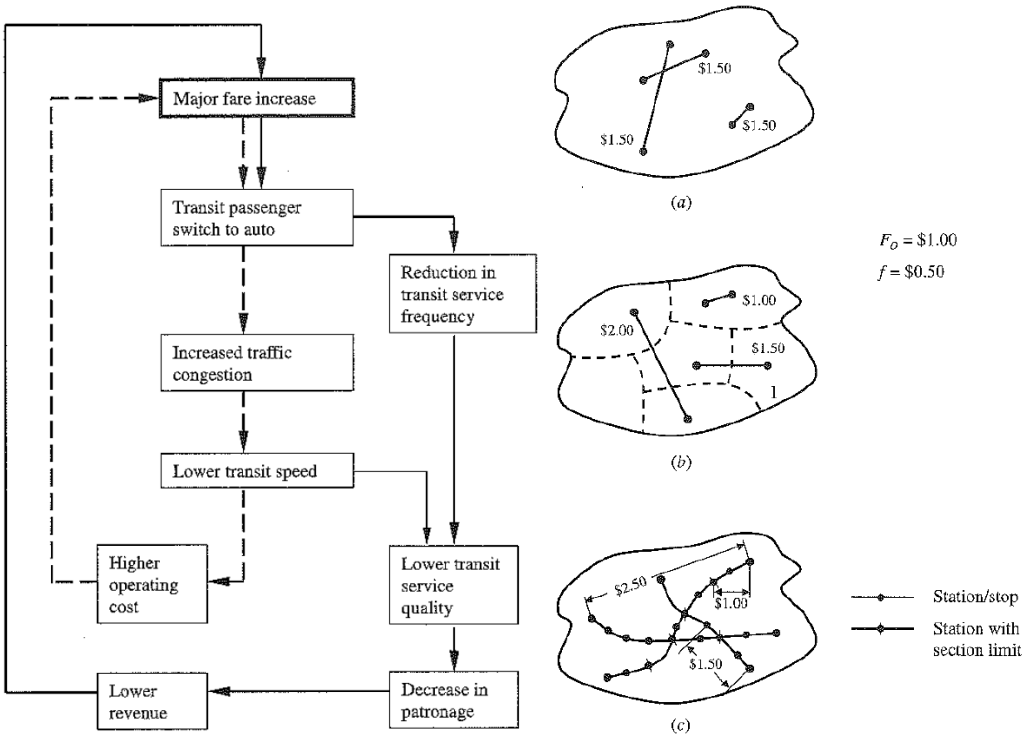


Figure 2.2. Consequences of Fare Increases and Fare Structures

(Vuchic, 2005)

As an example to zonal fare structure, the map of Hamburg in Germany is given in Figure 2.3.

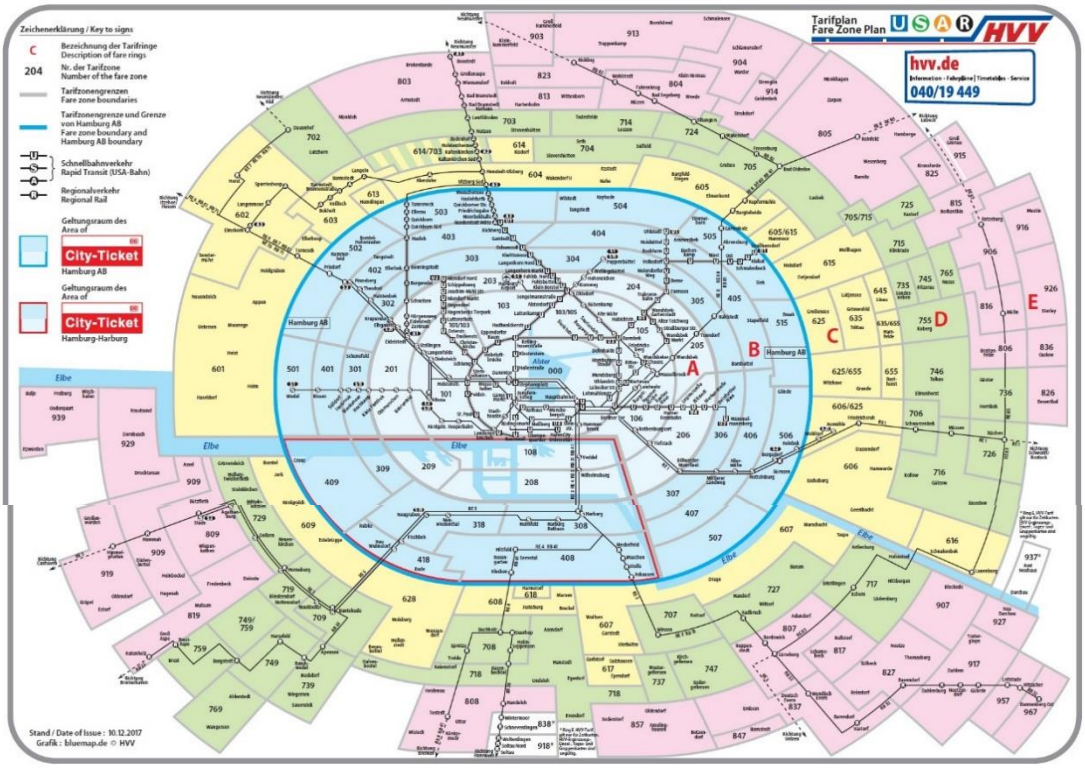


Figure 2.3. The Fare Zone Plan of Hamburg, Germany

(Source: http://www.hvv.de/, last accessed: 13.07.2018, 18.45)

There are some special higher and lower fares as follows: fares for high-quality services, peak/off-peak and commuter fares, child/family/student fares, senior citizens/disabled/low income persons' fares, night/group/family and other special fares. These differences in fares may have positive results, like attracting new passengers or some determined passenger types, increasing the revenues and achieving social goals. However, it can also lead to confusion for passengers.

Goldman and Gorham (2006, p.267) express the fare integration as a factor unifying various agencies and modes under a single fare media brand. Fare integration includes fare structure simplification, time-saving fare collection systems, inter-agency payment integration and the use of smart cards for multiple purposes. Fare integration implementations also serve as revenue sources for agencies, accessibility and promoter for monthly pass participations.

An integrated tariff/ticketing in public transport systems constitutes a fair pricing for every passenger and place of a city. Besides, tariff/ticketing is not only about fares or prices of travels. An integrated tariff/ticketing system also paves the way for an understandable and easy journey planning for passengers. This situation makes public transport attractive.

In the light of the information above, it can be said that an integrated tariff/ticketing has also a cost. It can be deduced that government subsidies and political support is something crucial for the appropriate tariff/ticketing. An integrated tariff/ticketing is necessary; in that every place of the city including city center and peripheries need to have an equitable ticketing.

In despite of the necessity, there are also limitations for tariff/ticketing integration. Table 2.1 shows some items which are with regards to fare determination and limitations for tariff/ticketing integration.

Table 2.1. *Some Objectives and Necessities of Fare Determination and Limitations for Tariff/Ticketing Integration*

(Source: Author, based on the literature review presented above)

Objectives of Fare Determination	**Necessities of Fare Determination**	**Limitations for an integrated tariff/ticketing**
-Maximum number of passengers -Maximum revenue for agency -Specific aims relating places or users	-Affordable ticket prices -Easy and low-cost collection of tickets -Equity and fairness of prices -The quality of service -Competing modes or agencies' prices	-Public transport modes' different tariffs/ticketing -Fragmented operators -Financing/Profit motive/Expenses -Lack of government subsidies/political support

Integration of tariff/ticketing is also related to transfer fares. Transfer tickets are generally arranged in a lower amount when compared to full amount. Yet, transfer fares vary according to city, public transport mode or operator. A separate fare can be

charged for each line in some cities, if there is no particular transfer fare. Nevertheless, large cities often have transfer fares in their fare structure. This is a crucial part of tariff/ticketing because transfer fares can encourage people to use public transport due to affordable and convenient transfers. It that case, it can be said that transfer fare regulations are crucial for the integration of tariff/ticketing and to attract possible passengers in public transport modes' and/or lines' catchment areas. The important thing here is that transfer fare regulations should include all modes and operators. Because people in large cities need to transfer between public transport modes and lines, which are sometimes conducted by different operators. Besides, a line or a mode they use can contain only few stations. That's why, affordability is a crucial point for passengers as it has been stressed before. Then, tariff/ticketing integration is also an important constituent for an integrated public transport.

Sharaby and Shiftan (2012, p.63) indicate that changes in fare policy are usually carried out as a part of a larger reform or policy change, which aims to increase ridership, accessibility, and quality of public transport.

To add more, there are strategies in the Council of Urbanization's (2009) Commission Report of Urban Technical Infrastructure and Transportation about integration of public transport. According to these strategies, public transportation modes should be selected in conformity with the city's physical and geographic structure and each mode should be integrated with major and/or feeder-lines. Integration should not only be about physical aspects, but also about timetables and tariff/ticketing**.** Three indicators are determined in this report to achieve tariff/ticketing integration. These indicators are putting smart tickets into practice, increasing the percentage of smart ticket usage and increasing smart ticket numbers (passengers) (The Council of Urbanization, Urban Technical Infrastructure and Transportation Commission Report, 2009, p.59-74).

2.3.4. Information Integration

A public transport mode and its lines are planned and designed according to possible passenger volume, physical conditions and characteristics of demand. A line's

integration with other lines and other modes is ensured by transfer stations. Transfers are classified according to headway length, type of line, schedules and tariffs. All of these factors are also components of information. That's why a public transport system is needed to have an information integration to secure a wholly integrated system.

Good information makes public transport services human-oriented and passenger-friendly. It also makes cities livable places and public transport systems more attractive.

Sinha (2003, p.340) explains that the use of information and communication technologies is a key for providing a seamless intermodal transportation and a crucial factor to make public transportation competitive.

There is a change from 'transit users by necessity' to 'customers by choice' in public transport (Vuchic, 2005). That is because passengers have various choices for travel, including the choice of automobile. Under these circumstances, transit agencies need to retain the present and potential users instead of assuming passengers as automatic users without any choice. Public transport information systems are needed to be more elaborate and passenger-friendly to make public transport attractive.

A transit information system constitutes a meaningful whole with its components and planning-testing requirements. Vuchic indicates (Vuchic, 2005, p.350) two aims when planning information system. These are providing information about the system and its services and increasing efficiency of operations and utilization of services.

Babalık-Sutcliffe (2017, p.158-160) explains understandability as one of the service parameters. She also points out service parameters as effective factors for passengers' decisions about deciding to use or not to use public transport. Understandability here refers to information. Understandability is a principle that informs people about public transit system's route, terminal stations and their locations, ticket fares and ticketing system, places to buy tickets, how to buy them from ticket machines and the form of payment. As a consequence, information makes public transport systems understandable and it is user friendly by meeting their requirements.

For instance, if a passenger wants to transfer from a railway line with a short headway to a bus line with a long headway, she/he wants to have information about her/his

waiting time. She/he needs to have information about schedules in order to have this clarified. She/he also needs to know transfer point or possible transfer points in separate lines or modes. Information then can also be explained as a passenger's resource while selecting own pathway in a public transport system. This information includes public transportation modes with their lines and routes, stations and transfer stations, the schedules and headways, tariff and ticketing.

Likewise, Goldman and Gorham (2006, p.266) highlights the intelligent transportation system developments of major metropolitan areas' transit agencies to provide real-time information to travelers. These information integration works are shown as an indirect way for attracting additional travelers and mobility.

Generally, passengers in major cities have a chance to plan their trip by using internet via these intelligent transport systems. Origin, destination, preferred time and mode, transfer numbers are inputs for those kinds of applications/services. That kind of information gives passengers a chance to plan their journeys without wasting time and money. For example Figure 2.4 is obtained from one of the major cities; Istanbul Metropolitan Municipality's website (Istanbul Electric Tramway and Tunnel Establishments –IETT-) about public transportation. The website is named "How do I get to?".

Figure 2.4 shows how to reach a specific point, which is Göktürk Street, from Sabiha Gokcen International Airport by using public transport. This website allows passengers to find their own pathways to reach where they want to get although there are fragmented public transport operators in the city. A positive feature of the website is that it shows various options according to passengers' choices. There are options related with transfer numbers, walking distances, travel times and public transport mode selection.

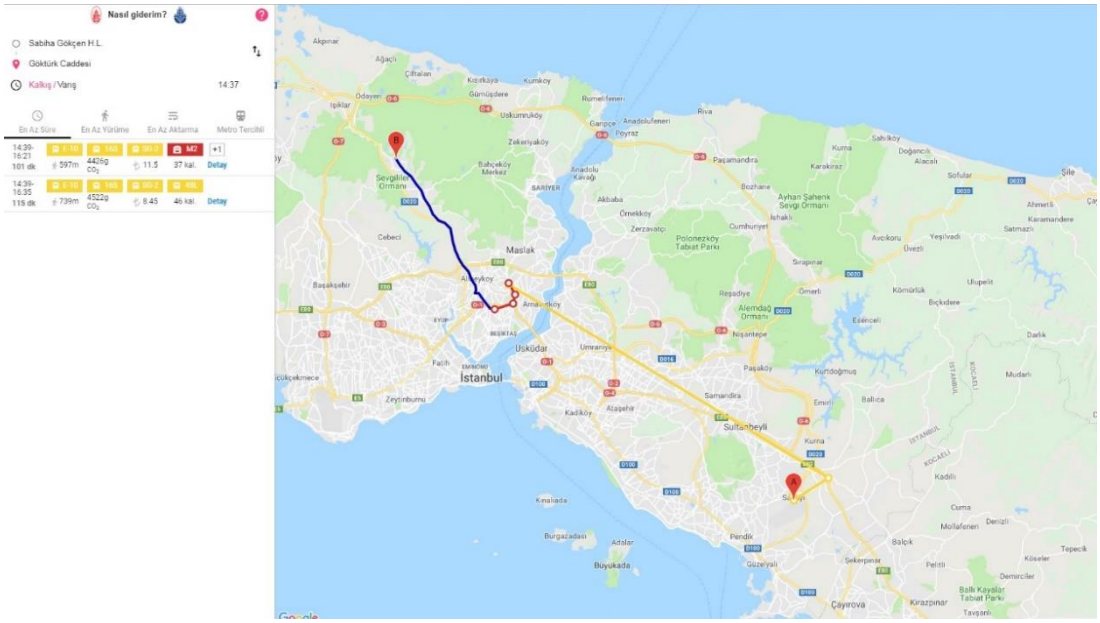


Figure 2.4. A Website of Istanbul Electric Tramway and Tunnel Establishments –IETT- Shows Various Ways to Reach a Determined Point from a Specific Point in Istanbul

(Source: http://harita.iett.gov.tr/, last accessed:10.07.2018, 16.07)

Figure 2.5 shows these various options for personal choices.

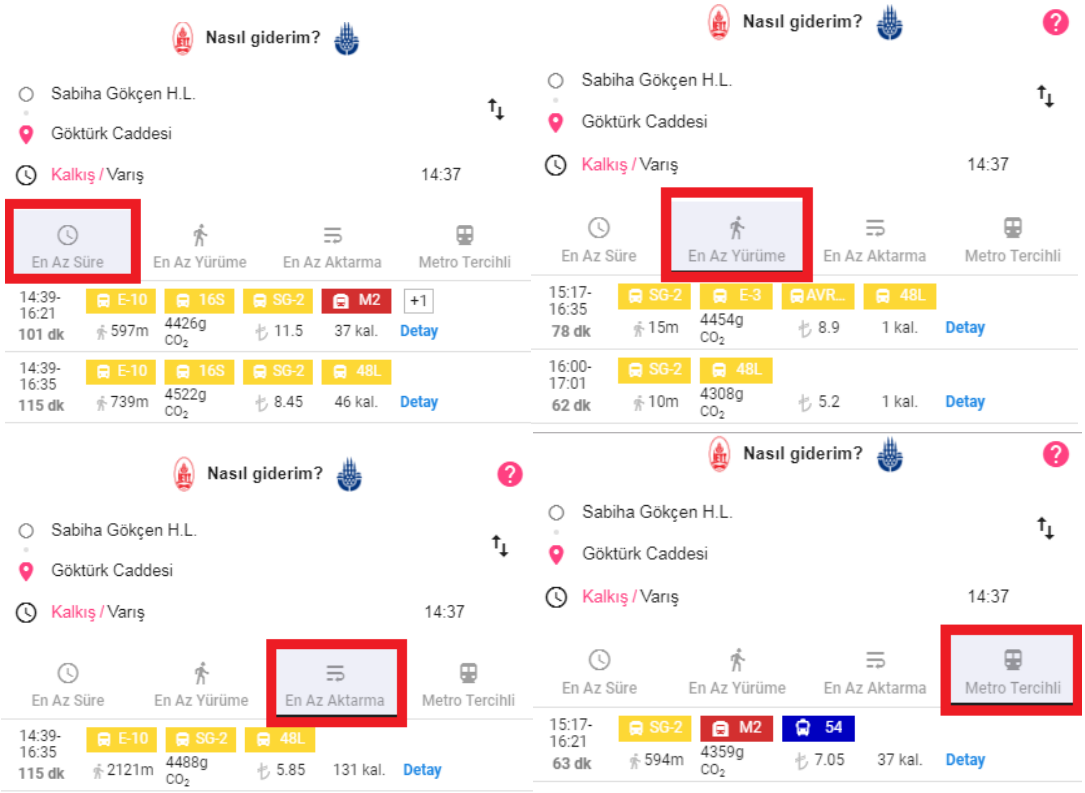


Figure 2.5. Various Pathways Determined According to Transfer Numbers, Walking Distances, Travel Times and Public Transport Mode Selection

(Source: http://harita.iett.gov.tr/, last accessed:10.07.2018, 16.15)

The website also gives details about every part of the journey with time schedule and travel times. Besides, part of the journey is colored differently and shown with icons in order to make passengers understand transfers and distinguish public transport modes. The details about a whole journey and explanation of colors and icons are shown in Figure 2.6.

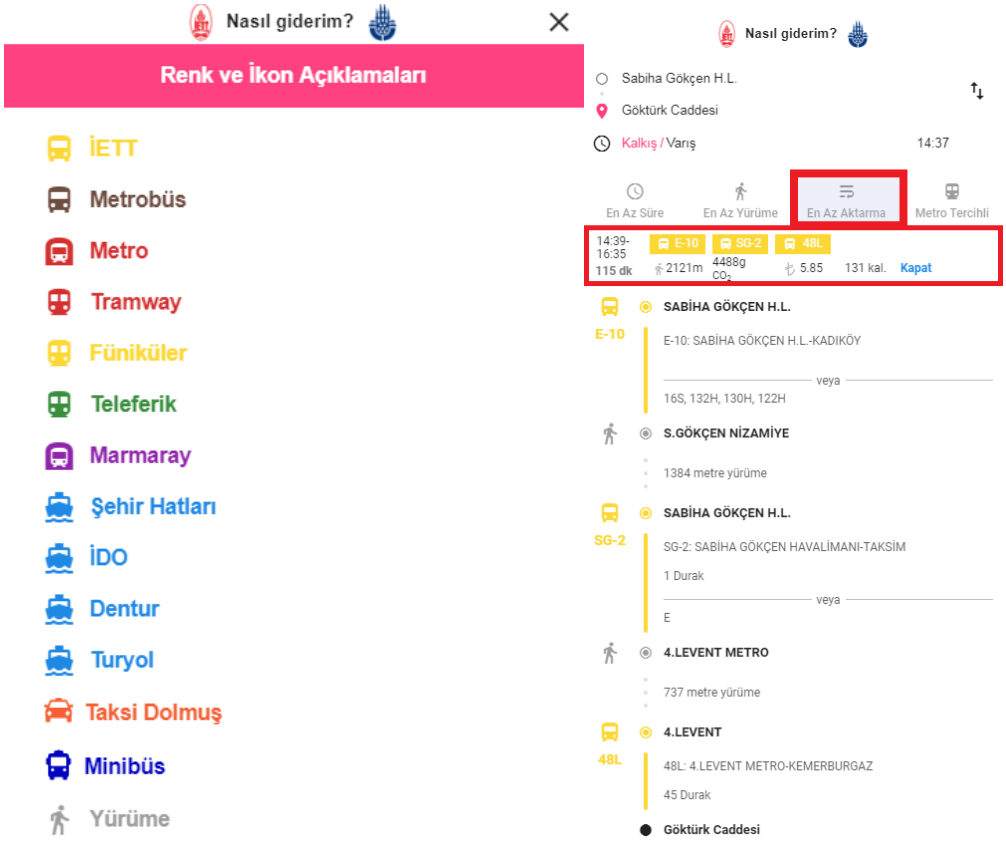


Figure 2.6. The Details About a Whole Journey and Explanation of Colors and Icons

(Source: http://harita.iett.gov.tr/, last accessed:10.07.2018, 16.20)

This IETT website might be a good example to understand information integration since it integrates different components of information, which are public transportation mode, headway length, type of line, and schedules. There is only a deficiency about information of ticketing ways, prices and tariffs.

Vuchic (2005) states that information systems' components should have a coordination with each other. That is because only such an integrated system can provide information for every individual of the public. He also addresses the necessities of a transport service information as classifying present and potential users (regular users on regular lines, regular users on different lines, incidental users, visitors etc.), information items (networks, lines, schedules, transfers, fares, special services, changes etc.) and information locations (before beginning a trip, information in

vehicles, information in public places, general information distribution for the public etc.) (Vuchic, 2005, p.351-356).

Updating all information resources is also necessary for all of the transit agencies and public transport modes in order to prevent poor or confusing services and to procure continuous maintenance. An integrated information is therefore also dependent on the attitude of transport agencies and employees and their contact with passengers.

Integrated information is a key point for an integrated public transportation system, because even though a public transport system may be well integrated in terms of tariff/ticketing, lines/routes and schedule/headway, passengers may still not wish to use public transport due to confusing and seemingly, long and costly journeys if there is not an adequate information integration among these variables. Different operators and fragmented institutional structures have a crucial role for information integration. Institutional structure is an issue further analyzed in this study, under the title of "Challenges for Achieving Integrated Public Transport".

Lack of integrated information, as well as failure in coordinating schedules and joint fares, causes confusing, long and costly transfers for passengers. Great Britain with its deregulation and legal prevention of multimodal companies is shown as an example for this (Vuchic, 2005, p. 223).

2.3.5. Schedule/Headway Integration

Schedule/headway integration is the last component of the integration of public transport. There are a lot of resource types, which are the concerns of different groups in public transport sector. Individuals' available time is one of those resources that they consume while travelling. Hence schedule/headway integration is one of the solutions to reduce depletion of time source (Goldman and Gorham, 2006, p.262).

Headway is the time interval between two same transit mode's vehicles passing from one defined point. Headways can be clearly seen on schedules. One significant thing is that the terms headway and frequency have different meanings (Vuchic, 2005, p.7-11). While headway indicates the waiting period of a passenger, frequency indicates the number of transit units (bus, train, etc.) in a time period. For example; if an

underground railway's vehicles depart in every 15 minutes; its frequency is 4 departures per hour and it's headway is 15 minutes. Accordingly, it can be said that schedules show both headways and frequencies.

Scheduling is governing the frequency of service, number of transit vehicles, their travel time and elements of operating. Regular headways minimize waiting times, prevent delays and lead to reliability of service and higher capacity. Almost all of the well-planned and well-operated public transit services are scheduled with their uniform headways. Scheduling periods can refer to days (operating hours or peak/off etc.), weekly (weekday/weekend) and seasonal (winter/summer). Schedules show the passengers headways, frequencies, terminal times, kilometers and sometimes vehicle types and passenger capacities. Figure 2.7 depicts the flowchart of scheduling with its three phases, which are 1-Input: Data Preparation, 2-Scheduling Work, 3-Output: Schedules, Performance Data, Their Uses.

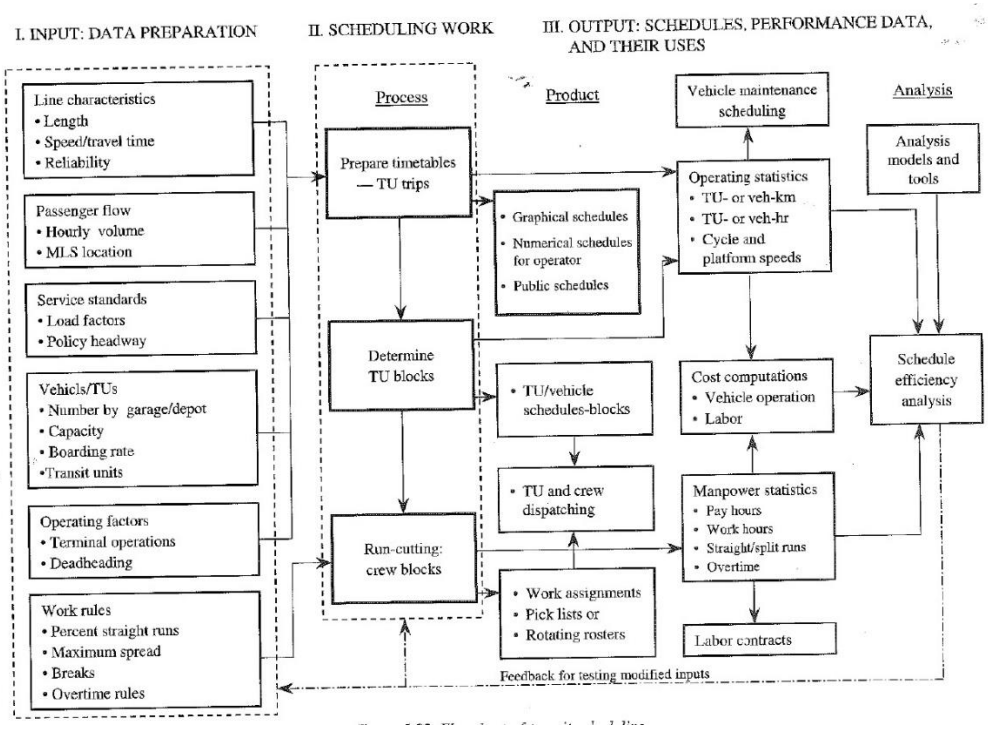


Figure 2.7. Scheduling Flowchart

(Source: Vuchic, 2005, p.45)

Every line and mode have their own schedules. Yet they interact with each other through transfer stations. That is why schedule/headway integration of public transport modes and lines is crucial for an efficient planning of public transport operations for passengers.

As explained in the previous title, there are strategies in the Council of Urbanization's (2009) Commission Report of Urban Technical Infrastructure and Transportation about integration of public transport. According to these, integration is also about timetables/schedules. Two indicators are determined to achieve timetable/schedule integration. These indicators are decrease in the journeys' average transfer duration (minutes per transfer) and decrease in the journeys' average transfer number (transfer per journey) (The Council of Urbanization, Urban Technical Infrastructure and Transportation Commission Report, 2009, p.74).

It is seen that the components of integration investigated in this study are very much related with eachother, and they whould be considered althogether to achieve an integrated public transport. Edwards (2011, p.7-19) states that a well designed line/route integration is also a way for decreased time spent on travel.

However, as described above, scheduling is also crucial in ensuring decreased time spent on travel in public transport. It can also be argued that information about the time that a traveller is likely to spend in making a journey in public transport will also play a key role in the choice of public transport as a travel mode. In short, components of integration foster each other's aims.

2.3.6. A Summary of Literature on Public Transport Integration

The review of the literature reveals that integration in public transport is multidimensional. Integration is a factor that makes urban transport efficient and sustainable since it helps public transport have high ridership rates. Although there are many different dimensions expressed by literature there are some common aspects. First of all, integration about operational (schedules, tariffs etc.) and physical (integration of lines, modes etc.) aspects are required in order to response to increasing transport demand and to allure travelers to use public transport in urban areas. They

have comprehensive positive effects in increasing public transport ridership and providing an efficient transportation. It is also crucial that public transport investments are accompanied with spatial planning measures. Spatial planning measures, such as design for convenient transfer (Edwards, 2011), makes greater performance achievement and is an effective tool for improving an integrated public transport system. In addition to these spatial planning measures, horizontal integration between transit agencies/operators is also emphasized.

Integration aspects should be planned and applied together in order to receive positive feedback from the commuters in terms of high ridership levels and to gain maximum benefits from investments.

Integration of lines and modes can be supplied not only through the phsyical integration of lines and routes, but also with schedule/headway, information and tariff/ticketing integration. Information integration can yield benefits if it provides information upon other dimensions of integration. Besides it is important to achieve these arrangements in parallel with spatial and transport plan decisions and visions.

The literature on public transport integration reveals a number of considerations, which are as follows:

- The concept of integration within the literature has many dimensions, some of which are relatively more common such as operational (schedules, tariffs etc.) and physical (integration of lines and modes) integration.
- According to the literature, the backbone of an integrated system is based on transfer stations and the physical integration of different lines of various modes.
- However, this should be supported by other types of integration: not only tariffs/ticketing integration but also information and schedule integration.
- However according to the literature, the backbone of an integrated system is based on transfer stations and the physical integration of different lines of various modes.

- The literature generally emphasizes that in order to create an efficient and integrated public transport system with a high ridership, these various integration aspects should be planned and applied together.
- According to the literature review, the most common challenges for achieving an integrated system are lack of regulatory control of institutions and fragmented institutional framework (diverse planning/delivery of the service, lack of coordination, blurred definitions about institutions' roles). Fragmented institutional structure, in particular, is emphasised strongly in the literature; however, there are also successful examples of well-integrated systems in spite of having fragmented structures, such as London and Toronto, which are analysed also in this study.

To sum up, various dimensions of integration in public transport can be achieved if each of them can be applied as components of a wholly integrated system, and this can yield high ridership. That's why it is crucial that public transport operations should be planned and implemented by feeding eachother so that the system can be effective and integrated. For this, integrated and coordinated planning and operation is required, as emphasised above. However, due to fragmented operators in many cities, this can also present a challenge. This issue is discussed in further detail below.

2.4. Challenges for Achieving Integrated Public Transport

Even though there are many planning approaches, operational strategies, policies and goals to achieve integrated public transport, successful implementation of policies still seems to be a major problem.

Lack of knowledge about public transportation is one of the main problems in many cities/countries. Although there can be many national policies, urban transportation should also have the cooperation and bilateral understanding of the public to maintain a good public transport service. Regulatory control for integration and coordination of public transport services are needed. It can be achieved by a main institution that

coordinates and regulates public transport services and fragmented operators. Policy documents that feed main plan documents are also needed for regulatory control.
Countries/cities around the world have institutional structures relating to urban public transportation. The regulation and management of the public transport services vary by these structures. Institutional structures also vary from place to place. Hence, variety of institutional structures pave the way for diverse planning and delivery of public transport services.

Planning and delivery (operation) of public transport services have also changed due to the increased involvement of private sector in public transport throughout the world since the 1980s (Babalik-Sutcliffe, 2016, p.464). Privatization leads to two outcomes. On the one hand, more cost-efficient, productive and profitable operation may be expected, and the private operators can help remove a cost burden from local authorities. On the other hand, involvement of private operators often results in fragmentation in the planning and operation of transport (Babalik-Sutcliffe, 2016, p.464). Hence, the physical integration of routes as well as fare, schedule and information integration can become a major challenge.

Public transportation in an urban area can be provided by a lead institution. However, Agarwal and Kumar (2015) also argue that public transport services are often fragmented across multiple institutions. Effectiveness of planning and delivery of public transport services are related with that kind of fragmentation and/or integration of institutions in some way.

Public transportation systems' planning and delivery strategies are related with the integration between different planning and delivery institutions. Although planning service institutions and delivery service institutions are different, coordination of them is crucial to integrate them. Babalik-Sutcliffe (2017, p.207) explains the two contrary tendencies as follows: City authorities have realised that integration of all public transport modes leads to a synergy and also an opportunity to attract more passengers to public transport, and hence a decrease in car use. So, institutions/stakeholders

initiate a restructuring process about their organizations. However, in most cities, and in Turkey, various agencies and organisations continue operating public transport services (e.g. privately operated buses, paratransit) and therefore city authorities act as coordinators. A coordination body may not be as effective as having one transit authority providing all services; but in today's fragmented service provision, the former has become more common.

Babalık-Sutcliffe (2016, p.464) states that transit service providers might be public agencies as well as privatised organisations, and privatisation generally takes place during the delivery of public transit system. It can be deduced from the literature sources that public transportation planning is not being privatised. Although there can be privatisation about delivery of transit services; the regulation about timetables/fares etc. is often under the control of public agencies.

As for the types of privatisations; there can be various ways to privatise the delivery of services. They might be in the form of subsidiaries, corporate companies, quasi-governmantal or hybrid companies (Babalık-Sutcliffe, 2016, p.464-465).

Susniene and Jurkauskas (2010) argue that private organisations in the public transport sector should look for and implement new management models in their system, and that private sector characteristics can help these public transport companies to survive long-term by responding to stakeholder needs. Consequently, private companies as operators of public transport services can achieve successful public transport servies (Susniene and Jurkauskas, 2010, p.216-219). While this may be true, their increased involvement presents a risk of fragmentation of services, as already mentioned.

Discussing that the operation of public transport services are fragmented across multiple institutions that have blurred definitions about their roles, Agarwal and Kumar (2015) argue that there is a need for establishing a lead institution. Clear division of responsibility, well-defined functions, decisions produced by consultative processes can be produced at a spatial and functional level by a well-functioning lead institution (Agarwal and Kumar, 2015, p.142).

These arguments show that an institutional reorganization may be required for integrated, high-quality and efficient public transport services. Quality in public transport systems can be measured by some factors related to service performance (e.g. System accessibility, travel time, trustworthiness, frequency, maximum load, vehicle characteristics, adequate information and support facilities, mobility in accordance with necessities). Efficiency in public transport systems can be measured by some factors related to performance indicators (e.g. low operational cost to users, minimum number of vehicles, personel but without a decrease in the quality of service provided). Sampaio et al. (2008) state that analyzing the efficiency can produce a proposal for institutional re-organizations.

In addition to institutional issues and service fragmentation, there may be other challenges for achieving an integrated public transport system. For example, some challenges stem from system deficiencies. When the infrastructure systems are old, some integration problems could occur during the later integration with other modes or lines. For example London has an old MRT system. Although it is a positive feature to have an already built up MRT backbone, it constitutes also difficulties, i.e. adaptation difficulties with new systems resulting in increased transfer times.

In spite of various challenges, Vuchic (2007) states that many improvements have been accomplished by most large cities regarding integration. There have been examples of formerly independent transit services being integrated into regional or national public institutions. Intermodal coordination have been developing effectively since the 1990s, bringing new institutional settings, which coordinate transportation with parking, pedestrianization and traffic regulation. He also emphasizes that cities that have best transport services like Stockholm, Toronto, Paris, Munich and Portland (Oregon) have one common feature: all these cities have achieved full integration of all the public transport operators and modes (2007, p.41).

To summarize, even though there are many challenges for ensuring integrated public transport systems, there are also successful cases from different parts of the world.

Some cities have ensured integrated public transportation successfully for decades in spite of the challenging factors. Analyzing these successful cities give an insight to realization of integrated public transport systems. Therefore, three of those good practice cases from different parts of the world are investigated in detail in Chapter 3.

CHAPTER 3

ACHIEVING INTEGRATED PUBLIC TRANSPORT: GOOD PRACTICE CASES FROM THE WORLD

In Chapter 2, four main components of public transport integation have been elaborated. As stated before, these main components are information integration, line/route integration, tariff/ticketing integration, and schedule/headway integration.

In this part, several good practice cases from the world are selected and evaluated. It was aimed to provide a systematic selection of cities by means of determined criteria. In this way, good practice cases' experiences and their key to success are tried to be revealed before analyzing the Turkish case. That is because it is crucial to find out underlying factors for progress or achievement of successful cases in the world. The analysis helps to reveal common components or different variables that enable successful integration, and these are stated at the end of the chapter. Yet, the main focus is to query the status of the cases in terms of their achievements in the four components of integration.

In this regard, determined criteria are the population of the city, diversity of transit modes and the level of mobility. Taking these factors into consideration, transit systems of three cities from several countries of the world are selected. The selected cities are Singapore in Republic of Singapore, London in United Kingdom and Toronto in Ontario Province in Canada.

Figure 3.1 is produced as an outcome of a mobility study. According to the evaluations London and Singapore has a mobility rate above the average. Yet, Toronto and Istanbul have an average mobility rate.

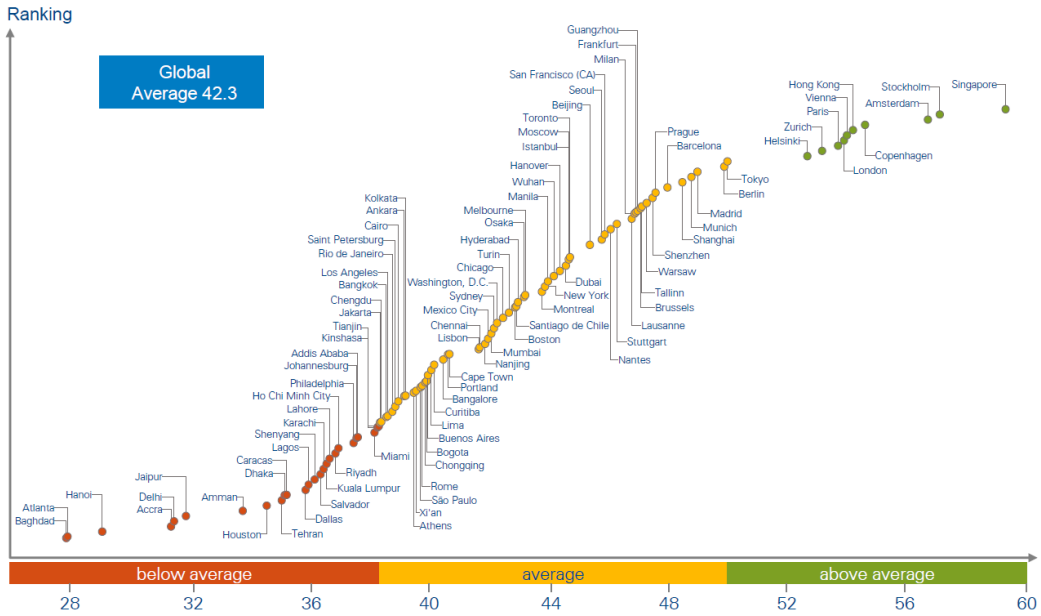


Figure 3.1. Urban Mobility Index

(Source: Arthur D. Little Corporate, 2018, p.23)

There is also a study that investigates cities that have a successful multi modal public transport. These successful cities are London, Singapore and Portland. According to the study, the common features of these cities are having visions about an integrated multi-modal public transport system and embracing pedestrians and bikes within the system (Lennard et al.,1995, cited in Beyazıt, 2007, p.37-40). Cervero (1999, cited in Wheeler, 2000, p.133-134) categorized cities in five different types in terms of the concord between urban form and transit services. Toronto is categorized as a metropolitan area that has pursued transit-oriented development and Singapore is categorized as an adaptive city that shapes the metropolitan footprint around the transit system and thus has extremely high public transport ridership levels, cycling and pedestrian activity.

3.1. Singapore, Republic of Singapore

Singapore is both a country and a city in Southeast Asia. Singapore is located in Southeast Asia and in the southern tip of the peninsular Malaysia.

According to the data of Singapore Department of Statistics, Singapore had a population of 5.612.300 people in 2017 (Singapore Department of Statistics, 2018).
The agency responsible for planning, designing, building and maintaining Singapore's public transport infrastructure and systems is the Land Transport Authority (LTA) which is a statutory board under the Ministry of Transport. Land Transport Master Plan was published by LTA in 2013, for nearly 20 years period, for 2030. Singapore Urban Redevelopment Authority works with Land Transport Authority to fulfill the objectives of enhancing bus services, doubling the rail network, reducing car usage, increasing cycling and creating walkable places via Active Mobility Plan and Act (Singapore Urban Redevelopment Authority, 2018).
The four components of integration are examined in the following sections within the context of Singapore's public transport.

3.1.1. Route/Line Integration in Singapore

Singapore Land Transport Master Plan addresses three areas of the land transport systems: more connections, better service and a more livable and inclusive community. When the plan is scrutinized it is apparent that the aim of more connections is planned to be implemented through integrated transport hubs, which makes passengers switch between different types of transport easily and have shopping, dining etc. opportunities (Singapore Land Transport Master Plan 2013, p.50).
Singapore public transport service tries to achieve the line/route integration with currently constructed integrated transport hubs. The line/route integration in the city is also highly dependent on ticketing system of public transport. Because distance-based fares system makes authorities feel the necessity for finding spatial solutions for transfers regardless of additional ticket charge. The two examples for transport hubs in Singapore are given in Figure 3.2. The hubs are not planned solely for transfering. They also have food and beverage, shopping and even health facilities. These hubs are designed to achieve inter-modal integration.

Figure 3.2. Artiste Impression of Bukit Panjang Integrated Transport Hub Opened in 2015 (left) and Image of Serangoon Integrated Transport Hub (right)

(Source: https://www.lta.gov.sg/, last accessed:26.07.2018, 20.22)

There are also other solutions to achieve one specific mode's line integration. For example, Figure 3.3 is the train system map in Singapore. Beside integrating different transport modes by transfer stations, Singapore public transport system also has a circle rail line which is named CCL6. That line aims to link all the rail lines in the city.

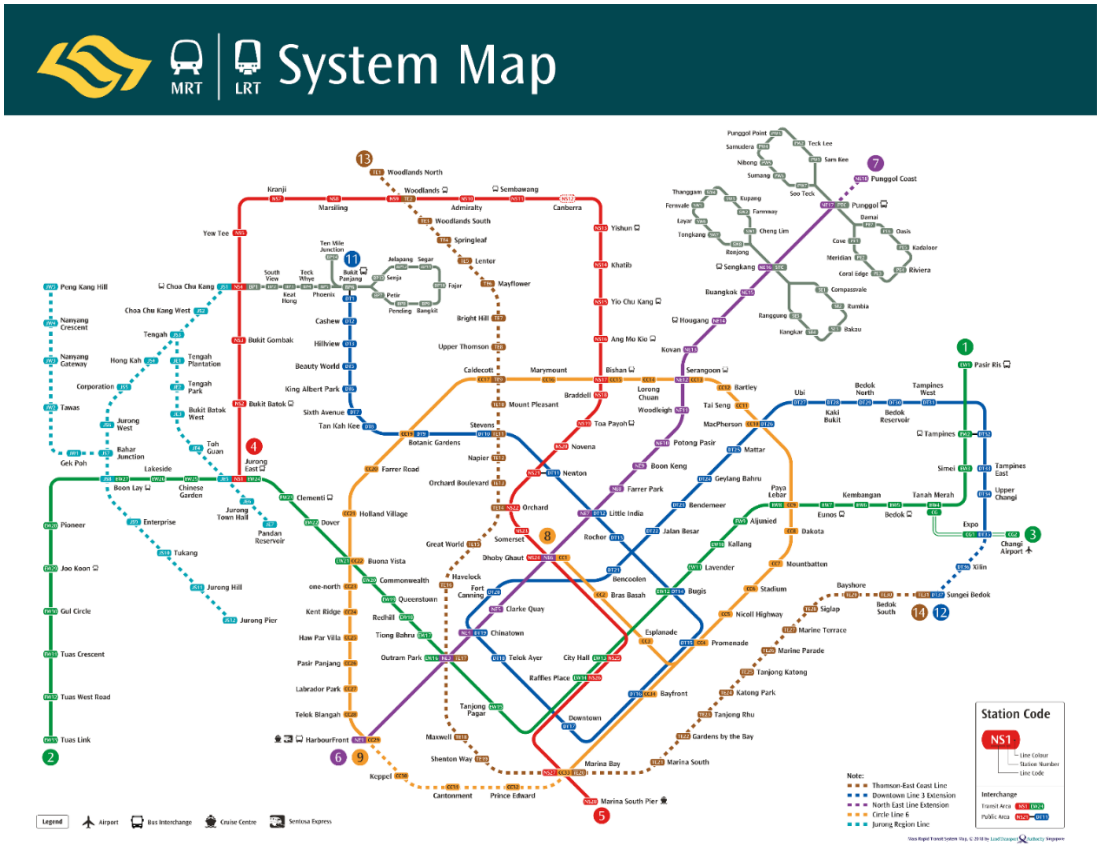


Figure 3.3. Train System Map in Singapore

(Source: https://www.lta.gov.sg/, last accessed:21.06.2018, 16.41)

The map of CCL6 linking line can be seen in Figure 3.4. The positive feature of the circle line is shown to provide passengers with essential connections to the city with fewer transfers at busy interchanges. (Source: https://www.lta.gov.sg/, last accessed:21.06.2018, 12.45)

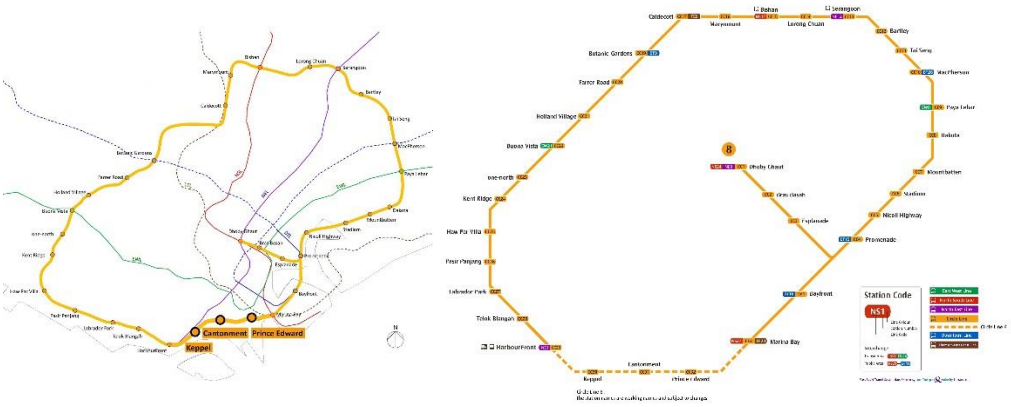


Figure 3.4. Maps of CCL6 Linking Line in Singapore

(Source: https://www.lta.gov.sg/ , last accessed: 26.07.2018, 12.58)

Furthermore, Land Transport Authority in Singapore facilitates and regulates a range of private bus services. As for the tariff and ticketing of these bus services it should be first addressed that LTA has a regulator and a policy maker role in private bus services. To clarify it more clearly, LTA Singapore regulates the use and ownership of private buses, ensures that private buses undergo regular inspections, tests the qualification of private bus drivers and crafts policies on licensing. Private bus types are private hire bus, private bus, excursion bus, school bus and asean member country-registered bus. Namely, private buses serve for individual or for determined groups instead of serving as a public transport. (Reference: https://www.lta.gov.sg/ , last accessed: 25.07.2018, 19.00)

Public transport system in Singapore also has a lot of park&ride spaces, cycling, walking and motoring facilities in stations. There are 41 major park&ride facilities that are located next to interchange stations. For park&ride spaces, it is possible to follow available parking lots online from updated data on the institutional website of Land Transport Authority.

As for the taxis, 7 private taxi companies' quality standards are enforced by Land Transport Authority. Yet, fares are determined by the companies.

In conclusion, Singapore's developments and objectives in order to achieve line/route integration are as follows:

- Integrated transport hubs,
- Doubling the MRT network to 278 km by 2020,
- Two new MRT lines and two extension in MRT lines,
- CCL6 circle rail line,
- Feeder bus lines,
- Public transport Council's stardardization studies about connectivity of feeder services to transport hubs (bus stop locations, route design etc.),
- Locating new bus stations near MRT stations,
- 41 major park-and-ride sites which are located near major transport hubs, MRT stations or bus interchanges,
- Bicycle parking facilities at most of the MRT stations and bus interchanges, and allowance of foldable bikes on board,

(References: Haque, Chin and Debnath, 2013, https://www.lta.gov.sg/, https://www.ptc.gov.sg/)

Taking the descriptions above into account, it is possible to state that Singapore is a successful case for line/route integration with its continious works.

3.1.2. Tariff/Ticketing Integration in Singapore

Public transportation in Singapore has a system which is named 'distance fares' introduced in 2010. Distance fares are based solely on distance travelled. So, distance travelled is regardless of transfer numbers. With distance fares, transfer passengers have the flexibility to decide on their own route. Interchange stations are being transformed into integrated transport hubs for the execution of the distance fares system (Singapore Land Transport Master Plan, 2013, p.50).

It can be said that distance fares system attracts people inthat it is free from transfer numbers and zonings. The system has an attractive feature for short journeys in particular.

There are multiple travel cards to use public transport services in Singapore. Standard ticket can only be used on mass rapid transit (MRT) and light rail transit (LRT) while adult stored value smartcard can be used in various modes. Adult stored value

smartcard types are EZ-Link and NETS FlashPay. These personalised smartcards are named concession cards which can also be used for food, beverage, health care, library, and communication (payphones and post) services within the city.

The ticketing is planned according to service type. For example trunk services, feeder services, express services and rail/light rail transit have their own and seperate ticketing. This situation is shown in Table 3.1, which is produced according to updated data of Singapore Land Transport Authority, and for student fares.

Table 3.1. *Public Transport Fare Structure in Singapore*

(Source: https://www.ptc.gov.sg/ , last accessed:25.07.2018, 18.45)

	Up to 3,2 km (cent)	3,3 km- 4,2 km (cent)	4,3 km- 5,2 km (cent)	5,3 km- 6,2 km (cent)	6,3 km- 7,2 km (cent)	Over 7,2 km (cent)
Trunk Services	37	42	47	52	55	58
Express Services	67	72	77	82	85	88
MRT/LRT	37	42	47	52	55	58
Feeder Services	Fare per ride (cent): 37					

The Figure 3.5 is acquired from the official website of Singapore Land Transport Authority. It is an application for passengers to calculate their journey fares.

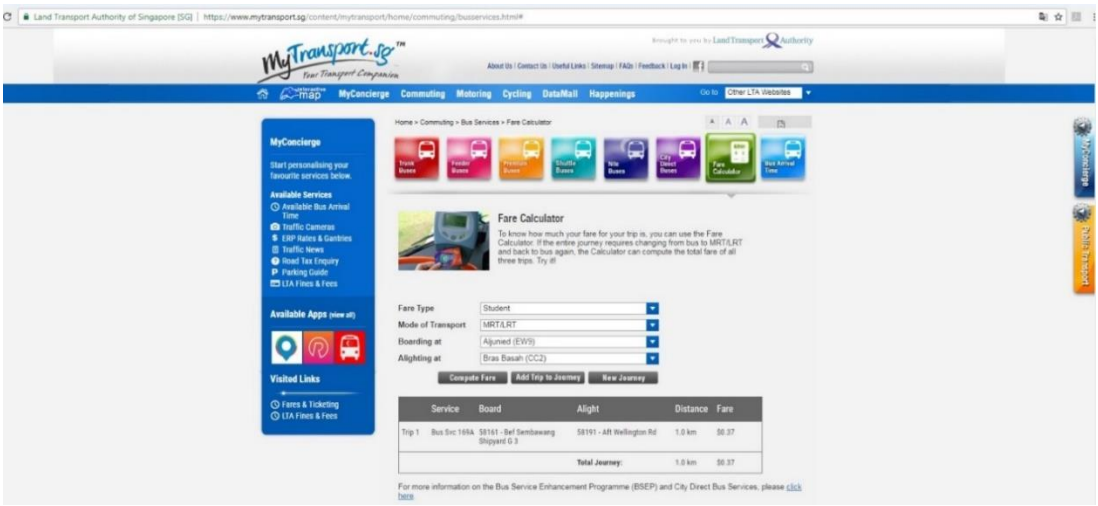


Figure 3.5. Fare Calculator of Singapore Public Transport System

(Source: https://www.mytransport.sg/, last accessed:25.07.2018, 15.00)

Likewise, Figure 3.6 shows the interactive map of public transport system of Singapore. All these applications allow commuters to plan their journeys with its transfers, calculate their journey fares and also routes regardless of public transport modes.

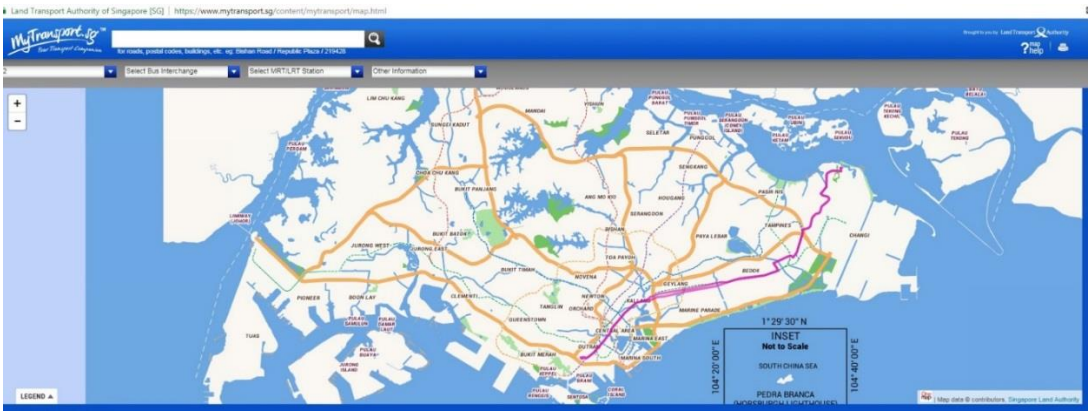


Figure 3.6. Interactive Map of Singapore Public Transport System

(Source: https://www.mytransport.sg/ , last accessed:25.07.2018, 15.59)

Figure 3.7 shows some fare calculations of distance fares journeys. The first one is a journey from Whampoa Road to Vivocity. Eventhough it was 1.46 dollars before the distance fares system, it is 1.33 dollars by the implementation of distance fares system. The second visual illustrates a journey from Upper Thomson Road to Collyer Quay. As it can be noticed, journey fare was 1.33 dollars and takes 41 minutes before the distance fares system. The journey takes 35 minutes and costs 1.29 dollars after the distance fares system.

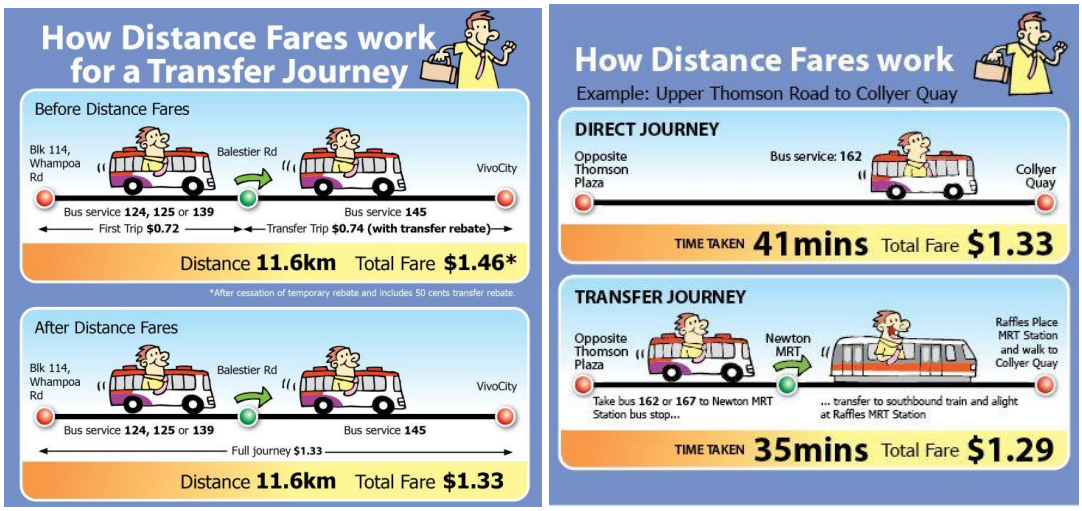


Figure 3.7. Journey Examples with Distance Fares

(Source: https://www.mytransport.sg/, last accessed:21.06.2018, 16.46)

As for the Table 3.2, it is illustrated by LTA to make passengers better understand the calculation of fares. The distance fare system might connotate a negative financial response for passengers in distant travels. Yet, as it is seen from Table 3.2, distance travelled and fares have not been increasing in the same rate. While the distance increase ten times, the fare of the trip increase only two times. While this situation is positive for the passenger, the officials have some recipes to prevent the negative financial gaps like ERP road pricing system, which is explained in later sections. It is understood from these examples that distance fares system has advantages for public transport systems to be more affordable and time-productive, although it can be presumed more expensive.

Table 3.2. *Journey Fare Examples Calculated with Distance Fares System in Singapore*

(Source: https://www.mytransport.sg/, last accessed:21.06.2018, 21.12)

Journey	Distance	Fares
From Yio Chu Kang MRT station to Ang Mo Kio MRT station	1.5km	$0.71
Transfers to bus service 853 and alights at the next bus stop	0.4km	$0.00 There is no additional fare for the bus ride as the total distance travelled on the MRT and bus is 1.9km, and this is within the first fare band of 3.2km.
Woodlands MRT station to Ang Mo Kio MRT station	15km	$1.45
Transfers to bus service 135 and alights at the next bus stop	0.4km	$0.04 The total distance travelled is 15.4km. This crosses over to the next fare band of 15.3km. Hence, the fare for the bus leg is $0.04.

There is another crucial point about tariff/ticketing of Singapore in that Singapore Government's Public Transport Council regulates public transport fares and ticket payment services. In parallel with the travel smart implementation in the city, the council claims to supply the integration of bus and train fares since 1998. (https://www.ptc.gov.sg/, last accessed:25.07.2018, 21.20)

Hence, distance fares system in Singapore can be considered as a good example of an integrated tariff/ticketing system. Because passengers travelling the same distance on the same type of service pay the same fee (whether on the highway or railway), exempt from the limitations of sectional/zonal systems or transfer fees.

To summarize, Singapore can be identified as a city which has an integrated tariff/ticketing public transport with its smart travel, distance fare system, travel cards, fare calculator applications, head institution (Land Transport Authority) and Public Transport Council. However, fares vary by service type. This situation could be seen as one unfavorable feature to achieve tariff/ticketing integration.

3.1.3. Information Integration in Singapore

An integrated information system needs to provide information about the system and its services, and increase operational efficiency and utilization rates, as stated before. A transit information system constitutes a meaningful whole with its components and planning-testing requirements.

The public transport information in Singapore is supplied by Land Transport Authority. There are e-services and applications of the institution to inform commuters. The website of the institution has three major entities which are public transport, walk/cycle ride, roads&motoring.

There is a website named “How2Go -H2G-”. This website produces possible pathways between two points in the city. There are tabs named journey planner, fare calculator, system maps, drivers&motorcyclists, line book, travel smart, releases etc.

Figure 3.8 shows how to reach One World International School (Point B) from the Jalan Ampang (Point A). It allows passengers find their own pathways to reach where they want to get to. There are options to find fastest routes or least transfers. The results show that this website make people have information not only about bus or trains but also walking distances, waiting times, fares, time of travel, transfer times. Thus, a commuter can have information about routes/lines, tariff/ticketing and schedule/headway integration.

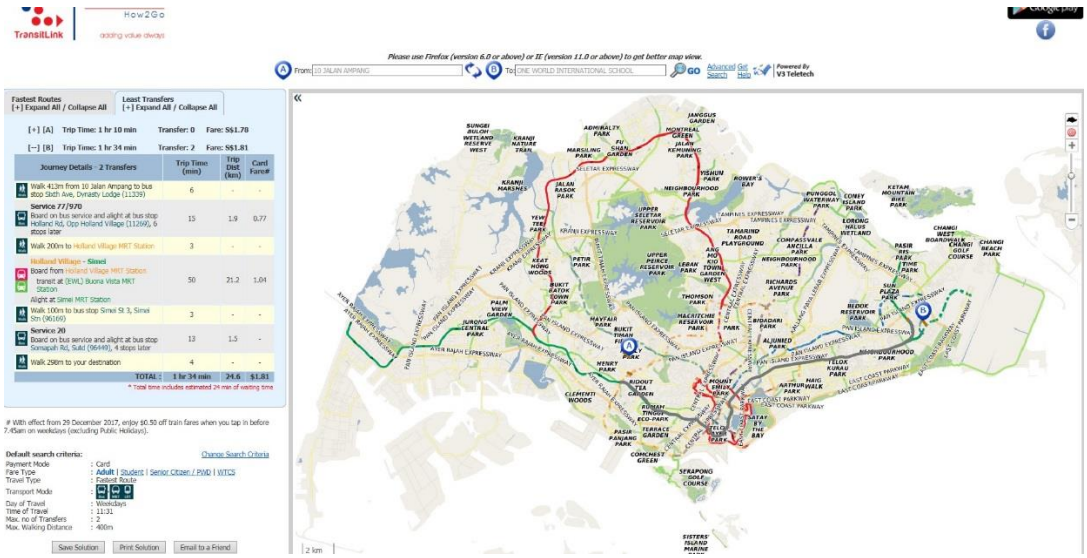


Figure 3.8. Various Ways to Get B Point from A Point in Singapore

(Source: https://www.transitlink.com.sg/, last accessed:26.07.2018, 11.38)

There are also information tools which vary by public transport mode. For example, Figure 3.9 shows the information tools of bus stops with or without a shelter. While the bus stop with shelter has an electronic board for information, the bus stop with no shelter has maps and informative tables about operations.

Figure 3.9. Some Bus Stops with Notice Boards or Printed Information in Singapore

(Source: https://publictransportsg.wordpress.com/, last accessed:11.03.2019, 21.10)

Some other practices for information integration in Singapore are as follows:

- Public Transport Council's (the independent regulatory body responsible for the quality of the bus services) developments about bus stop standardizations and designs that include notice boards,
- Travel information via fixed and mobile platforms (information screens at stations, in-vehicle devices, applications, LTA portals)
- Smart parking guidance system that display real-time availability of parking areas in several important locations of the city. (References: Haque, Chin and Debnath, 2013, https://www.lta.gov.sg/, https://www.ptc.gov.sg/)

It is understood after searching the website that an integrated information system is accessible for commuters in Singapore especially if the commuter has an internet connection.

3.1.4. Schedule/Headway Integration in Singapore

Singapore's Land Transport Master Plan is trying to achieve schedule/headway integration via various arrangements. Mandatory Give Way to Buses Scheme is one of them. This scheme was announced in 2008, and it aims to prevent time waste of buses. According to the scheme, a vehicle approaching the bus bay must stop if there is an exiting bus. Any other vehicle must give way to buses and can only go on if the bus left the bus bay. A visual of the scheme can be seen in Figure 3.10.

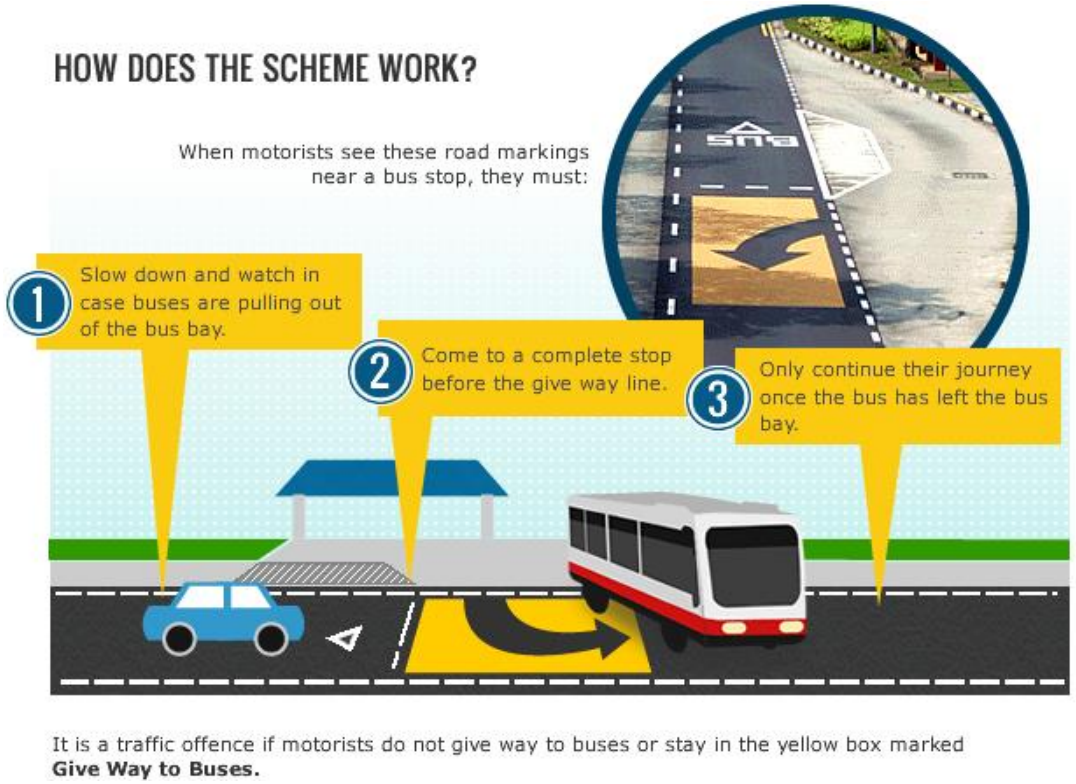


Figure 3.10. An Illustration of Mandatory Give Way to Buses Scheme in Singapore

(Source: https://www.lta.gov.sg/, last accessed:11.03.2019, 20.55)

Land Transport Authority has also other studies like Bus Signal Priority Scheme, applied in 2009. A visual of the scheme is located on the right side of Figure 3.11.

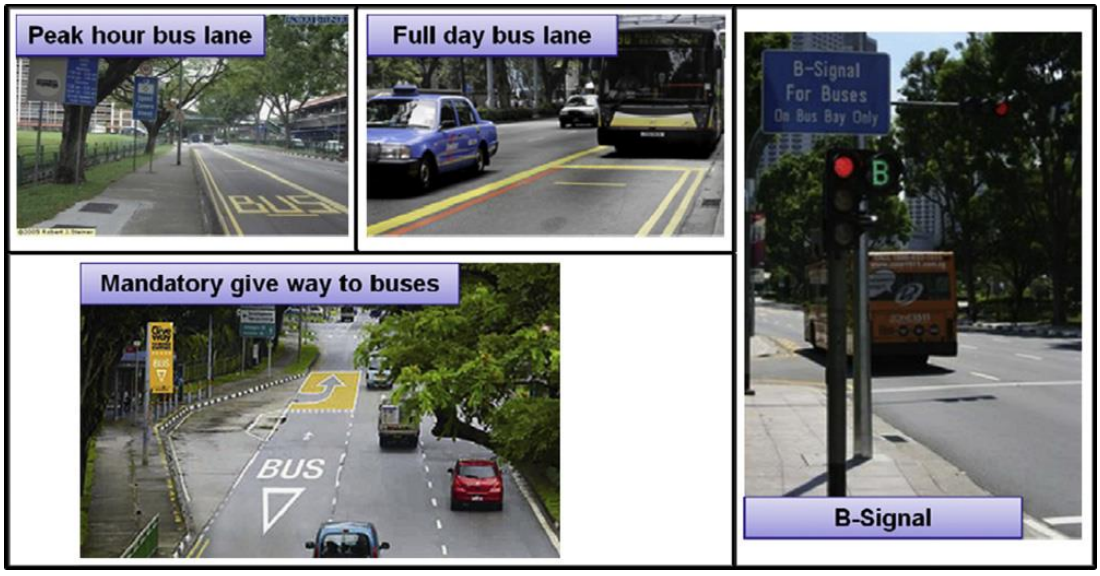


Figure 3.11. Schemes About Bus Operations in Singapore

(Source: Haque, Chin and Debnath, 2013, p.23)

This scheme ensures to give priority to buses at traffic light junctions. Bus routes with higher ridership are designed as bus hubs and the buses used in these routes are longer and have bigger bus bays to prevent the delays of other buses.

LTA also has had accessibility investments that enhance schedule/headway integration. For example, 80% of MRT stations have barrier free routes, 40% of all stations have extra lifts, 95% have pedestrian passes, while bus and taxi shelters are barrier free, and Walk2Ride Programme lead to easy and fast walkways to high usage stations and interchanges. (https://www.lta.gov.sg/, last accessed:31.03.2019, 21.37)

Information tools about public transport in Singapore can also lead to some information about the schedule/headway integration. The two example routes in Figure 3.12 show passengers their estimated waiting times while transferring between lines or routes. But the schedules or headways are not given in these applications. There are seperate schedules and headways for every line. Online systems of Land Transport Authority give passengers information about estimated waiting times for the whole journey with all transfers. The negative feature of schedules/headways is that there are various public transport operators (SMRT Corporation, etc.) in

Singapore. First and last times of vehicles can sometimes be different. That situation may cause passengers' tendency to private automobiles in certain hours.

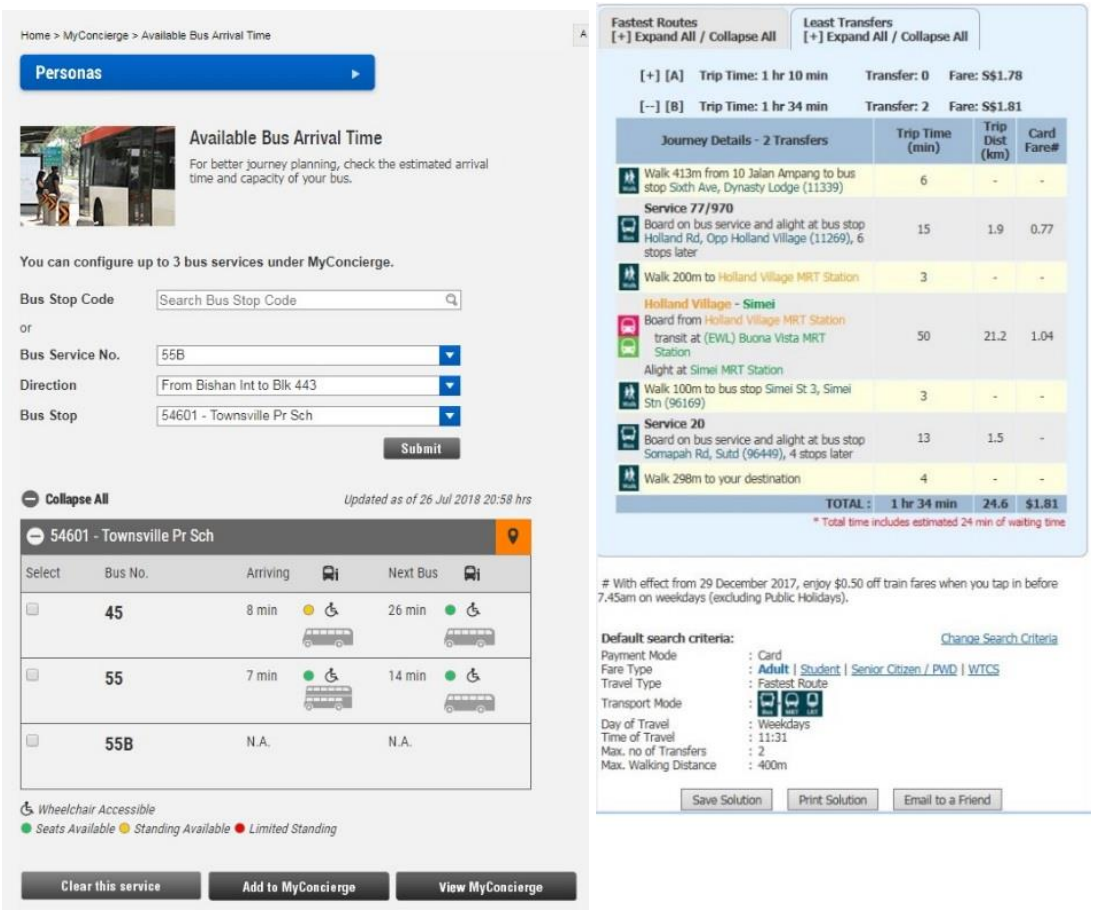


Figure 3.12. Example Routes with Their Estimated Waiting Times

(Source: https://www.mytransport.sg/, last accessed:26.07.2018, 16.05)

It can be said that the schedule/headway integration effort run by Land Transport Authority are mainly on buses since rail transit have more frequent and stabilized schedules and are generally out of street traffic. However, the transit authority in Singapore cooperates with operators to achieve schedule/headway integration. It has the efforts as follows:

- Mandatory Give Way to Buses Scheme,

- Bus Signal Priority Scheme,
- More frequent MRT services and enhancing the capacity of existing lines by increasing carriage numbers,
- Electronic Road Pricing (ERP), located in expressways and major arterials in Central Business District, to reduce congestion,
- Regular updates of feeder bus services by Public Transport Council,
- Private B traffic signals for buses on bus lanes

(References: Haque, Chin and Debnath, 2013, https://www.lta.gov.sg/, https://www.ptc.gov.sg/).

3.2. London, United Kingdom

London is the capital of England and is located on the southeast of the island of Great Britain. London has 8.800.000 population which also constitutes 13% of the population of the whole country. London's population growth is twice as much when compared to the country's general population growth (https://www.trustforlondon.org.uk/, last accessed:27.07.2018, 19.30).

London has a high public transport ridership for its size. Especially London's subway system is complete and carries 21.7% percent of all passenger travel in scope of miles travelled. This rate reaches above 50% while the journeys are evaluated in terms of passenger numbers (Parry and Small, 2009, p.14-15). This situation shows that there is an attraction of public transportation in London.

London is the first city in the world which has started the public transport integration work in the early 20th century. The officials in transport department has a vision about integration. It emphasizes the continuity of public transport across the city. They state that the districts that do not have a tube (subway) line, have bus lines in London city (Beyazıt, 2007, p.29).

Today, London has an authority and operator, responsible for the integrated transport. Transport for London (TfL) is a statutory body created by Greater London Authority

Act 1999. Mayor of London performs duties, which are given by the act, through Transport for London (https://tfl.gov.uk/, last accessed:30.07.2018, 12.55).

Givoni and Banister (2010) also point out the "White Paper", which was published by the UK Government in 1998, and concrete outcome of the paper, The Ten-Year Plan, as notable examples for the integration of public transport. The White Paper is called "A New Deal for Transport: Better for Everyone" and known as the integrated transport white paper. The London example is successful to generate an integrated public transport currently, requires further analysis to express the basis of integrated public transport policy in the United Kingdom.

The City of London's Strategic Plan proposes an integrated transportation planning. For this purpose, it identifies five aims which are linked to transportation infrastructure and services. These five objectives are: a vibrant and diverse community, a green and growing city, a sustainable infrastructure, a caring community, and a strong economy. Accordingly, a New Mobility Transportation Master Plan for London: Smart Moves for the Target Year 2030 was released. In addition, London Transit Commission completed a transit ridership growth strategy in 2006; aiming a bus rapid transit system implementation in London, and also completed a bicycle master plan in 2007. Five smart moves, some of which are related with public transport integration, are identified in the Transport Master Plan as follows:

- *Rethinking Growth to Support the Transportation Master Plan (Canada Ontario's Places to Grow Growth Plan legislation and policy direction are stated as important precedent for London):* increasing use of public transport, walking and cycling via nodes and corridors urban structure with its transit links, helping commuters with information integration to find attractive choices to automobiles,
- *Taking Transit to the Next Level:* a well-designed new BRT system that aims to reduce travel times and hence achieving schedule/headway integration, more frequent service on main routes, easy understanding of transit systems

with broader use of technology, expanded use of real time information, more fare options (including smart cards),

- *Actively Managing Transportation Demand:* Strategies about pricing of parking in order to influence modal choice decisions, implementation of park and ride facilities,
- *Greater Investment in Cycling and Walking Infrastructure:* On-street continuous cycling routes, greater degree of recognition and information,
- *More Strategic Program of Road Network Improvements:* Reduced modal share for the automobile and increased modal share for the public transport and active transportation (walking and cycling), road widenings for supporting the BRT initiative on roads, an integrated complete street concept in order to make streets less automobile oriented (file:///C:/Users/User/Desktop/London%20Transportation%20Master%20Plan.pdf, last accessed:10.03.2019, 14.16).

The four components of integration are examined in the following sections within the context of London's public transport.

3.2.1. Route/Line Integration in London

There are myriad lines/routes including underground rail, over ground rail, river, bus and air in London. London has 7 million daily journeys and approximately 16 million transactions per day (Gordon, et al., 2013, p.23). Figure 3.13 shows the rapid transit (subway) system in London.

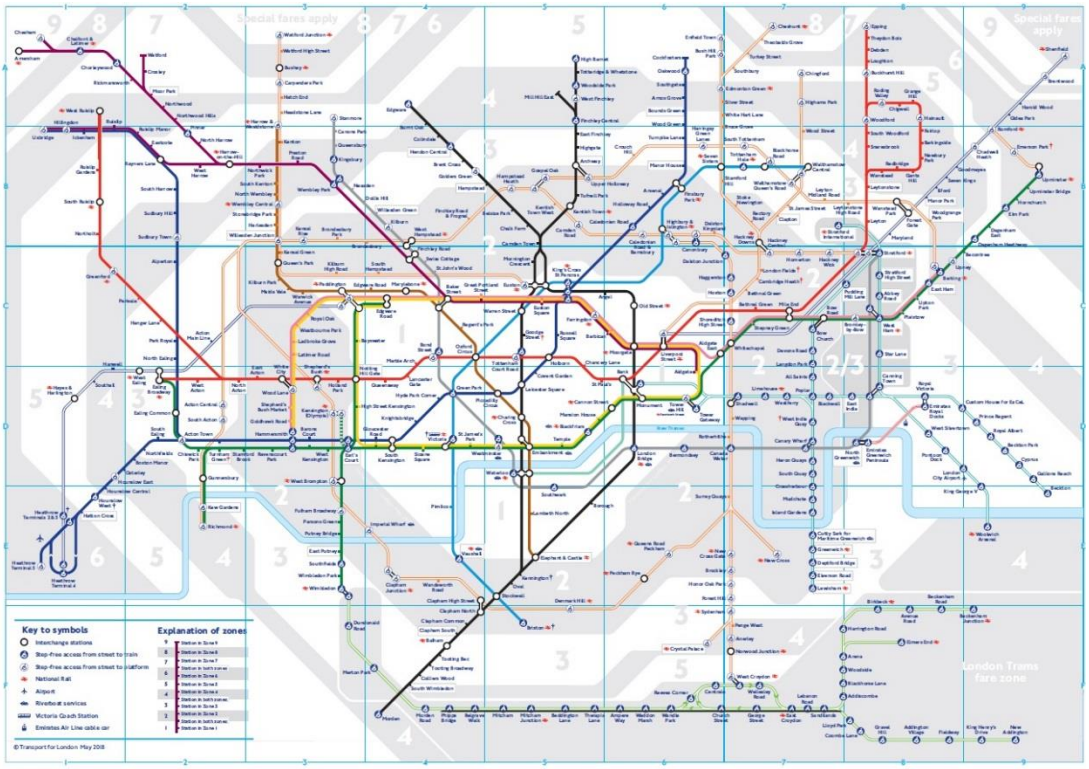


Figure 3.13. Standard Tube Map of London with Determined Zones

(Source: http://content.tfl.gov.uk/, last accessed:02.08.2018, 13.14)

Transport Master Plan of London determines transport corridor scenarios and aims to achieve integrated routes. The aim is indicated as a truly integrated multi-modal transportation system.

First of all, future rapid transit network is based on the access to both key destinations in outlying areas and key trip attractors. An assessment of the need for the downtown interchange is concluded with the need of integration in various modes. Hence it was determined that the arrival of high-speed rail service to the city would be the impetus for an integrated multi modal off-street facility. Furthermore, rapid transit networks are developed to combine corridors to integrated routes. There are also planned future hubs, like Old Oak Common, which can be seen in Figure 3.14.

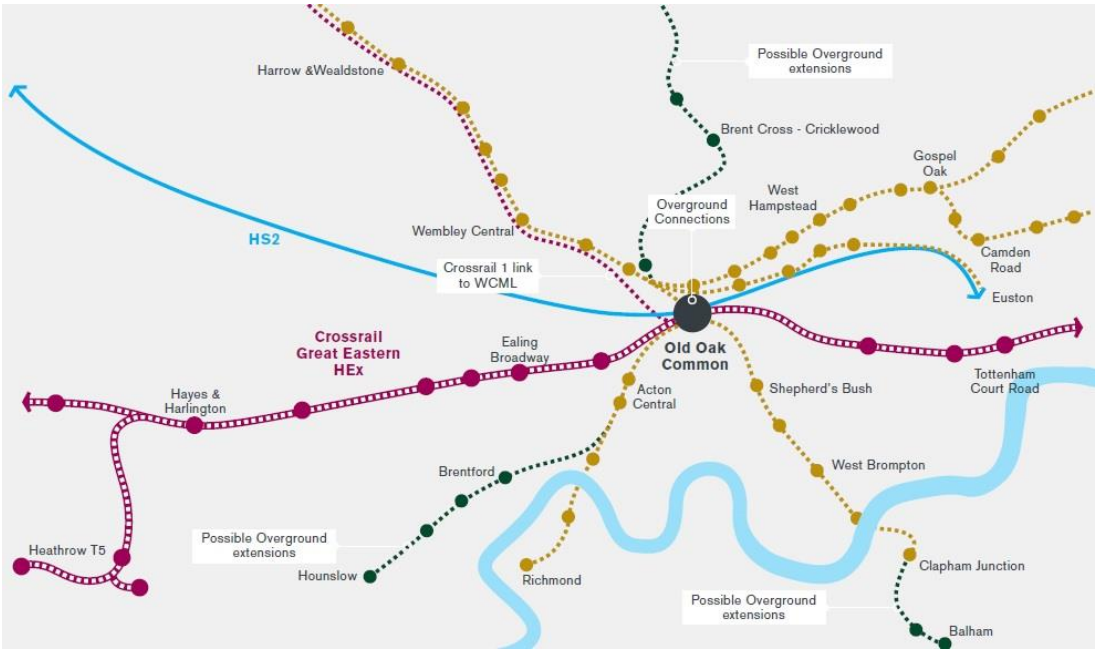


Figure 3.14. The Planned Old Oak Common Hub

(Source: London Infrastructure Plan 2050, p.73)

Rapid transit network is combined into a two route BRT network which is one of the main tools for an integrated public transport system within the transportation master plan. The BRT tool within the master plan is planned to integrate existing lines of different modes. They aim to integrate other routes into this BRT "spine" to provide seamless transfers across the city. The BRT network is planned as the backbone of the London Transit Commission network. The plan also envisions to provide new rapid transit infrastructure with the integration opportunity with bike lanes.

London Infrastructure Plan 2050 also has many purposes in terms of line/route integration. The Plan emphasizes the importance of integration due to the expected user crowd and an increase of 35-40 percent in the number of trips. As transport links become more crowded, they are expected to be less attractive for passengers. In addition, some users are expected to take less direct routes. Improving radial tube links, London over ground network extensions, creating orbital rail based capacity - shown in Figure 3.15 (like CCL6 Circle Line in Singapore), 200 kms of new Dutch-style cycle highways and 5 new major pedestrian/cycle bridges are some other plans

of London to achieve line/route integration (https://www.london.gov.uk/, last accessed: 10.03.2019, 12.50).

Figure 3.15. An Orbital Rail Based Capacity Model

(Source: London Infrastructure Plan 2050, p.90)

Public transport service planning aims frequent, reliable, simple and comprehensive network. Simple network reflects easy to understand and integration with other public transport. Comprehensive network here reflects providing service to all areas and to all sections of the community (Guidelines for Planning Bus Services, 2012, Transport for London, p.1).

The success of line/route integration of London public transport can be identified with strong operating and control mechanism of Transport for London authority and the

Mayor’s Transport Strategy. Various lines (night lines, feeder lines etc.) are regularly arranged according to the needs of passengers and the city space. All public transport modes in London, including tube, rail, bus and river, are integrated with pedestrian and cycling routes. The head institution has the maps of all modes and also lines. This paves the way for transferring between modes and lines for the passengers. Although there are integrated lines and routes in London public transport, a negative feature of the integrated lines/routes is still stated: while making transfers, passengers express that they lose time. Yet, the public transport system with its lines/routes as a whole is integrated. Figure 3.16 shows how long the interchanges take between platforms at tube stations.

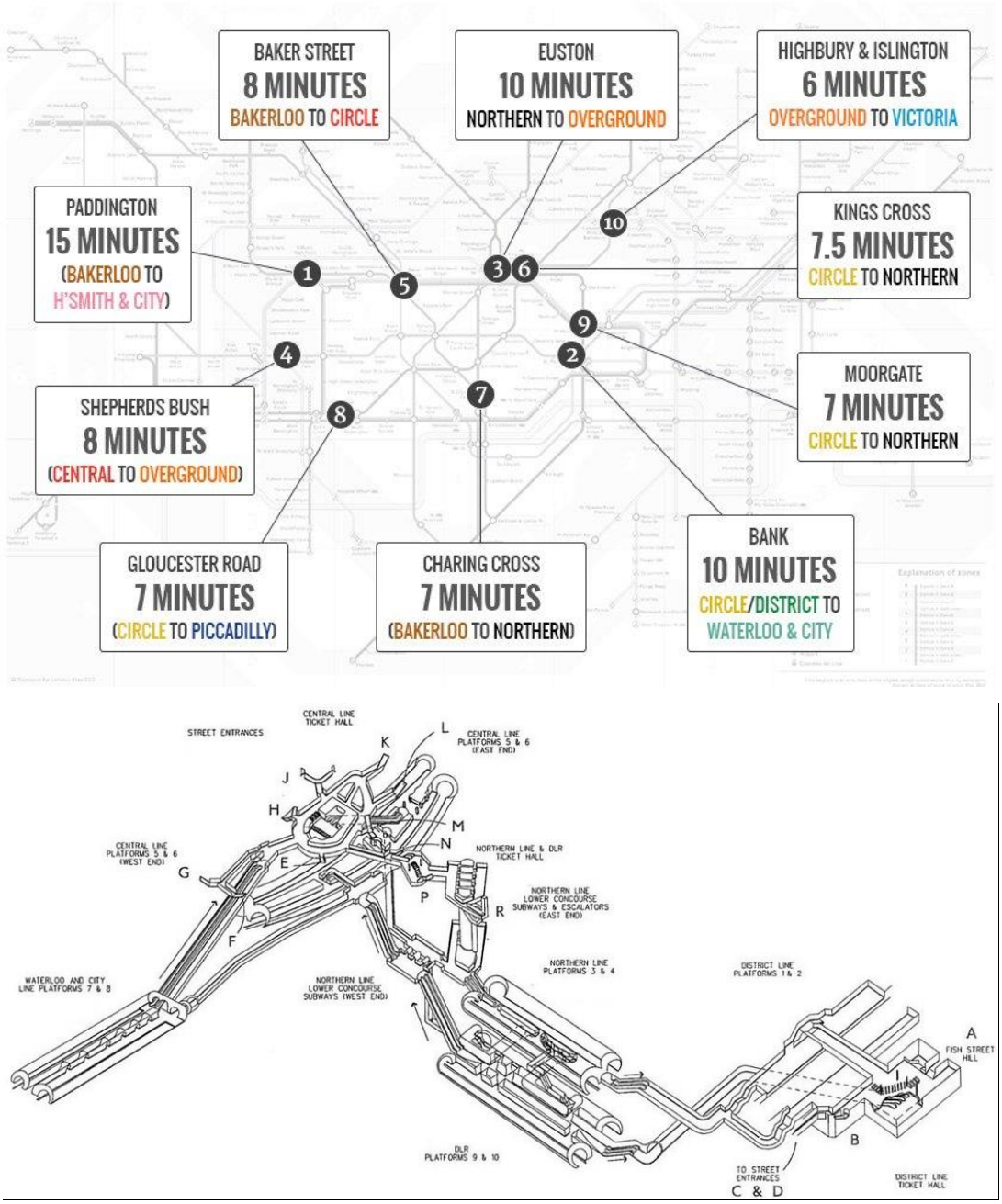


Figure 3.16. The Time Spent for the Interchange Between Integrated Lines

(Source: http://www.cityam.com/, last accessed:02.08.2018, 15.40)

Costa et al. (2010) estimated the accessibility for London with and without the underground network. After performing 10000 walks, the result is 41 steps. Namely,

each walk had a length equal to the average shortest path of the respective network (Costa et al., 2010, p.2).

Many underground stations in London also have park and ride facilities. Figure 3.17 shows the 55 underground stations in London with park and ride facilities. Many of them are located in outer zones of the city. Parking charges vary according to zones of the city and days, and can be paid with oyster card, which will be described within the following section. (http://parkandridelondon.com/, last accessed:13.11.2018, 18.40).

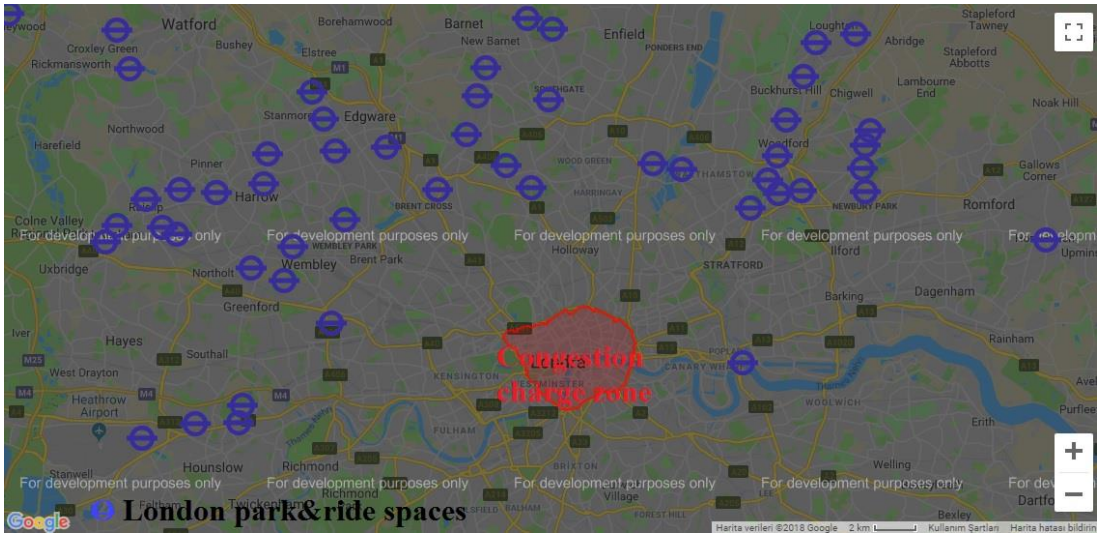


Figure 3.17. Underground Stations with Park and Ride Spaces in London

(Source: http://parkandridelondon.com/, last accessed: 13.11.2018, 18.30)

While there is a road pricing system in central London, bus routes in that area are shaped in the form of different sized circles. So many transfer points can be seen in Figure 3.18.

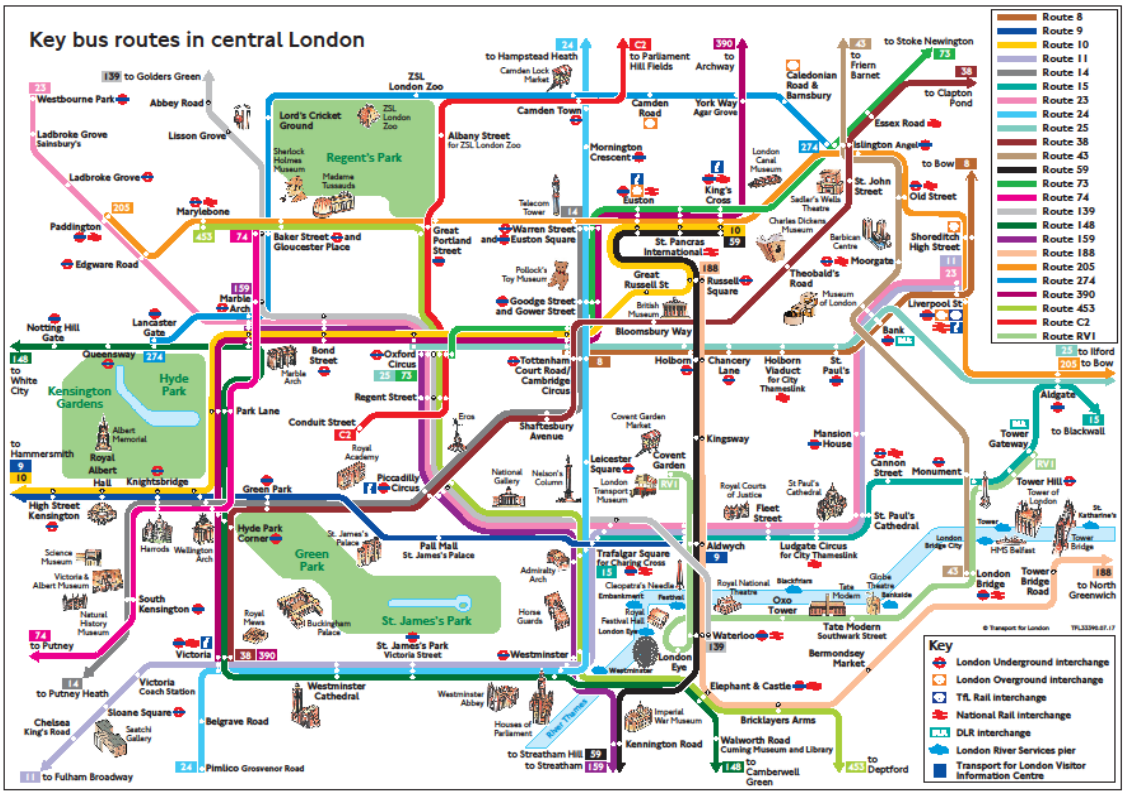


Figure 3.18. The Key Bus Routes in Central London

(Source: http://content.tfl.gov.uk/, last accessed: 02.08.2018, 13.22)

Beside integrating various modes, integrating cycling and walking facilities into the street network are considered by making on-street bike route recommendations. Existing networks are also taken into consideration while planning the bike routes.

3.2.2. Tariff/Ticketing Integration in London

Public transportation services in London are charged by zonal fare structure with its nine zones.

Oyster card in London is the smart fare card for public transport systems. It can be used in London buses, the London underground, the London over ground, the Docklands light railway, tram link and recently even in national rail. That's why oyster card is used by 90% percent of bus and 80% percent of rail passengers. London's most rail modes have zonal fare structure which requires riders to tap while entering and

exiting the vehicle or system. Buses have a flat fare structure. So, passengers only tap while entering the vehicle or the system (Gordon et al., 2013, p.17-18).

Parry and Small (2009) present the reasons behind the fare differences between modes. London has high costs for rail. Because railway in London is operated with an old infrastructure and infrastructure is often expensive to adapt. They also imply the competition between various bus operators as a reason for relatively low fares on buses (2009, p.16).

As stated in the Singapore case, Singapore has been constructing integrated transport hubs to integrate lines/routes and fares. There is a different solution in the London case. Public transport in London has nearly 132 out-of-station interchanges. Public transport card (Oyster card) and other contactless payment systems in the city allow passengers to transfer from a station or line to another without an extra payment. These stations allow passengers to walk on streets instead of walking in tunnels (https://tfl.gov.uk/, last accessed:02.08.2018, 18.12). Figure 3.19 illustrates one of these out-of-station interchanges.

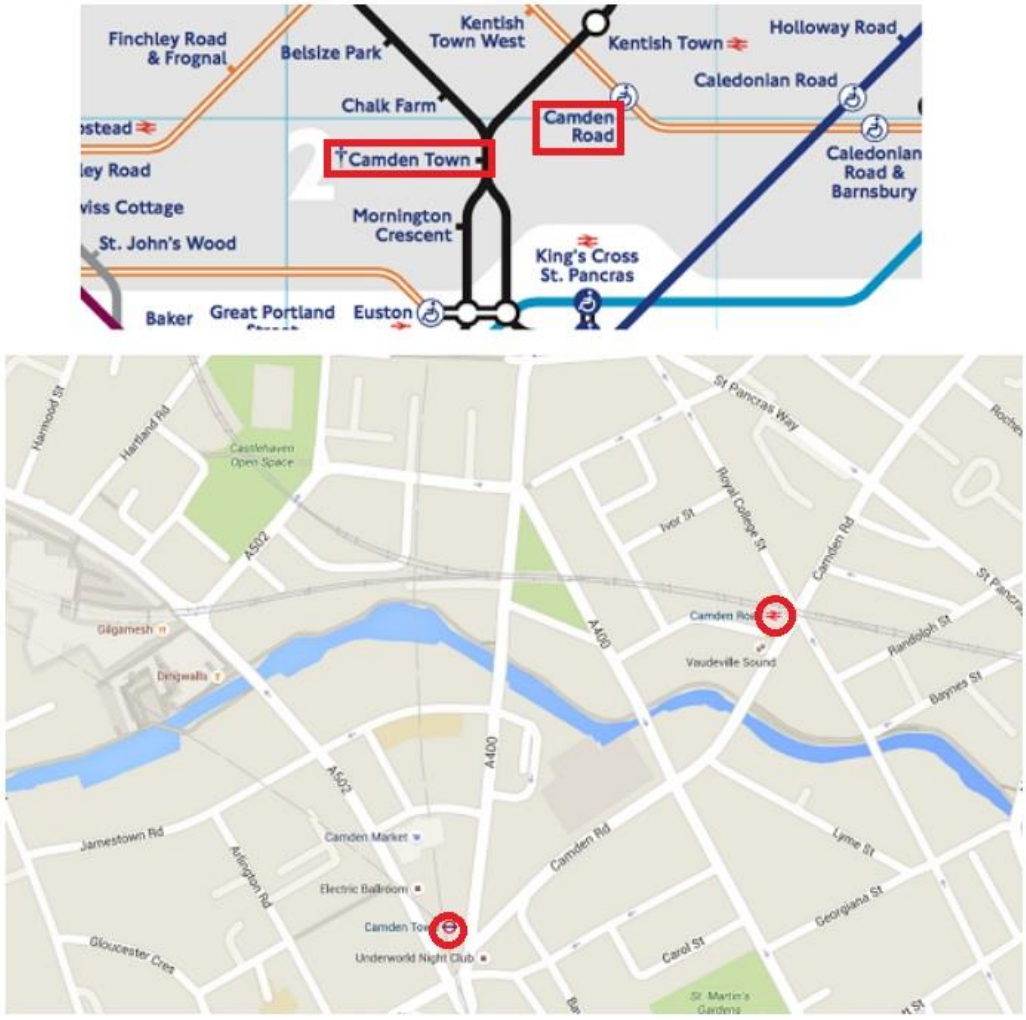


Figure 3.19. Out-of-Station Interchange Between Camden Town and Camden Road Stations

(Source: Author, based on the Standard Tube Map of London [see Figure 3.13], and Google Maps)

London is shown as a city that has undertaken ambitious fare integration strategies. London's fare integration strategies are as follows:

- Out-of-station interchanges (validity of transfer reduced fee),
- Fare structure simplification,
- Inter-agency fare payment integration,
- Utilization of time-saving fare collection technologies,
- Smart cards with multiple uses like parking/carsharing payments or even as a cash alternative,

- Variable pricing offering (determined via real-time information and real-time choices). (Goldman and Gorham, 2006, p.267, London Infrastructure Plan 2050)

London aims to stabilize the public transport fares and hence serves cheap fares to users for some years. The city accommodates this, through business plans which are operators' transportation spending proposals and congestion charging that uses daily vehicle charges (road pricing system) for improving transit service.

3.2.3. Information Integration in London

"New Mobility Transportation Master Plan for London: Smart Moves for the Target Year 2030" aims to achieve information integration by the amenities such as web-based trip planning services, real-time schedule information at stations and to mobile devices, enhanced shelters, seating, lightening, walking/cycling facilities at stations. It is indicated in the report that the information integration endeavors also to encourage integration of modes.

The public transport information in London is provided mostly by Transport for London. There are e-services in the official website of the authority and applications of the institution to inform people. The most crucial information sources of London public transport are the publications and e-services of Transport for London.

Besides, there are some other studies specific to modes. For example; the iBus is a system which is installed on London's red double-decker buses. The iBus vehicle location system is used to supply information about boarding/alighting times, locations, destinations, origins and transfers between modes together with oyster card. Oyster and iBus systems provide information about the entire public transport network (Gordon et al., 2013, p.17-18).

Some ongoing initiatives with regard to information integration in London are as follows:

- Real-time information at stops and devices,

- Live bus arrival information for bus stops (sending a text with mobile phones to 87287),
- Urban realm schemes at central locations,
- GPS based Webwatch,
- Automatic vehicle location system,
- Improvements on web-based trip planning,
- Providing Transport for London a rich source of travel data / for better planning and demand management (London Transport Master Plan, London Infrastructure Plan).

3.2.4. Schedule/Headway Integration in London

"New Mobility Transportation Master Plan for London: Smart Moves for the Target Year 2030" states that reducing travel times and the reliability of consistent travel times should be functions of the management of the network according to public expectations. These targets are related with schedule/headway integration. To achieve schedule/headway integration, technology is also used. Transit signal priority, real-time schedule reporting and real-time vehicle tracking are some samples. Potential changes are done with consultation with users.

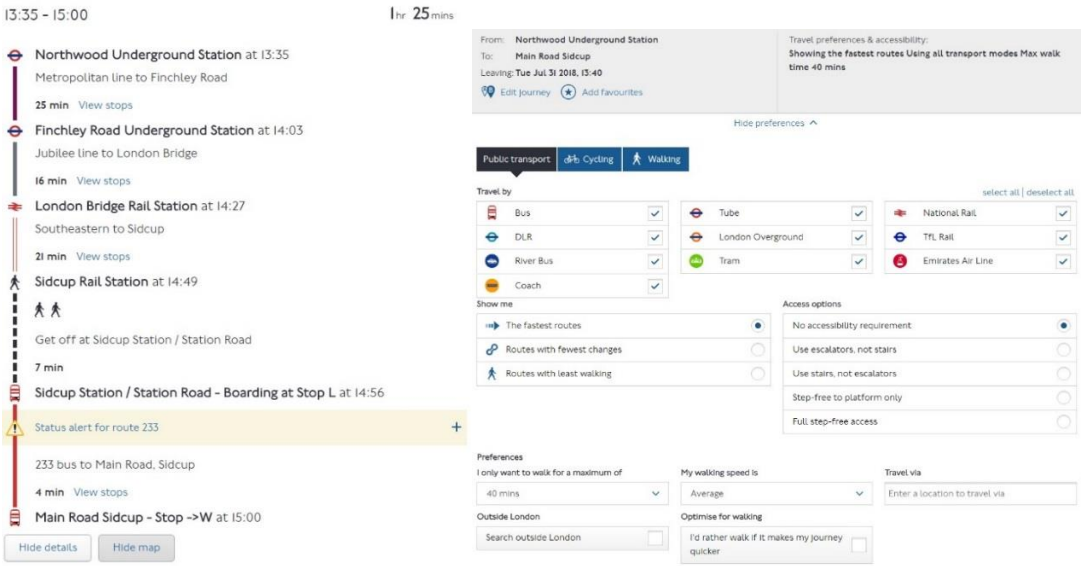
First of all, it should be stated that London's underground system is historic. That's why it has some troubles with new train carriages. One other negative feature of London mass rapid transit is shown as to be time-consuming, which hinders schedule/headway integration. Because transferring from mass rapid transit line to another mass rapid transit line and transferring from mass rapid transit line to other modes always take time. Transportation Master Plan emphasizes that the complaints of public about late schedules and missed passengers increased 55% over the last three years. That's why the plan offers to increase the level of frequency, in other words reduce headway length, on key routes in order to reduce the need for knowing schedules and waiting times of passengers.

Figure 3.20 shows the schedules of public transportation in London. It can be noticed that every public transport mode has its own timetable. Integration of schedule/headway is dependent on the operators, because based on the transport mode, there are various operators in public transportation in London. Transport for London is the regulatory body. For example, bus services in London are run by private operators in general. There are contracts between Transport for London and private operators and these contracts are managed by London Bus Services Ltd. When the schedules are analyzed in detail, the differences of starting hours can be noticed. For example, while most under or over ground railway systems start to operate between 5 am and 6 pm, river services start to operate at 10 am in general. Besides, many bus lines serve at nights while the rail lines do not. In other words, there are differences between schedules of public transport lines or modes in London due to the modes and operators as well.

Figure 3.20. Timetables of Public Transport Modes in London

(Source: https://tfl.gov.uk/travel-information/timetables/, last accessed:31.07.2018, 14.49)

A sample route, which can be seen in Figure 3.21 is selected to understand the schedule/headway integration by using information tools. Unlike the Singapore case, London has clearer schedules and thus gives the exact waiting times for each transfer during the whole journey.



Accessibility details

Total walking time:

7 minutes

2 escalators up

3 level walkways

Access, lifts and escalators

Figure 3.21. An Example Route with Different Preferences

(Source: https://tfl.gov.uk/plan-a-journey/, last accessed:31.07.2018, 16.20)

London has been experiencing some comprehensive studies across the city to achieve schedule/headway integration. Schedule/headway integration is mostly about the tubes and buses in London, since these two are the most frequently used public transport vehicles by commuters. Some other studies about schedule/headway integration in London are given below:

- London Bus Initiative (increases bus frequencies),
- Bus priority schemes,
- Increased frequencies on night tube services and Tramlink,
- BusPlus routes (that have passenger information, real-time bus arrival displays, low floor buses, more regular cleaning, modern bus shelters, transit priority traffic signals, automatic vehicle location, driven instruction systems to reduce bus bunching)
- Quality Incentive Contracts of operators (to improve the quality and reliability of the services, and attract additional ridership)
- Automated bus lane (improves the speed and reliability of bus service within the urban area)
- Congestion charging/road pricing on weekdays (valid in 21 km^2/1,3% of the city surface area) since 2003 (increases the reliability of bus schedules),
- Wider context of motoring taxation (for fuel efficiency of cars),
- Maximizing the performance and standards of the existing Tube network,
- Crossrail Project (increasing Crossrail 1 frequencies) (References: Mayor's Transportation Strategy, London Infrastructure Plan 2050, Croci, 2016).

3.3. Toronto, Canada

Toronto is located in the southern boundary of Canada and southwest of Ottawa; the capital. Toronto is the capital of the Ontario Province and is neighboring on the United States of America. It is the largest metropolitan area in the country by its population. The location of Toronto within Ontario can be seen in Figure 3.22.

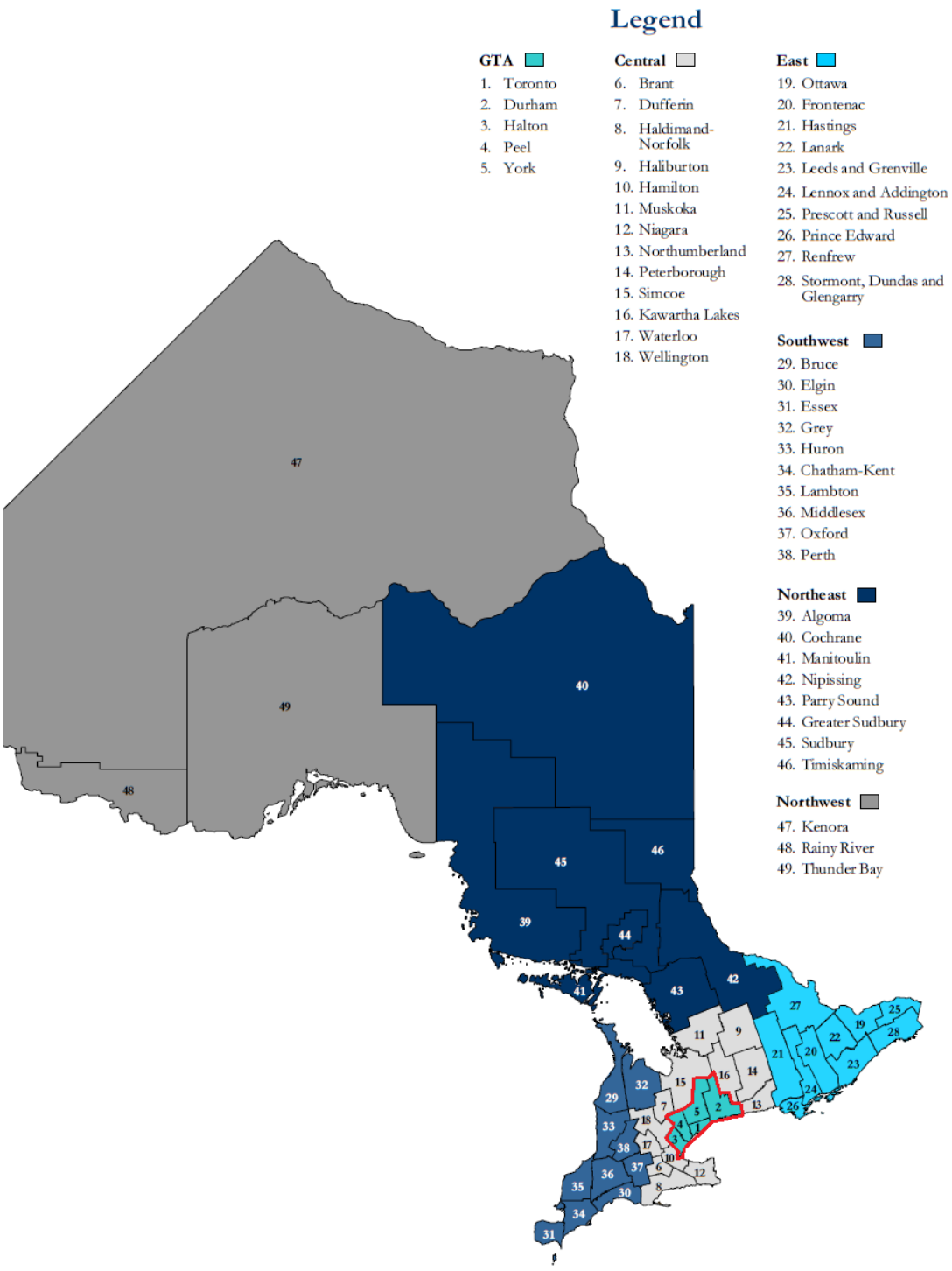


Figure 3.22. The Greater Toronto Area in the Map of Ontario Census Divisions

(Source: Ontario Ministry of Finance, Ontario Population Projections Update for 2017–2041, 2018)

According to 2016 census of Statistics Canada, Toronto has over 2,7 million population. The Greater Toronto Area, which is comprised of City of Toronto and four surrounding city regions named Halton, Peel, York and Durham, has nearly 6 million inhabitants (Population Size and Growth in Canada: Key Results From the 2016 Census).

The Greater Toronto Area (GTA) today corresponds to 40.8 per cent of Ontario population. It is projected to be the first in fastest population growing region in Ontario, is estimated to reach almost 9.7 million, or 52.3 per cent, by 2041. Toronto also has the youngest age structure as a result of natural positive increase and migration in the region and that feature of Toronto is estimated to remain so (Ontario Ministry of Finance Population Projections Update 2017–2041, p.2-4). Greater Toronto Area can be seen in Figure 3.23.

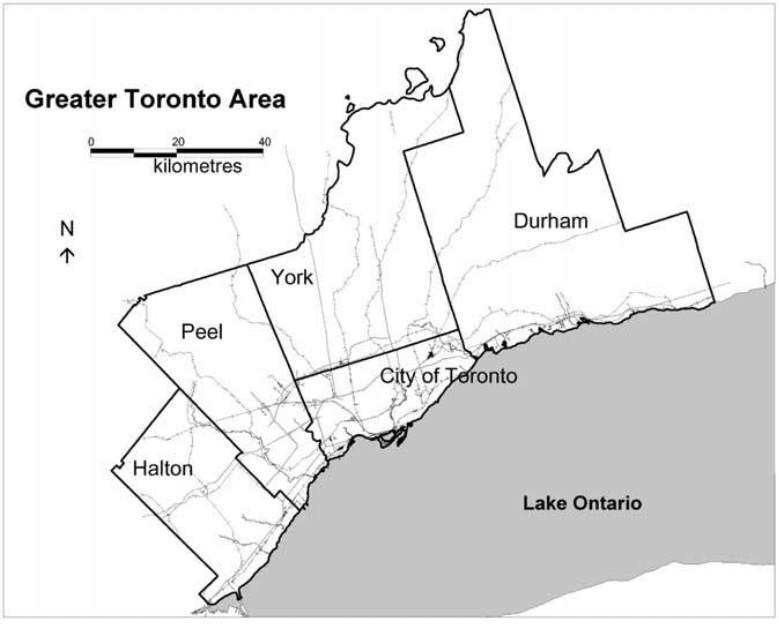


Figure 3.23. The Greater Toronto Area Comprised of City of Toronto (formerly Metropolitan Toronto) and Surrounding City Regions

(Source: Kennedy, 2002, p.461)

3.3.1. Route/Line Integration in Toronto

Providing leadership for an integrated and multi-modal transportation network is defined as a mandate of Metrolinx Act in 2016. Metrolinx 2015-2020 Five Year Strategy -Building Tomorrow's Transportation Network Today- focusses on working together with partners across the GTHA to strengthen integration. When the strategy is scrutinized it is apparent that the aim of integration is planned to be implemented through collaboration with municipal transit and paratransit agencies. Integration of lines/routes is planned by developing integrated multicarrier bus terminals at appropriate locations (e.g., Kipling Station, Jane Street, Eglinton Avenue) and by the construction of rapid transit infrastructure (2015-2020 Metrolinx Five Year Strategy: Building Tomorrow's Transportation Network Today, 2014).

Figure 3.24 shows the subway, streetcar and system maps in the GTHA. The 2017-2022 Metrolinx Five Year Strategy (named as Creating Connections) deals with line/route integration. It is envisioned in the 2017-2022 strategy that Toronto will have an integrated transportation system with full integration across all transit systems in 2031. By the year 2022, progress towards an integration of lines/routes operated by various service providers is envisioned by enhancing walking and cycling infrastructure and also almost 75 km of new rapid transit service. As understood from ongoing work conducted by the Metrolinx Company, the line/route integration in the city/region is highly dependent on implementation of all those strategies mentioned (http://www.metrolinx.com/, last accessed:07.11.2018).

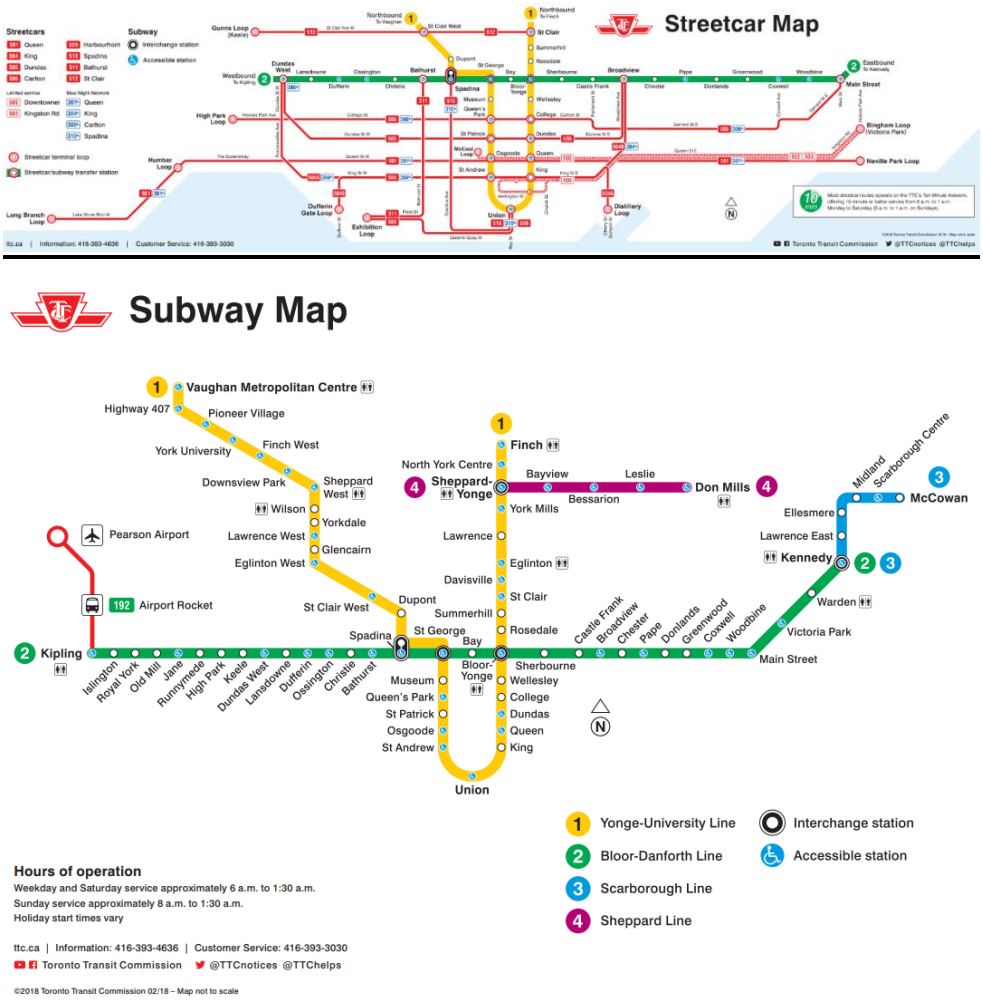


Figure 3.24. Subway, Street Car and System Maps in Toronto

(Source: https://www.ttc.ca/, last accessed:08.11.2018, 08.47)

Figure 3.25 illustrates existing rapid transit lines, envisioned extensions and envisioned new lines of other transit modes. The envisioned public transport lines/routes show the coherence between spatial planning and public transport planning. Because planned lines/routes are extended across urban growth centers. Light rail transit and rapid transit lines are planned to integrate different public transport modes' networks. For example, Viva Next Rapidways (Line 10 in the first map) is planned to integrate existing Yonge-University Subway Line with envisioned new lines like Go Rail Two-Way All-Day Line and Yonge North Subway Extension. The other example is The Crosslinx Project, shown in the first map with red mark. The Crosslinx Project (Eglinton Crosstown Light Rail System) is a 19-kilometer light rail system, opening in 2020, that links three subway lines, many bus routes and various GO Transit lines (Urban Transit Projects Are Shaping the Growth of Canadian Cities White Paper, 2015).

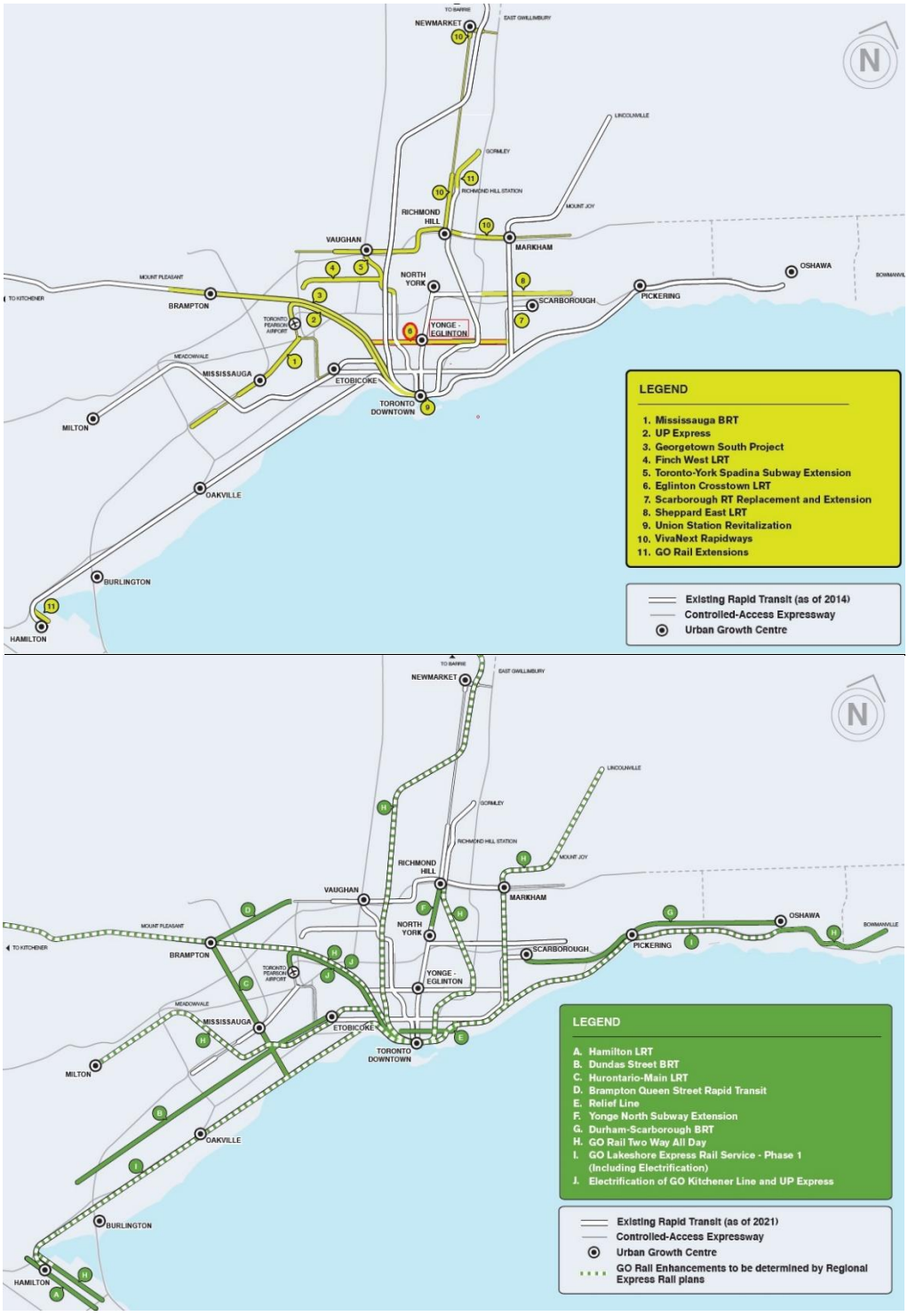


Figure 3.25. First Priority and Next Network Projects to be Completed by 2022

(Source: 2015-2020 Metrolinx Five Year Strategy: Building Tomorrow's Transportation Network Today, 2014, p.22)

Public transport system in Toronto also has a lot of park&ride and bike&ride facilities on-site or close by subway stations. 17 subway stations have park and ride facilities. Yet every station doesn't have parking lots. As for the payment of park&ride spaces, they have fares except weekends and statutory holidays.

Toronto adopts specific action plans for both public transit and bicycling such as TTC Ridership Growth Strategy, Toronto Walking Strategy, the Transit City Plan and Toronto Bike Plan. They also aim to achieve Official Plan's objectives. All these plans and strategies focusses on sustainability and mobility. Public transportation, bicycle and walking are presented as ways for building a sustainable city. It is stated that walkable communities always increase public transit usage rates in that nearly all trips begin and end with walking. The Walking Survey in Toronto indicates that 41% of Torontonians use public transport and 92% of those users walk to and from public transport stations. The Walking Strategy also envisions to develop criteria for high quality pedestrian environments in and around new stations and identify improvements for existing stations. These are specified to improve links between public transit routes and adjacent neighborhoods (Toronto Walking Strategy, 2009, p.9). Barriers for Toronto cycling network can be seen in Figure 3.26. It is produced by Toronto Transit Commission for the achievement of the implementation of Toronto Bike Plan.

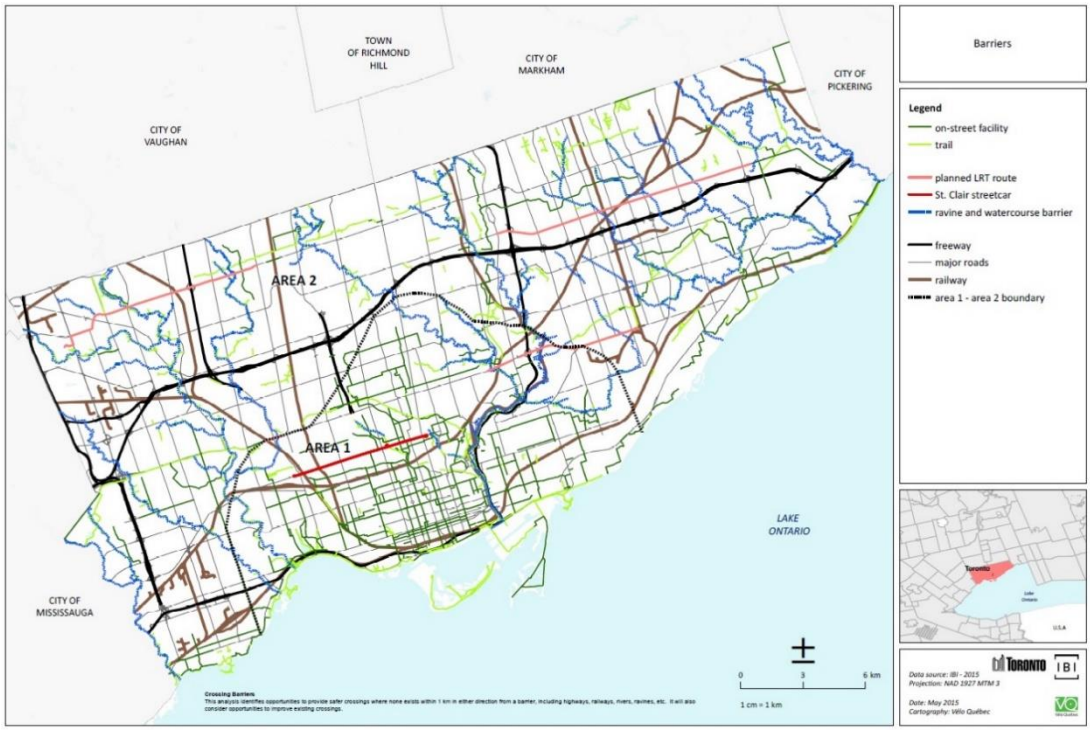


Figure 3.26. Toronto Cycling Network and Barriers

(Source: https://www.ttc.ca/Riding_the_TTC/Bikes/index.jsp, last accessed: 09.11.2018)

Various operators have park&ride facilities throughout Toronto. TTC, UP Express and Go Transit are the three of them (https://www.ttc.ca/, https://www.gotransit.com/, last accessed: 01.04.2019, 21.01). Besides, Bike Share Toronto was created and managed by Toronto Parking Authority, and has 3.750 bicycles and 360 stations. Bike share docking stations are located in the vicinity of public transport stations. 11% of the passengers in Toronto already cycle to public transport stations (https://www.ttc.ca/ , https://bikesharetoronto.com/, last accessed: 01.04.2019, 20.48).

3.3.2. Tariff/Ticketing Integration in Toronto

Tariff/ticketing or fare integration is kept on the agenda by institutions of both Toronto city and Ontario Region. The reason might be diverse operators in the city and region. Metrolinx works towards a consistent tariff system as the agency responsible for integrated transport across Greater Toronto and Hamilton Area in Ontario province.

Multiple service providers lead to different sets of fare policies which might be fragmented and inconsistent. Even though the 905 operators have significant degree of fare integration by permitting passengers cross boundary travel between their service areas without an additional fare, customers have still fare barriers under the fragmented fare structure. These three barriers are outlined in Figure 3.27 (GTHA Fare Integration Draft Preliminary Business Case, 2017).

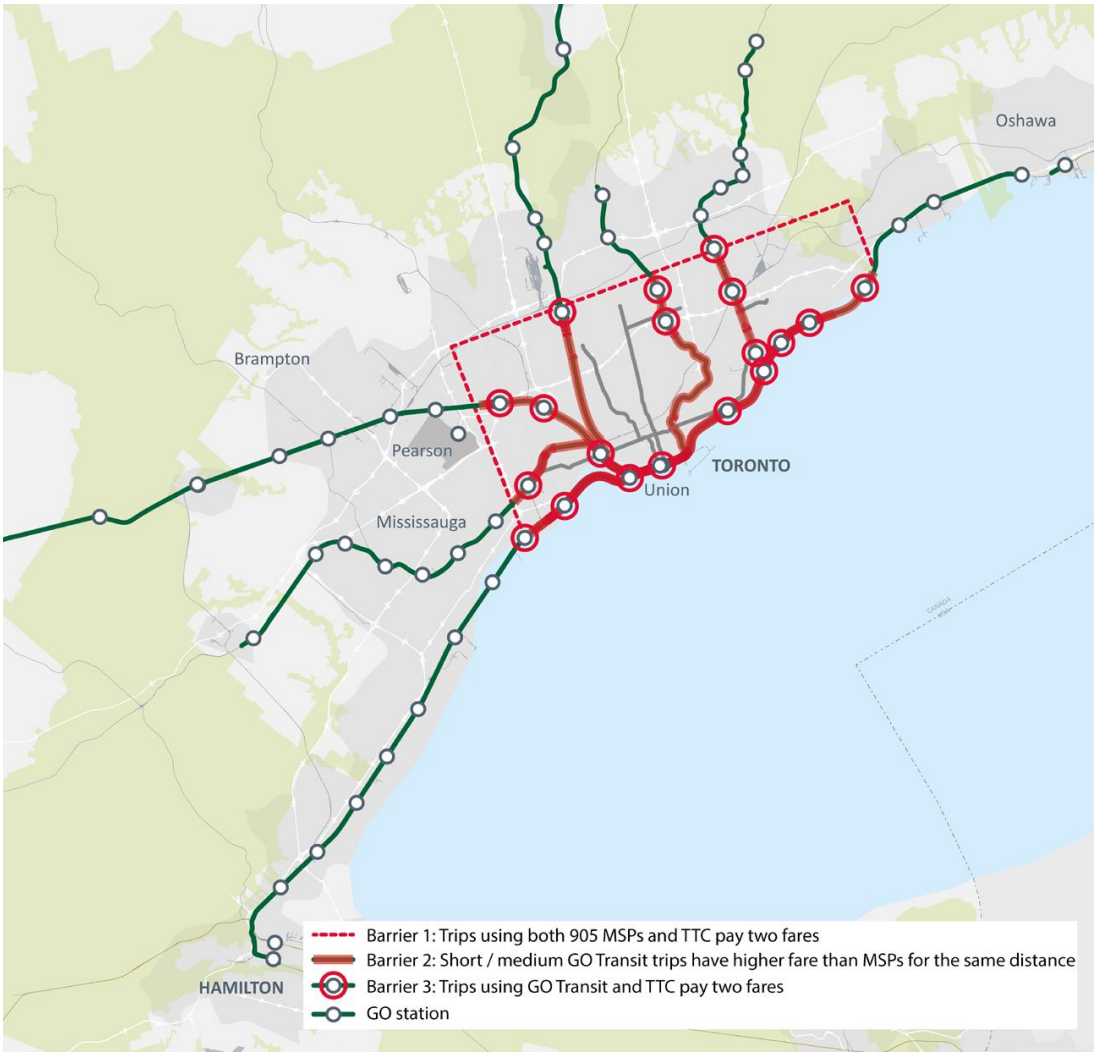


Figure 3.27. Greater Toronto and Hamilton Area Fare Barriers

(Source: GTHA Fare Integration Draft Preliminary Business Case, 2017)

Public transport fares in Greater Toronto Area are arranged by transit agencies (nine municipal transit agencies, GO Transit and UP Express) that provide transit services and their policies for transfers. When the Greater Toronto and Hamilton Area is considered as a region, the fare system as a whole function as a zonal fare system with each municipality serving as one zone. The multi-agency situation may discourage people from using more than one transit system, because Toronto has a complex fare system when compared to London or Singapore. The nine municipal transit agencies have various fare approaches. Yet they recently have had agreements. Presto Card is the farecard for public transport systems in nine municipalities. Go Transit and UP Express fares are set by the Metrolinx Agency's Board of Directors and structured in zones. Several agreements are in place in case of inter-agency transfers and cross-boundary travel. For example, all municipal agencies have a co-fare agreement with GO Transit. They accept other agency's transfers for up to 120 minutes. (http://www.metrolinx.com/, last accessed:05.11.2018, 14.25)

The Greater Toronto and Hamilton Area has a regional transportation plan called "The Big Move". The plan's one of ten strategic directions is the integrated regional fare structure. In line with this strategic direction, Metrolinx Agency has launched a series of studies like "Fare and Service Integration Strategy" and "Development and Selection of a Regional Fare Structure."

Toronto City Council carries out a current state assessment of GO Transit fare policy and implications to ridership in the city. It outlines two proposals for Metrolinx's consideration in the development of fare integration to remove disincentives to short/medium distance trips on GO Transit and to support integration between transit services. The first is increasing the distance component of GO fares. Second is extending the co-fare program like discount on double-fares, (e.g., between Go Transit and TTC) which was offered to TTC services -905 various transit operators- by Metrolinx agency in 2016. In 2017, Metrolinx Agency updated its board. It has endorsed a step-by-step strategy to advance the fare integration with four elements which are fare policy harmonization, adjustments to GO's fare structure, discounts on

double fares between GO and TTC and finally discounts on double-fares between 905 operators and TTC (Advancing Fare Integration Report for Action, 2017).

Cases have varied fare solution types while transferring. As stated before, Singapore has integrated transport hubs to integrate lines/routes and fares. London's public transport payment systems in the city allow passengers to transfer from a station or line to one other without an extra payment even if it involves street walks. As for Toronto case, an integrated fare structure is being developed currently. The GTHA Fare Integration Study is shown as a multi-stage study that aims to identify a preferred long-term transformational structure (first three stages) as well as an incremental delivery strategy referred to as the Implementation Strategy (fourth stage) (GTHA Fare Integration Draft Preliminary Business Case, 2017, p.3-4). As of the date, work conducted by related institutions have been developing. That is why, it cannot be deduced that Toronto has a fully integrated fare policy with its public transportation system as a whole. Instead, the Greater Toronto Area is a case where integrated fare policy is being currently developed. It can be inferred from this aspect that the Toronto Case is different from Singapore and London cases with its existing tariff/ticketing integration.

Figure 3.28 and Figure 3.29 are the calculations of a journey which starts from Danforth GO Station and ends at University of Guelph. The journey is planned for 13rd of November 2018, 10.30 a.m. There are applications for passengers to calculate their journey fares. The first one is calculated by GO Transit's fare calculation system on official website. The second visual shows the calculation of TTC Transit. As it can be noticed, journey fare is 14.30 dollars in GO Transit while it is 13.15 dollars in TTC. These examples present a fare difference between operators. Some transit operators' websites refer passengers to local authorities with some notifications in their websites. Hence, the example above can lead to an inference that Toronto might not be an unarguably successful case for a public transport system that has an integrated tariff/ticketing. Because the passengers travelling the same distance on the same type of service are not guaranteed to pay the same fee due to the fragmented operators.

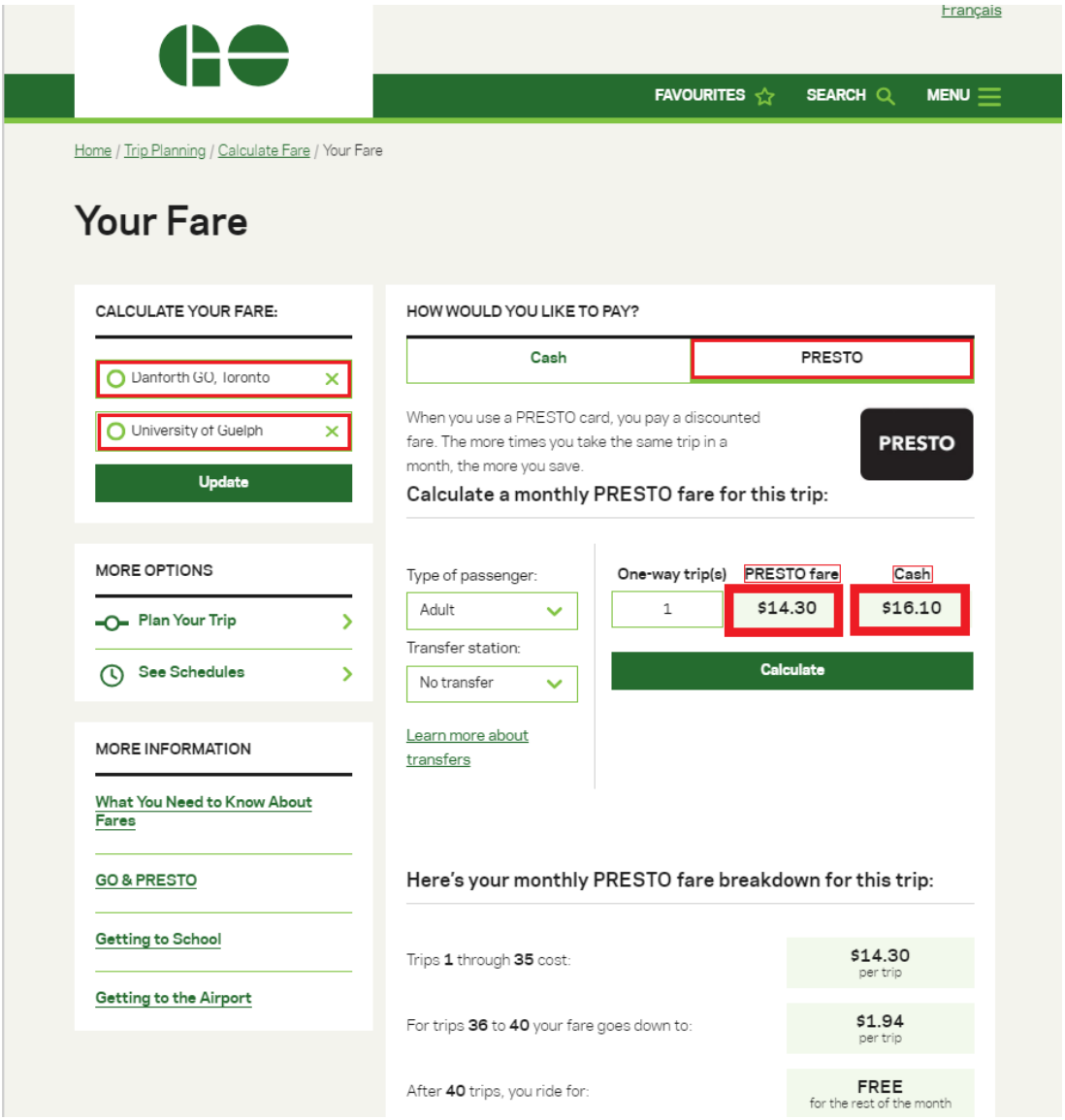


Figure 3.28. A Journey Fare Calculation via GO Transit Web Page

(Source: https://www.gotransit.com/, last accessed: 06.11.2019, 22.00)

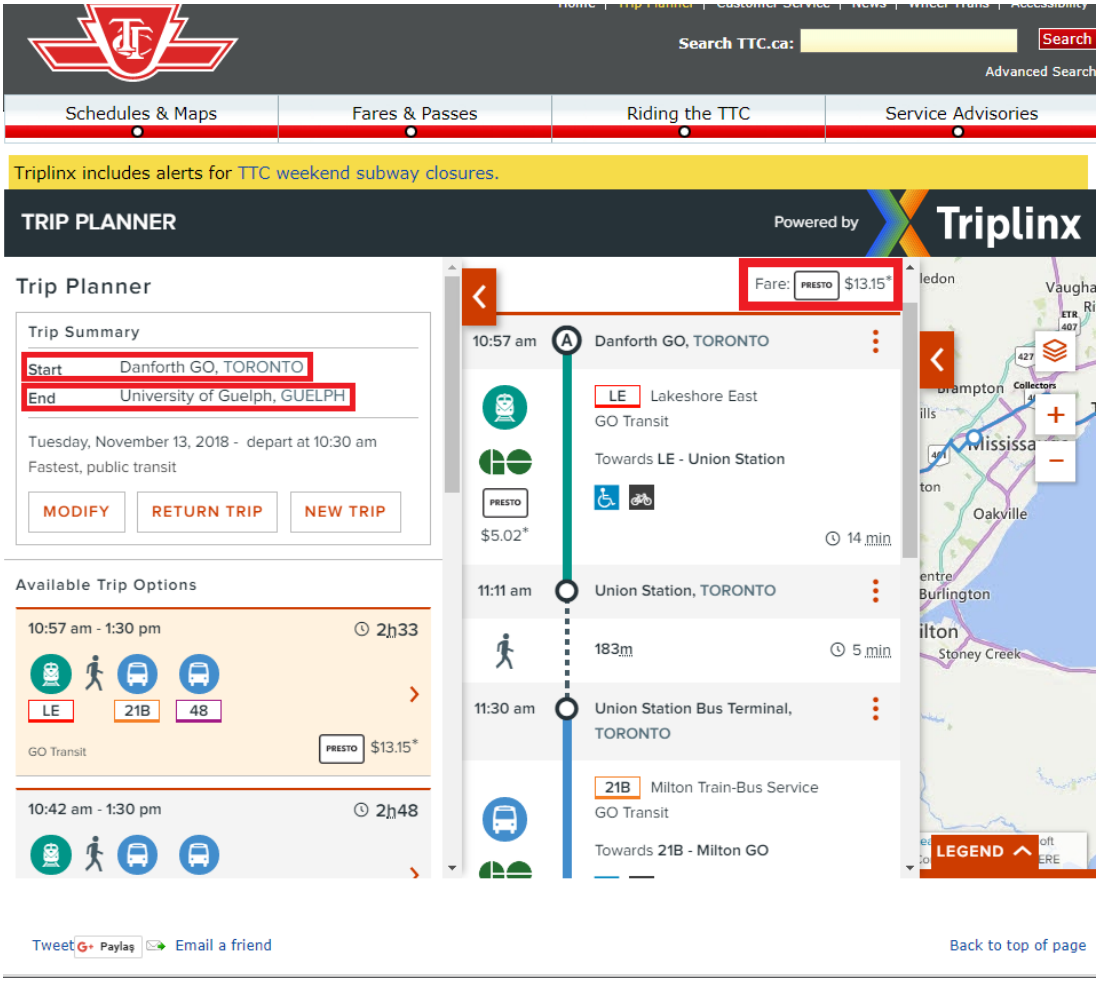


Figure 3.29. A Journey Fare Calculation Via TTC Web Page

(Source: http://www.ttc.ca/, last accessed: 06.11.2019, 22.25)

To add more, even though park&ride and bike share is prevalent across Toronto, payments of these amenities cannot be made with Presto Card; which is the smart fare card of Toronto. Yet, there is 30% discount in bike share to Presto card holders (https://bikesharetoronto.com/pricing/, last accessed: 01.04.2019, 20.52).

To summarize, Toronto cannot be identified as a city which has a public transport system with fully integrated tariff/ticketing. Yet there have been many concerted efforts of service providers for the last five years.

3.3.3. Information Integration in Toronto

The regional transportation plan, The Big Move: Transforming Transportation in the Greater Toronto and Hamilton Area, has ten strategies one of which is creating a customer-first transportation system. The strategy has its big move called “an information system for travelers, where and when they need it”. The Big Move Report addresses “design and operation with the needs of transportation provider rather than travelers” approach for the current ineffective transportation system. Taking travelers into the primary consideration is given as a key to an effective public transport system. Creation of a real-time and standardized regional transportation information portal is the aim. Singapore is exemplified in regional transportation plan as a successful city which provides travelers with information on a wide range of matters like travel times, trip planning, departures, transfers, optimal routings, comprehensive status updates etc. (The Big Move Baseline Monitoring Report, 2013, p.16).

The information about public transport in Toronto is supplied by multiple governmental institutions and other private or governmental organizations. Public transit providers have e-services to inform commuters. Yet the main and official transportation information resource is Triplinx. It is the collaborative initiative between Metrolinx and other transit providers serving the GTHA (http://www.metrolinx.com/en/, last accessed:06.11.2018, 13:25). This website produces possible pathways between two points in the city.

Figure 3.30 is a visual obtained from Triplinx and shows how to reach University of Guelph Station (Point B) from Danforth GO Station (Point A). It allows passengers find their own pathways to reach where they want to get to. There are trip options with diversified schedules, transit type and even tariff. It can be seen that a commuter can have an information about routes/lines, tariff/ticketing and schedule/headway integration in Toronto via Triplinx, notwithstanding fragmented public transport operators.

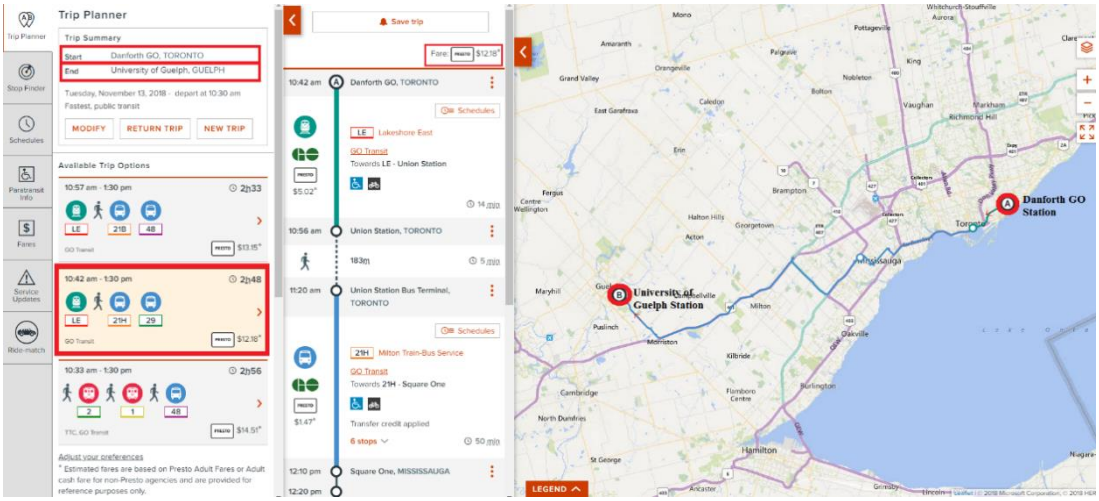


Figure 3.30. Various Ways to Get University of Guelph Station from Danforth GO Station in Toronto (Source: https://www.triplinx.ca/, last accessed:06.11.2018, 13.25)

3.3.4. Schedule/Headway Integration in Toronto

As stated in the London case, Toronto has various operators too. But Toronto has a more diversified and complicated public transportation system. Integration of schedule/headway is dependent on Toronto Transit Commission. Toronto Transit Commission makes service changes about ten times a year due to the multi-company structure. Schedules are changed every four to six weeks. The other significant feature of Toronto public transport is that service is often shown by headways of lines/routes. The approximate times for periods are listed. There exist some variations between routes. Except for the general schedules or headways, there is an overnight service called Blue Night Network. Blue Night Network reflects buses and streetcars that run every 30 minutes on most major routes from 1.30. a.m. to 5.30. a.m. There are almost 15 blue night lines. It is quite a high number when compared to other cases (https://ttc.ca/, last accessed:09.11.2018, 16.35).

When the schedules are analyzed in detail, the coherence between starting and ending hours can be noticed. For example, not only the subway systems but also regular bus routes start to operate around 5 am and end at 1 am or 2 am. When the headways are compared, it can be seen that subways are more frequent than buses. For example,

subways run every 2 or 3 minutes while buses have an average headway of 10-15 minutes. But Toronto Transit Commission explains the maximum waiting times as 5 minutes for subway systems and 30 minutes for bus and streetcar routes (https://www.toronto.ca/, last accessed: 09.11.2018, 17.00). To summarize, it can be deduced that Toronto has a public transportation system that has well integrated schedules/headways in spite of the presence of fragmented operators.

3.4. A General Overview of Singapore, London and Toronto Cities

The three cases are evaluated in this section by looking into their rates of public transportation utilization, car ownership, cycling etc.

Singapore doesn't have a wide range of public transport modes. There are mass rapid transit, light rail transit and bus services. Figure 3.31 shows average daily public transport ridership in Singapore. Notable from the graph is the increasing travel volume beginning in 2009. Growth in light rail transit is relatively slower. Notable point is the rate of increase in bus and mass rapid transit (MRT). This is thought to reflect the wider set of circumstances effected by improvements and institutions. For instance, Land Transport Master Plan in 2008 include Quality of Service Standards for feeder buses. Bus frequencies are also increased in peak periods. Bus Service Enhancement Programme, introduced in 2012, is a partnership of government public transport operators (https://www.mot.gov.sg/, last accessed: 16.11.2018, 22.45). Addition of 1000 buses to the fleet in 2014, opening of circle line (CCL) in 2009, growing fleet of circle line in the following years, growth on fleets of mass rapid transit lines like North East Line might also be other factors (http://www.asiaone.com/, last accessed: 15.11.2018, 22.09).

Figure 3.31 shows the high percentage of bus utilization in Singapore too. 48% of public transport travels are made by buses. The Land Transport Master Plan 2013 (The Big Move) focusses on developing a people-centered and commuter-inclusive system with connections. Besides, the growth in taxi in 2000 might be due to the Olympic Games made in Singapore in 2000.

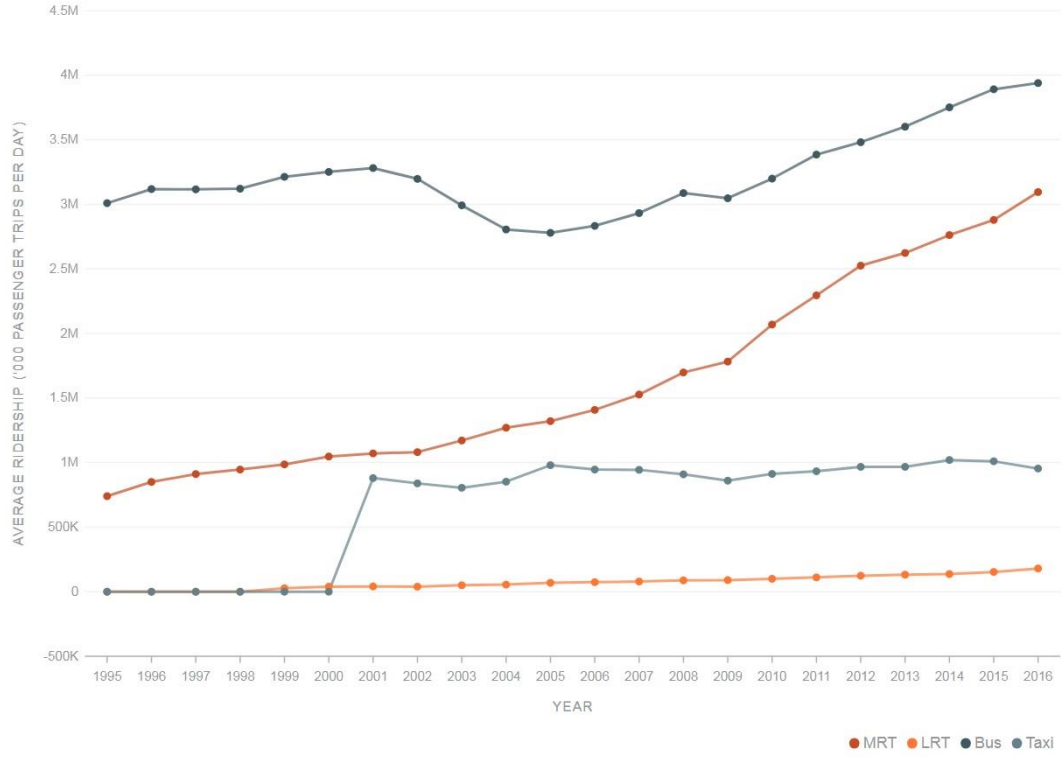


Figure 3.31. Public Transport Utilization: Average Daily Public Transport Ridership in Singapore (Source: https://data.gov.sg, last accessed:13.11.2018, 18.59)

Figure 3.32 illustrates annual effective car ownership in Singapore. While a sharp decline occurs in 2012, it begins to increase reversely in 2013. The increase goes on until 2016 and then it starts to decrease again. If these changes are associated to public transport utilization for the same time period, it can be noticed that both car ownership and public transport utilization increase.

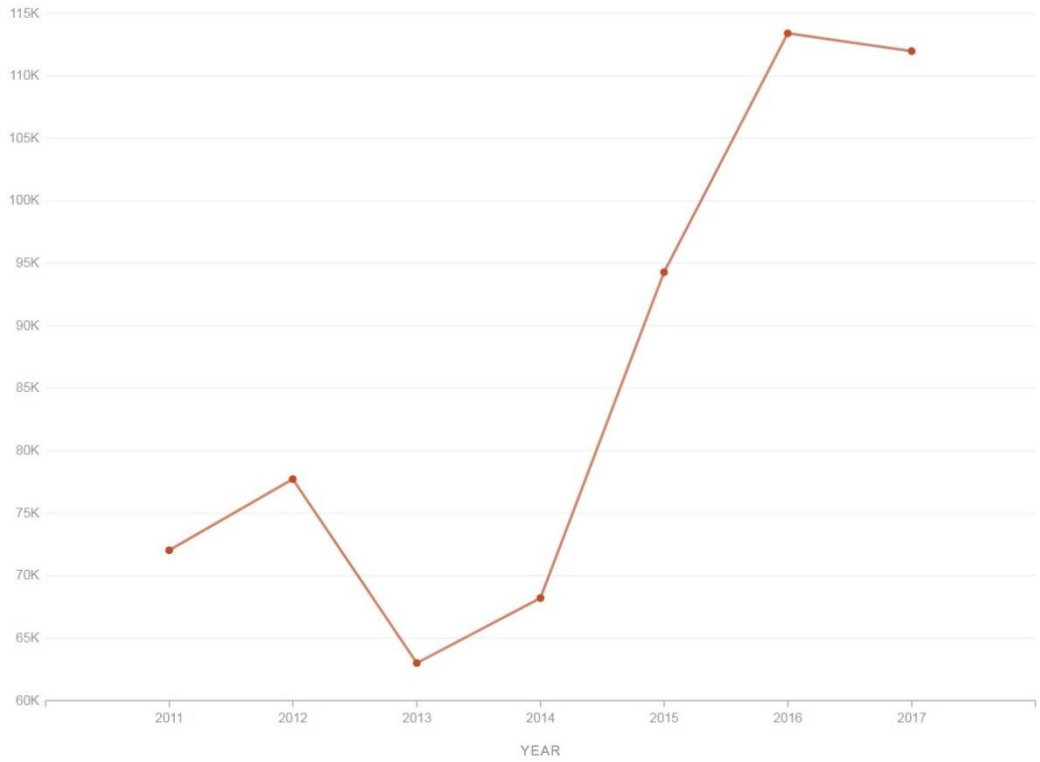


Figure 3.32. Annual Effective Car Ownership in Singapore

(Source: https://data.gov.sg, last accessed:13.11.2018, 19.41)

Average modal public transport ridership in Singapore is given in Figure 3.33. Bus is the dominant mode with 48 per cent. Mass rapid transit follows bus with 38 per cent. The dominancy of bus mode is similar in all cases in this study. One difference of the Singapore case is that the share of taxi is higher in Singapore. The reason might be the widely used private-hire taxi applications like “grab taxi” and “uber” in the city probably due to the inner-city automobile usage fares and cheap prices in case of multiple passenger usage.

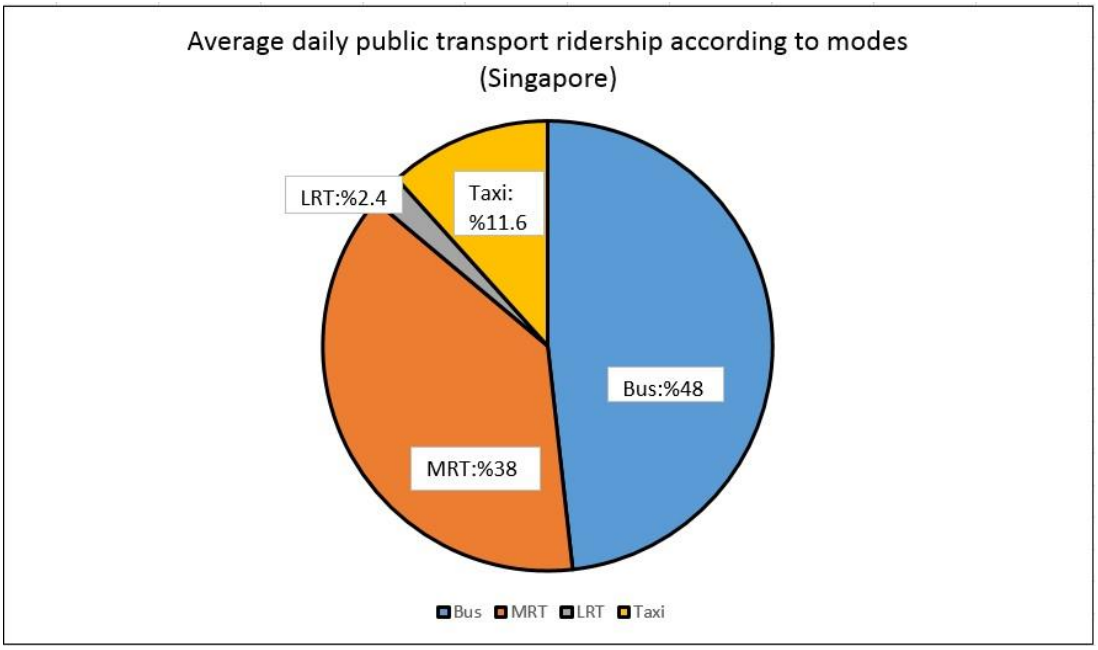


Figure 3.33. Singapore 2016 Average Daily Public Transport Ridership According to Modes

(Source: Author, based on the data obtained from: https://data.gov.sg/group/transport, last accessed: 15.11.2018, 08.20)

As for Figure 3.34, it illustrates the annual modal shares in London. Although car is by far the dominant mode in transport in London, when modes of public transport are combined (underground, rail and bus) their share is the same with private transport. Cycling and walking are also monitored as sustainable transportation modes together with public transport modes in annual report of the Transport for London. The report also shows that almost 50% of cycling and 20% of walking trips are made on the purpose of reaching work or education place.

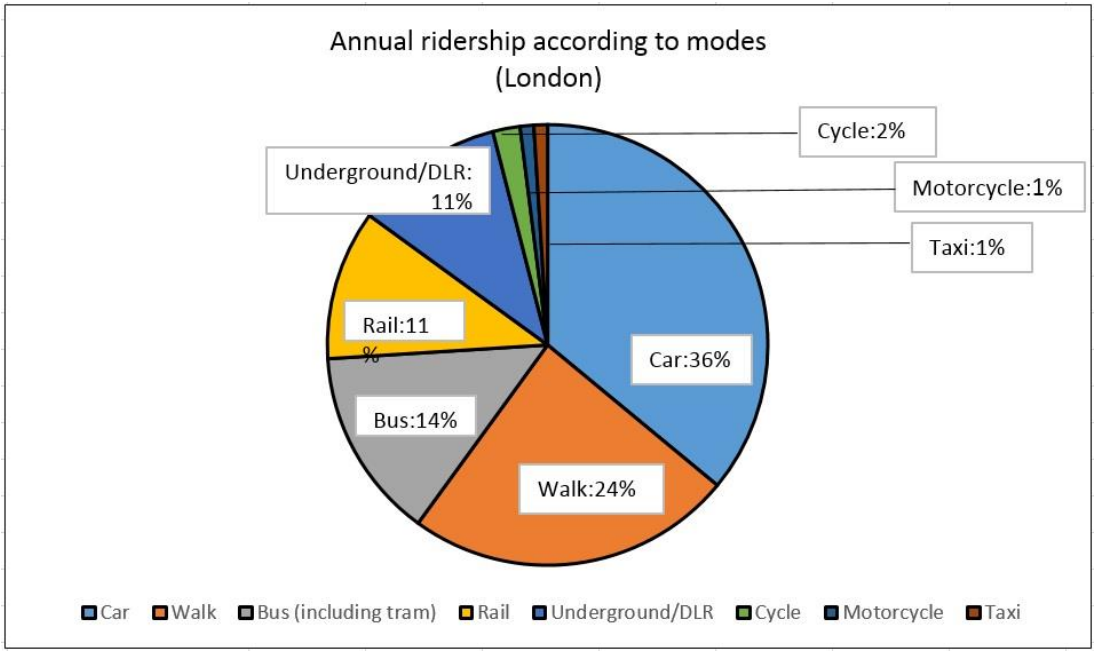


Figure 3.34. London Annual Modal Shares of Trips

(Source: Author, based on the data obtained from Travel in London Report 10, 2016, p.30)

While the population growth is a major influence on travel demand, unsteady rises can be explained by outside influences. That is because the population growth is expected to have an effect on each mode with same steady increase. For instance, formation of Greater London Authority and creation of Transport for London have led to improvements in customer experience through integrated interchanges and better provision of information since 2000 (Drivers of Demand for Travel in London: A Review of Trends in Travel Demand and Their Causes, Transport for London, p.17).

Figure 3.35 shows growth in journey stages in selected modes between 2001 and 2016. The Tenth Travel in London Report states that (2016, p.30) public transport use grows faster than population over this period. Despite a 0.5 per cent increase of private transport mode share from 2015 to 2016, public transport mode share remains higher than private transport since 2013. Some years represent turning points for all or some modes. For example, year 2014 represents a strong growth of cycling in London. This situation is linked in the report to Transport for London's measures of cycling to monitor the impacts of the Mayor's Vision for Cycling in London in 2013. There can

be a breaking point in public transport modes starting from 2010s. Public transport, cycle and walking flows increased by significant rates. The increase might be due to several actions. Yet oyster card history could be one of the reasons. While oyster card is introduced in 2003, it has been valid even in river services in 2009. The fare integration might be one of the reasons for the increase of sustainable modes.

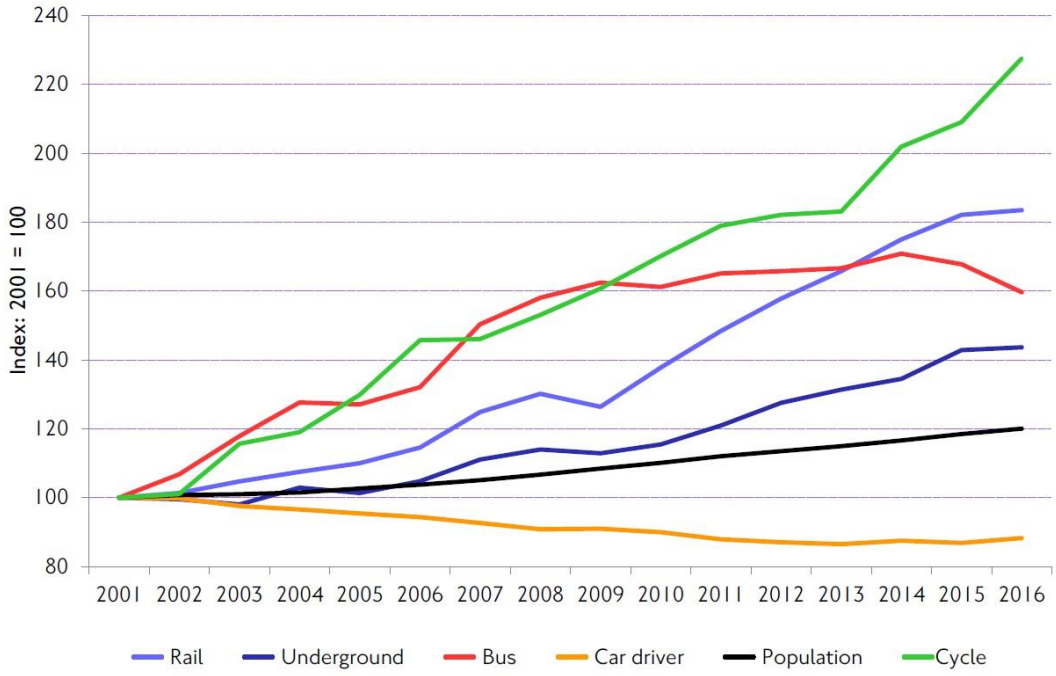


Figure 3.35. Growth in Journey Stages on Selected Modes From 2001 to 2016 in London

(Source: Travel in London Report 10, 2016, p.31)

Figure 3.36 and Figure 3.37 illustrate the public transport ridership and length of bike lanes in the City of Toronto. A parallel growth or decline doesn't occur within the determined time interval. While bike lanes grow sharply after 2006, public transport ridership grows steadily.

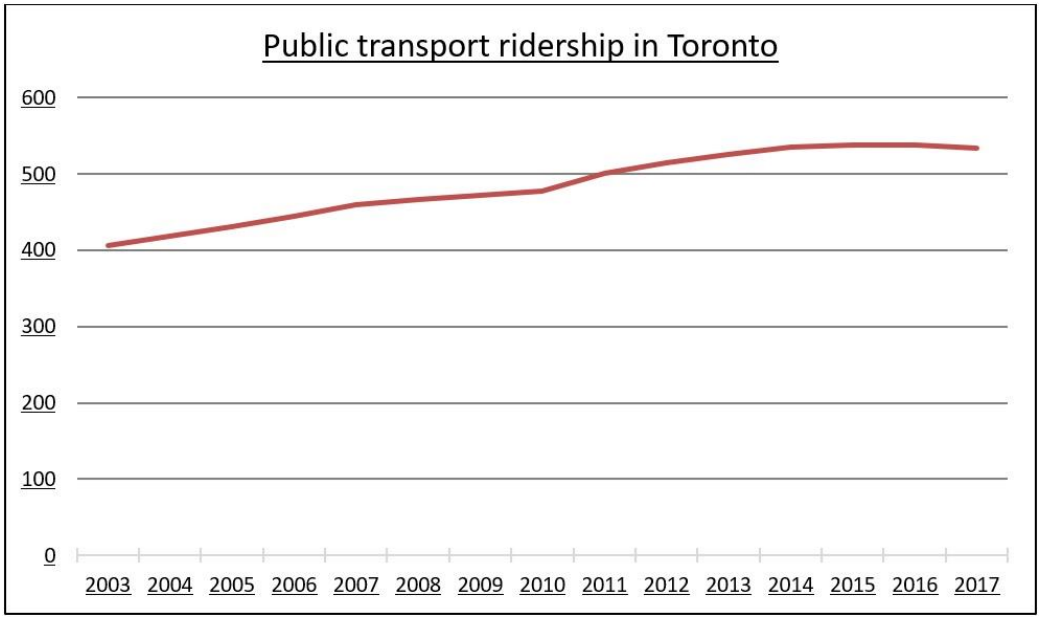


Figure 3.36. Public Transport Utilization: Annual Public Transport Ridership in Toronto

(Source: Author, based on the data obtained from https://www.ttc.ca, last accessed:14.11.2018, 19.36)

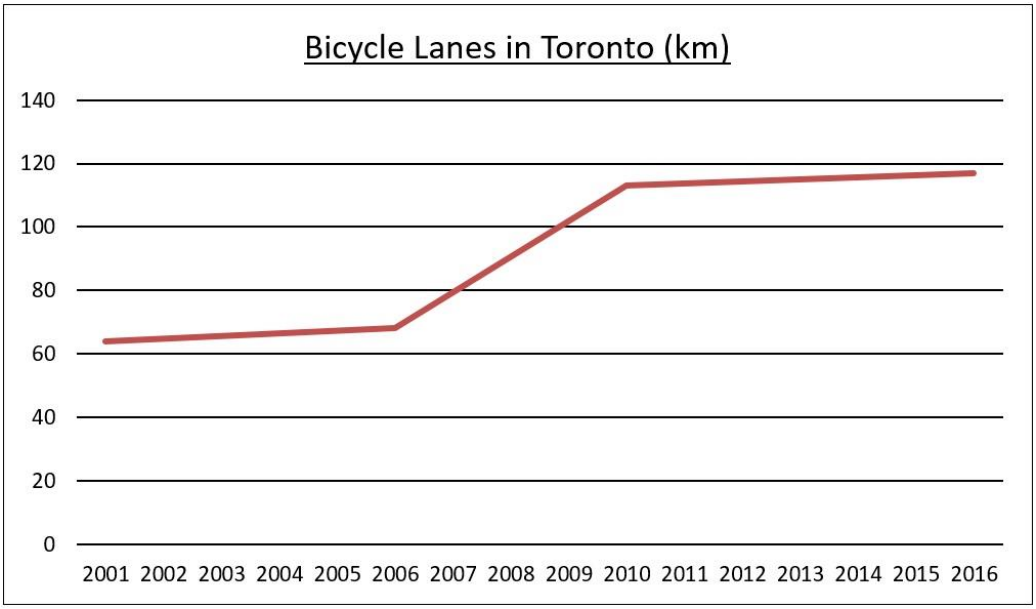


Figure 3.37. Length of Toronto Bike Lanes

(Source: Author, based on the data obtained from Greater Golden Horseshoe Transportation Plan, 2017, Ministry of Transport Ontario, p.47)

Figure 3.38 illustrates modal public transport ridership annually in Toronto. Bus is by far the most dominant mode within the modes, as is the case with Singapore. Annually, 59% of journeys are made by bus. Subway follows bus with 34 per cent. This situation is similar to other two cases. Nevertheless, Toronto envisions new subway lines that crisscross the existing lines. Therefore, it can be expected for Toronto to have more transfer subway stations and bridge the gap between bus usage ratio in near future.

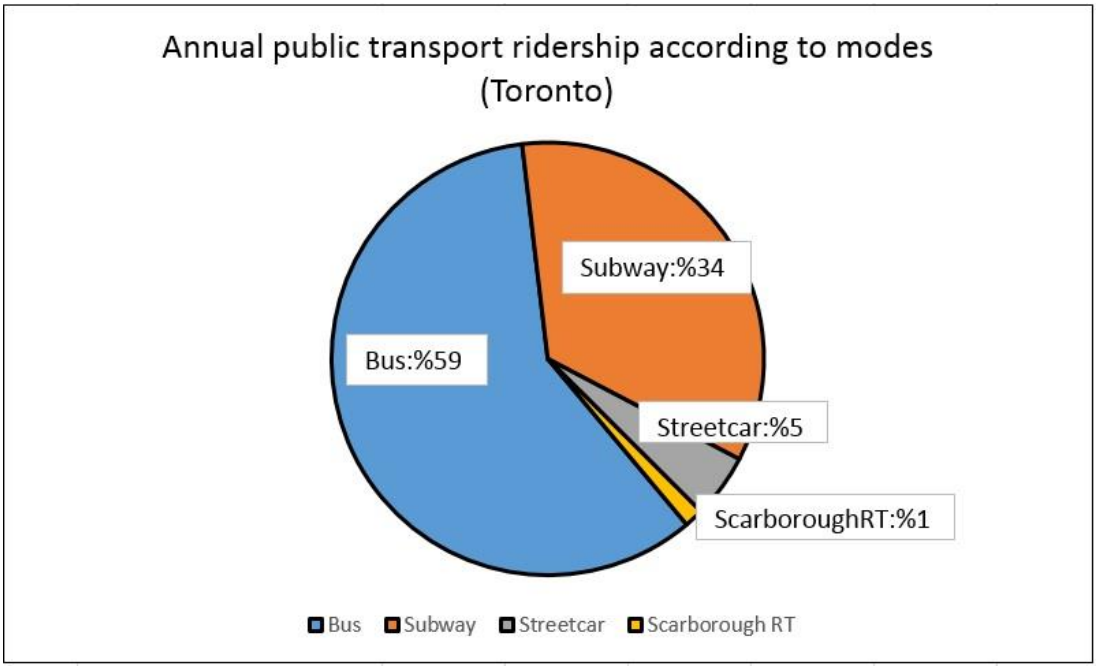


Figure 3.38. Toronto Annual Public Transport Ridership According to Modes

(Source: Author, based on the data obtained from Toronto Transit Commission Annual Report, 2017, p.64)

There are multiple public transit service providers in Toronto. The Toronto Transit Commission, the agency that operates subway, streetcar and bus networks, provides public transport in Toronto (Grise et al., in press, p.4). The Commission was created in 1921 aiming to be a financially self-sustaining and politically independent public corporation. It preliminarily operated bus services in suburbs. It then became responsible for all public transit in the metro area too in 1953 (Kaplan, 1967, p.179). However, The Toronto Transit Commission is not the sole institution providing public

transport. Go Transit, by its fleets of trains and buses, provides public transport service to downtown Toronto and surrounding suburbs. There are also Union Pearson Express and York Region Transit (https://www.torontopearson.com/en/toandfrom/public/##, last accessed:30.10.2018, 12:20). Union Pearson Express, operated by the governmental agency named Metrolinx, transfers between Toronto Pearson International Airport and Union Station. York Region Transit, funding and operating public transit services throughout York region, provides bus, subway and bus rapid transit service in Toronto. To specify the operators in brief, there are nine municipal transit agencies, GO Transit and UP Express. Nearly 85% of all transit trips in the Greater Toronto Area are made on the Toronto Transit Commission (https://www.ttc.ca/, last accessed:14.11.2018, 16.42).

The research about public transportation in Toronto shows a multiple institutional framework. There is a diversified structure of organizational chart. For this reason, Province of Ontario suggests a recipe. Province of Ontario constitutes Metrolinx as the agency responsible for the integrated transportation system in 2006. It is tasked to work with provincial, municipal and federal partners and private sector throughout the region. Besides, it operates GO Transit and UP Express in Toronto. (http://www.metrolinx.com/en/, last accessed:30.10.2018, 14.57)

Despite having a multi-agency public transit system, Toronto is inscribed as a well-designed North-American city with high density of population and efficient public transport system, in spite of the predominance of automobiles (Kennedy, C.A., 2002, p.460).

3.5. A Summary of Good Practice Cases on Public Transport Integration

A summary of literature on public transport integration was examined in Chapter 2. Good practice cases have some common features or developments about their public transport. This section of the study gives some common criteria in the light of case study investigations from the world. Although a checklist has been produced (see Chapter 5) and is examined in Chapter 6, some criteria from the analysis of world

cases in terms of public transport integration is shown in this section. Common criteria that are acquired from the analysis of the Singapore, London and Toronto cases are as follows:

- Physical integration of both a mode's lines and different modes,
- Physical integration of public transport modes with paratransit lines,
- Feeder or circle lines designed to link different lines/modes and/or serve for a specific time period (peak hours, at night etc.),
- Increasing the frequency of services,
- Determining line/route integration and future interchange stations according to transport master plans, or strategies or other plans and written documents,
- Least waiting time factor especially while transferring between different modes (Schedule/headway integration),
- Coherence between operating hours of different modes,
- Some specific design criteria/solutions for transfer stations or hubs,
- Less walking distances between different modes at interchange stations,
- A smart fare card that has a comprehensive usage area (all modes),
- Smart fare card's usage for various purposes like national rail, parking facilities, bicycle racks, food and beverage in transfer stations or even health facilities etc.,
- Specific fare solutions in the city (on-street transfers in London to avoid additional fees of zonal fare structure or degressive increase rates of fares in Singapore to avoid negative financial outcomes of distance fares system)
- Transfer reduced fare while transferring between lines or different modes and its validity in all public transport modes (no fare barriers),
- Road pricing systems/private car traffic charges in central and dense areas of the city,
- Information integration that is achieved via web-pages, mobile device applications, displays and boards in specific locations in the city and information at stations/hubs,
- Understandable and easy information tools,

- A unique standardized and real-time information system (independently of mode or operator-based systems),
- Information resources' diverse and detailed information (on waiting time, vehicle locations, fares, walking distances, headways, average travel time, real time parking availability etc.),
- Making integration dimensions involve paratransit modes,
- Park&ride and bike&ride facilities at stations,
- A facilitator/regulator institution to achieve public transport integration.

These items can be considered as criteria for a successful integration of public transport system, or can be used as a checklist. They can help to develop a framework, consisting of these items as a checklist, enriched and supported with the findings of the literature. Then the experience in the city of Istanbul, Turkey will be analyzed with the help of this framework, i.e. checklist. The common criteria are used as a basis for producing the checklist in Chapter 5. The criteria are modified as questions. Then in Chapter 6, the checklist is shown as a table (see Table 6.9) with answers for both good practice cases and Istanbul. So, these questions are answered in Chapter 6.

Before this detailed analysis, however, Chapter 4 presents a general overview of public transport policies in Turkish cities and ongoing studies, reports and strategies with regards to integrated public transport.

CHAPTER 4

PUBLIC TRANSPORT POLICIES IN TURKEY WITH A SPECIAL EMPHASIS ON INTEGRATED PUBLIC TRANSPORT

4.1. Introduction

The topic of urban transportation and in particular public transport services are issues that are broadly discussed in reports, meetings, strategy documents and plans at the central government level in Turkey. In this chapter, public transport policies at the national level is investigated in terms of public transport integration. It can pave the way for forming a frame for existing implementations. Before analyzing the city of Istanbul as the main case study, this chapter is expected to give useful information on how public transport policies are shaped for the country since nation-wide policies are expected to have effects on city or region-wide implementations.

This policy investigation is divided into four sections, which are as follows:

- The Five-Year Development Plans
- The Council of Urbanization-2009
- The Council of Transportation, Maritime and Communications-2013
- Public Transport and Integration Issues in Turkish Cities

There are three main policy documents in Turkey at the national level. These documents have a wide range of context. They include not only transportation but also urbanization, development of regions and/or cities and communications. Yet, they are analyzed within the frame of public transport integration in this study. In the case of Turkish public transport policies, Five-Year Development Plans, the Council of Urbanization and the Council of Transportation and Maritime and Communications will take place in this chapter.

The last section; public transport and integration issues in Turkish cities, is the evaluation of nation-wide public transport policies by taking significant metropolitan cities' public transport systems into account. This section is both a discussion of this chapter and exemplification of this chapter's issues.

4.2. The Five-Year Development Plans

The five-year developments plans are published by the Ministry of Development for five-year periods. The only exception was the ninth development plan, which was prepared and approved for 7 seven years between 2007 and 2013. The last development plan of the country is the tenth development plan, which covers the 2014-2018 period. The eleventh development plan for 2019-2023 period is being worked on currently. There is an expert commission on transportation in this ongoing plan according to Guidebook of Expert Commissions and Working Committees for the Eleventh Development Plan (2019-2023). However, it hasn't been published yet.

A review of the Five-Year Development Plans has been made with a view to find out whether there have been any predominant goals or discussions about integrated public transport. The findings of this study are given below:

- The First Five-Year Development Plan (1963-1967) emphasized the inadequacy of transportation policies. There isn't a focus on integrated public transport. But there are a lot of implications regarding integration. There are two principles under the Transport title as follows: Establishment of a vehicle organization which feeds and completes highway, marine and railway transportation in short-distances and binding all transport systems under the same obligations and imperatives (First Five-Year Development Plan, 1963, p.386). There are also precautions about integration of transportation. It is stated that all transportation systems would be operated in a centralized manner. The Ministry of Transport is regarded as the responsible body for transport lines' foundation and tariff (First Five-Year Development Plan, 1963, p.392).

- The Second Five-Year Development Plan (1968-1972) emphasized that highway transport gains importance as opposed to railway or marine transport (Second Five-Year Development Plan, 1967, p.562). There aren't any statements about public transport, which is surprising after the statements in the First Five-Year Development Plan.
- The Third Five-Year Development Plan (1973-1977) mainly focusses on the objectives regarding production, sectors, manufacturing industry, national and international investments and importation. Therefore, transportation principles of the plan are related to building of transport networks for manufacturing goods (Third Five-Year Development Plan, 1973, p.216). So, the third five-year development plan does not include any objective or principle about integration of public transport systems either.
- The Fourth National Development Plan (1979-1983) indicates rapid and unplanned way of urbanization as the reason for major public transport problems (Fourth Five-Year Development Plan, 1979, p.161). It also stresses the inadequacy of transport infrastructure (p.4). Nevertheless, public transport integration is not mentioned in the Fourth Five-Year Development Plan either.
- The Fifth National Development Plan (1985-1989) has an aim to carry out transportation plans in integration with urban development plans in cities. It has another objective regarding investment and improvement of suburban railways and other public railway systems (Fifth Five-Year Development Plan, 1984, p.112-117). However, there are no policies, goals or objectives concerning public transport systems' integration.
- The Sixth National Development Plan (1990-1994) has an aim in parallel with the former development plan. Policies and objectives about transportation are given under Services/Transportation section. Urban transportation investments are aimed to be conducted in line with land use plans and also public transportation plans (Sixth Five-Year Development Plan, 1989, p.276). But there are no policies or goals specific to integration of public transport systems.

- The Seventh Five-Year National Development Plan (1996-2000) has policies about public transport while the main emphasis is the need for transport master plan which aims to increase the marine and railway transport rate throughout the country and the coordination between transport master plan and urban development plans. In this regard, there is a policy that public transport system studies would be fastened in compliance with transportation master plan. There is also an objective about privatization in urban transport. It is stated that the rate of private resources and contribution in urban transport should be increased with new approaches via institutionalized entrepreneurs. These policies and objectives above are stated under the title Structural Alteration Project on Infrastructure Services/Transportation. There is also a statement on the current situation about the ineffectiveness and the lack of integration of railway public transport with other public transport modes (Seventh Five-Year Development Plan, 1995, p.133-148).
- The Eighth Five-Year Development Plan (2001-2005) gives wide coverage to transportation. Transportation and urban transportation of urban and rural infrastructure are subtitles under the title of "Development Objectives and Policies Related to Social and Economic Sectors". When these sections are elaborated within the scope of integrated public transport, it is seen that there is not a focus on public transport; but there are implications about integration of public transport modes. The plan focuses on the lack of Master Plans on Transportation and legal arrangements. Master Plan on Transportation is shown to restore balance among transportation means. It is stated that there are problems regarding nearly all sub-sectors of transportation and they are tackled without any correlation. There is also a focus on fragmentation and privatization about investing and operating agencies; however, this seems to be mostly related with long-distance travel, i.e. railways, highways, airlines, and seaways. Different ministries and undersecretaries are stated as the reason for the fragmentation and lack of cooperation and collaboration problems among transportation sub-sectors. With regards to urban transport, it is stated

that privatization complicates collection of data, and that for example data cannot be obtained about starting point and the last station of journeys (Eighth Five-Year Development Plan, 2001, p.172). Integration of public transport takes part only in two objectives which are as follows: “integration of suburban rail operated by the General Directorate of Turkish State Railways, with urban transport system shall be ensured and the quality of services shall be enhanced”; and “regulation on car parks shall be revised and arranged in accordance with the parking lots along the roads and collective parking lots” (Eighth Five-Year Development Plan, 2001, p.201).

- The Ninth Development Plan (2007-2013) has some principles about integrated public transport. Transportation infrastructure considerations are the focus in particular. The plan has basic principles about integrated public transport under the title of Improving the Energy and Transportation Infrastructure as follows: “In creating a balanced, rational and efficient transportation infrastructure where transportation modes will be used in the most suitable areas in technical and economic terms, the transportation system will be handled in an integrated approach; furthermore, policies, which will ensure shifting freight transportation to railways and transforming major ports to logistic centers and which will emphasize safety in transportation modes, will be followed” (Ninth Development Plan, 2006, p.83). “Towards creating a sustainable urban transportation system within the EU harmonization process, pedestrian and bicycle transportation and public transportation modes will be prioritized and the use of these modes will be encouraged” and in addition, “Diversity and integration in urban transportation modes will be ensured through taking care of the original structure, dynamics and potentials of each city” (Ninth Development Plan, 2006, p.86).
- The Tenth Development Plan (2014-2018) does not include a separate part about transportation issue. But it is a title with logistics under the head title of “Innovative Production, High and Stable Growth”. Transformation program from transportation to logistics is one of the priority transformations programs

of the development plan and it relates to long-distance travel rather that urban transport. When the tenth development plan is examined within the scope of integrated public transport, it can be noticed that there is not a separate section or reference to it. It can be analyzed and inferred from the tenth development plan that is has neither got a focus on integrated public transport nor transportation in particular. Yet under some titles of the plan there are some aims about public transport. Aims and objectives about integrated public transport of the plan are given as follows: "Urbanization and urban transformation will be conducted in association with manufacturing industry. In this context, production and export capacity will be increased in areas such as smart buildings, building and construction materials, and public transport and signaling systems." (under the title of Transformation in the Manufacturing Industry) (The Tenth Development Plan, 2013, p.87). "In urban transport, information technologies and intelligent transport systems will be efficiently utilized in traffic management and public transport services" (under the title of Urban Infrastructure) (The Tenth Development Plan, 2013, p.131). The plan also proposes "disseminating use of public transportation, small engine volume and electric and hybrid vehicles, establishing smart bike networks in appropriate residential areas and creating pedestrian paths closed to traffic" (under the title of Energy Efficiency Improvement Program) (The Tenth Development Plan, 2013, p.177).

The review shows that although there are references to public transport, issues of integration have not been considered as strategic plan decisions and proposals in the Five-Year Development Plans. This may be due to the fact that these plans cover all sectors, and not only the transport sector. Furthermore, the transport sector covers long-distance national and international transport, and significant proportions of the plans focus on highways, roads, railways, seaways and airways. As a result, urban transport receives limited attention and public transport integration is therefore not referred to adequately. This can be considered as a shortcoming, particularly when

compared to some of the best-practice examples given in Chapter 3, in which national strategies and White Papers have addressed the issue of public transport integration.

4.3. The Council of Urbanization - 2009 and 2017

The Council of Urbanization (2009) was conducted by the (former) Ministry of Public Works and Settlement, which was restructured and named as the Ministry of Environment and Urbanization in 2011. The council have had ten council commissions and were carried out with high level of participation of private entities, public institutions and universities/academicians. Ten commission reports were published. One of those commissions were Urban Technical Infrastructure and Transportation Commission.

There is a Public Transport Policies Section under the title of Urban Transportation in the Commission Report of Urban Technical Infrastructure and Transportation. Public transport and integration of modes have a wide coverage in the report. It is stated in the report that integration of public transport system approach was regarded as a way for institutionalization of urban transport in the Eighth Five-Year Development Plan and Reorganization Project of General Directorate of Turkish State Railways (TCDD). Inability to supply an integrated public transport system is designated as the main problem within the framework of public transport (The Council of Urbanization, Urban Technical Infrastructure and Transportation Commission Report, 2009, p.28). It is discussed that decisions related to public transport are mostly shaped by the executives/administrations rather than according to logical plans, and that this situation paves the way for project-based public transportation. These kinds of projects are usually conducted in a limited time just to prove that the administrations make investments. Integration is not just dealt with focusing on motorized public transportation means. There is a focus on non-motorized modes of transport too. It is stated that bicycle parks should be installed inside or near public transport stations across the cities in the country. There should also be bicycle stands inside public transport vehicles. Integration of public transport modes with each other and with bicycles/pedestrians' roads and with private automobiles' park facilities is shown as a

mean for travel demand management. Integration is discussed as a crucial means to decrease today's huge demand for private car usage and to shift passengers towards public transport modes.

There are many strategies in the report about park and ride and bike and ride stations. There are also strategies in the commission report about integration of public transport. According to these strategies, public transportation modes should be selected in conformity with the city's physical and geographic structure and each mode should be integrated with major and/or sub-lines. Integration is not only about physical aspect, but also about timetables and tariff/ticketing (p.59-74).

The Council of Urbanization that was held in 2017 does not contain a commission about transportation. Yet, the commission report of Identity, Planning and Design in Our Cities makes a mention of integration of public transport. According to the report, it is necessary to head towards a diverse transportation system. This kind of diversity is in direct proportion to quality of life. A diverse transportation system means also an integrated transportation system, which also includes pedestrians and bicycles. The systemic pattern of integrated public transport can also develop social integration and sustainable living areas. In this direction there is a commission recommendation that public transport (subway, tramway etc.) should be extended (The Council of Urbanization, Identity Planning and Design in Our Cities Commission Report, 2017, p.118-125).

4.4. The Council of Transportation, Maritime and Communications (2013)

Councils of Transportation, Maritime and Communications are organized by the Ministry of Transportation, Maritime and Communications. The last council of the country was the eleventh council, which was organized in 2013. This council's final declaration is examined within the concept of integrated public transport.

The Eleventh Council of Transportation, Maritime and Communications (2013) does not have a discourse on integration of public transport in a broad extent. Yet, when the final declaration of the council is examined it can be seen that there are some points about it. Integration of transit modes with regards to transit lines, pricing and schedules

in the urban area, and planning railway, airway, bus terminals and ports effectively to integrate to all transit modes are given as targets in the urban transportation section. Developing smart transport infrastructures and systems in order to integrate railway lines with other transport systems is the other objective set for the year 2023 (Final Declaration of 11th Council of Transportation, Maritime and Communications, 2013, p.27-34).

4.5. National Transportation Master Plans

The first National Transportation Master Plan was prepared for the period from 1983 to 1993. It highlights coordination between transportation plans and development plans. Coordination between the responsible institutions and the need for advances and improvements in public transport systems in cities in the country are also emphasized in the plan (Yaman, 2015, p.72).

National Transportation Master Plan Strategy (2005-2015) discusses various issues like developing future transportation network scenarios of Turkey, transportation types, combined transport, urban transport, environmental effects and cost analysis. It is highlighted that policies in the strategy are formalized in consideration of EU Commission's directives. The need for coordination between transportation plans and development plans are emphasized in this document too. Besides, there is a section named urban transport in the strategy document. Policies and issues about integration of transport are specified as follows:

- Bus terminals should be integrated with public transport systems.
- Integration is a problem in urban transport managerialism. There is not a fully accomplished integration in terms of lines, timetables and prices. That's why connecting journeys can become a problem for passengers. It causes a decrease in the public transport usage.
- A transport authority which has a private statue should be constituted in order to overcome the existing complexities of institutions. This authority will supply administrative harmony, prevent unfair competition between various

modes and have an autonomy with its own financial structure and independent from local governments.

- Integration of public transport modes increases productivity in the existing infrastructure. Integration is ensured by physical integration, line/route/time integration, common ticket system and ticket price integration.

There are also some policies about specific places. For instance, Sabiha Gokcen Airport in Istanbul is discussed and it is planned to integrate it to Istanbul's railway systems.

4.6. Public Transport and Integration Issues in Turkish Cities

Currently, public transportation and the integration of its services is an issue that is discussed to a certain extent at central government level. Nation-wide policy documents have been analyzed within the frame of public transport integration.

When the five-year development plans are analyzed, it can be seen that they have not exactly discussed the integration of public transport until the seventh five-year development plan. Although the first plan had some implications about a transport authority that has control over all services, there had been assessments only regarding general transportation including highway network infrastructure, freight transport needs, lack of a transport plan, deficiency of public transport systems within urban areas etc. within the first four plans. Beginning from the seventh five-year development plan and after the privatization policies, there are some implications about fragmented institutional structure of public transport services in some cities. Lack of integration of railway services with other public transport modes is also emphasized in the seventh plan. The problems regarding transportation sub-sectors and deficiency of collaboration are emphasized in the eighth plan. Particularly, the ninth (2007-2013) and the tenth (2014-2018) plans have a wider coverage on public transport; however, strategies on integration are limited.

When the Council of Urbanization is analyzed, there is a wide content upon public transport and integration. There is a separate expertise committee about urban transportation. The report discusses both public transportation in ever-growing urban

areas and integrated public transport systems within those urban areas. The necessity of a mode's integration with major and sub-lines is emphasized. Integrated public transport systems are discussed by taking cyclists and pedestrians into account.

When the Councils of Transportation Maritime and Communications are analyzed, it can be seen that there is a separate urban transportation section. The council has tackled not only with inter-modal integration but also some aims regarding schedule/headway and tariff/ticketing integration.

Likewise, the transportation master plans have focused on inter-modal integration. Public transport's institutional integration also has a wide coverage on the report. It highlights the importance of line/route integration and tariff/ticketing integration.

To sum up nation-wide policy documents widely handled with public transport integration especially beginning from 2000s. Growing and sprawling urban areas and following traffic problems pave the way for discussions. Privatized services also provide the need for integrated public transport systems. The more modes and lines increased, the more the integration is discussed within nation-wide policy documents. It is possible to make mention of nation-wide policy documents' effect on local institutions. Because the local or institutional documents also discuss the public transport integration within their responsibility areas. Railway systems in cities are appeared to be main modes to be integrated within national documents. Today some metropolitan cities across the country have railway systems. 12 of 81 cities have railway systems. They are Istanbul, Ankara, Izmir, Bursa, Eskisehir, Kayseri, Gaziantep, Konya, Samsun, Adana, Antalya and Adapazarı. However, some of them has only one tramway line. Nevertheless, major metropolitan areas like Istanbul and Ankara has various rail modes. The majority of cities in Turkey has a monopolized public transport that is constituted of conventional buses. Likewise, bus is generally the most used public transport modes in metropolitan cities. It is generally the backbone of the systems. That's why integration is always on the agenda of institutions currently. Istanbul is by far the dominant and the unique city regarding public transport and also railway modes diversity. The more population increase and urban area widens, the more public transport system becomes diversified. That's why

Istanbul has a rich context of public transport modes and is a good example to investigate the integration. To sum up nation-wide policy documents dealt with public transport integration especially beginning from the 2000s. Growing and sprawling urban areas and following traffic problems pave the way for discussions. Privatized services also provide the need for integrated public transport systems. The more modes and lines increased, the more the integration is discussed within nation-wide policy documents.

Railway systems in cities appeared to be main modes to be integrated within national documents. Today some metropolitan cities across the country have railway systems. 12 of 81 cities have railway systems. They are Istanbul, Ankara, Izmir, Bursa, Eskisehir, Kayseri, Gaziantep, Konya, Samsun, Adana, Antalya and Adapazarı. However, some of them has only one tramway line. Nevertheless, major metropolitan areas like Istanbul and Ankara have various rail modes. The majority of cities in Turkey has a monopolized public transport that is constituted of conventional buses. Likewise, bus is generally the most used public transport mode in metropolitan cities. It is generally the backbone of the systems. That is why integration is always on the agenda of institutions currently. Istanbul is by far the dominant and the unique city regarding the diversity of public transport and also railway modes. The more the population increases and urban area widens, the more public transport system becomes diversified. That is why Istanbul has a rich context of public transport modes and is a good example to investigate the integration.

It is necessary to observe nation-wide policy documents' effect on local institutions. That is because local or institutional documents also discuss public transport integration within their responsibility areas. For example, Istanbul has a Master Plan for Istanbul Metropolitan Area Integrated Urban Transport (2011), and this document is evaluated with regards to integration in detail. Capital city Ankara has not accomplished its Transport Master Plan, although efforts for the Master Plan was started in 2013. Nevertheless, the drafts for future transport system show that Ankara aims constructing new rail lines and two radial rail lines to enhance integration between rail lines and bus lines, as emphasized in national documents. When Izmir's

Transport Master Plan 2030 is investigated in terms of public transport integration, it is seen that there is a wide coverage on public transport integration. First of all, inter-modal integration is a target which is going to be supplied via new three types of Transfer Terminals. The key mode for integration is railway systems. It also aims at integrating pedestrians and cyclists to the public transport system. The plan also has some targets about fare integration. Final report of the plan has separate parts about paratransit, pedestrian and disabled people, cycling, parking and institutional structure in Izmir. Izmir seems to have public transport integration targets in compliance with national documents.

The main findings and considerations in this chapter are summarized below:

- The analysis of national documents in Turkey showed that there are policies about nation-wide and urban transportation and some of those documents included public transportation aims and goals.
- When the plans and other documents are examined, it can be seen that they have not discussed the integration of public transport until about 1996. That is why one can make interpretations about the late realization of the importance of public transport integration as well as the public transport itself.
- When the plans and Council reports are compared, it is seen that Council of Urbanization has more coverage on public transport integration as the Council had separate expertise committee about urban transportation. Both a mode's integration with major and sub-lines and cyclists and pedestrians in integrated public transport systems are taken into account. Likewise, the Council of Transportation Maritime and Communications had a separate urban transportation section. The Council has tackled with inter-modal integration and involves some aims regarding schedule/headway integration and tariff/ticketing integration. Also, the transportation master plans aim for inter-modal integration. Public transport's institutional integration also discusses within the report. The report gives importance to line/route integration and tariff/ticketing integration.

- The other remarkable thing is that although the nationwide documents have emphasized public transport integration, they have addressed some of the integration components. For example, the Council of Transportation Maritime and Communications had some aims regarding schedule/headway integration and tariff/ticketing integration, while the transportation master plans focused on line/route integration and tariff/ticketing integration. From that point of view, it can be stated that although there are some references, there is a lack of a comprehensive understanding of public transport integration, which focusses on integration in every aspect.
- There could be a reason for the previous issue. When the documents are examined according to their timings, it can be seen that policies or visions about public transportation integration have been produced to tackle with some already existing problems like the outcomes of fragmented structures and implementations, traffic congestion or privatization. While these endeavors have positive effects to deal with the problems about public transport integration, they could not have their worthy of note by policy makers during the implementation processes.
- Besides, the documents do not seem to be supported by implementation tools and enforcements. For example; while the seventh five-year development plan offers the privatization policies in public transport delivery, the eighth development plan defends the idea that privatization of public transport is tough to control and monitor. This example has an implication that privatization without a groundwork had some negative outcomes. It demonstrates the shortcoming of feeder tools such as laws, by-laws, guidance papers or acts. The other example is about the lack of enforcement. There are many implications within the national documents about public transport integration beginning from the 1990s. For example; even though the National Transportation Master Plan Strategy (2005-2015) discuss lots of issues regarding public transport integration, most of them has not come into practice due to, presumably, the lack of the power of sanction.

To sum up, integration is discussed at national level. However, the discussions on means of achieving the integration is also necessary. In recent years integration components, such as line/route integration and tariff/ticketing integration, seem to take increasing place at national documents. However, these are only some of the components, as described before. There is a need to approach the issue of public transport integration in a more comprehensive way. Following this need, Chapter 5 helps develop a framework of analysis and planning for an integrated public transport system. This framework is based on the findings of the literature review and best-practice cases, and it is to be implemented on the case of Istanbul.

CHAPTER 5

METHOD OF RESEARCH

5.1. Context (The Scope of the Thesis)

Vehicles and infrastructure of transportation has had an advanced development for the last 150 years, as explained in Chapter 2. This development becomes a turning point when it is contextualized particularly with its dual relationship with urban land and development. Over the years, the main subject of this development has become, private transportation vehicles, which have severe negative environmental, economic and social outcomes. Not only they conflict with sustainable transport concept, but also make cities suffer from traffic congestion, pollution emissions and unproductive use of the land.

Public transportation on the other hand is unique for providing the most efficient means of transport for large numbers of travelers in urban areas. Furthermore, public transport system in a city with all its modes is one of the sustainable transport alternatives. Hence, maintaining improvement and efficiency of public transport systems is considered as a crucial component of contemporary transport policies and policy makers. It is also considered as a tool to decrease car dependency and associated traffic problems, such as congestion and air/noise pollution, which are the consequences of extensive and excessive usage of privately-owned automobiles.

Both national and local authorities started to focus on providing a basis for an improved and high-quality public transportation system. The major public transport reforms that are launched and conducted in recent years have been triggered by the notion of improving overall integration. In investigating the way to increase public transport ridership, integration is the key to attract passengers. That is because integration generates a high-quality and accessible transit system, which attracts

passengers and creates a shift to public transport. It is clear that constructing and/or extending transit lines/routes alone are not enough for a transport system to be attractive. It can be made by promoting commuters' interest through the supply of integration.

As discussed in earlier chapters, integration refers to different levels. It has four main aspects which are route/line integration, information integration, tariff/ticketing integration, and schedule/headway integration.

Many cities have experimented with integration levels to encourage greater use. New pricing programs, transfer stations, information technologies, coordination actions between operators are planned. In this sense, experiences and implications of cases from various parts of the world are of crucial importance.

Moreover, integration of public transport systems is something which should be done all the time to preserve continuance by reason of different backgrounds like spatial planning, changing macroform and population etc. An integrated public transit system is like an organism that contains always new relationships being established.

Istanbul metropolitan area was chosen as the study case since the population of the city, diversity of transit modes and the level of mobility can be compared with best practice cases in the world. Istanbul has also been implementing integration projects, for its subway system in particular. Prevention of traffic congestion and serving public transit in the city at parallel grades with population increase are always on the agenda of executives in Istanbul.

Briefly, the context of the thesis is the investigation of public transport integration in Istanbul depending on inferences made from the literature review and the best practice cases from the world. Taking these into consideration, public transport systems, planning background, public transport operators/institutions, public transport framework and policy documents, future plans with an emphasis on integration of public transportation in Istanbul in terms of route/line integration, information integration, tariff/ticketing integration and schedule/headway integration are investigated.

This study is expected to reveal whether the overall public transportation in Istanbul can be shown as an integrated system. It aims at investigating positive and negative aspects of the current system in terms of public transport integration. The analysis will also be expected to help assessments on geographical/institutional/demographical differences between different metropolitan areas in the world.

5.2. Research Question, Aims and Objectives

Public transport ridership, together with other sustainable transportation means like walking and biking, are the main policy tools to preclude traffic congestion in many cities, especially in metropolitan areas. Hence subway lines are being extended; bus systems are being improved, and walking and biking, including bike-sharing systems, are always on the agenda of local governments.

Many cities in Turkey have limited public transportation means. To be more precise, many cities have solely buses as public transportation means. However, larger cities have multi-modal and more developed systems. Istanbul is one of those cities that have larger metropolitan areas and population. Geographical features of the land, population level and density, and central government's involvement in transportation decisions also trigger a versatile and multi-modal public transit system in Istanbul.

Nevertheless, there has not been a comprehensive analysis on the whole public transportation system's integration experience in Istanbul. Most part of the studies focus on either one transit mode or various modes' integration just with one or two aspects of integration. Besides, Istanbul has been experiencing mega projects, such as Marmaray tube crossing (strait's rail line), Yavuz Sultan Selim Bridge (the third bridge on northern tip of strait) and Istanbul Airport (the third and the largest airport of city), affecting its transportation system recently. Integration of public transportation system as a whole is crucial to attract commuters and to increase ridership. That is why, the aim of this research is to analyse and provide a better understanding of public transportation integration firstly, and then to compare best practice cases in the world and Istanbul in Turkey by also evaluating their situation according to literature review.

Since public transport integration is the focus of this study, the two main research questions of this study are how to ensure integration in metropolitan cities' public transport systems which have multi-modal systems and whether or not Istanbul public transport system reveals a successful example of integration.

In order to assess success, the thesis developed an analysis framework based on a checklist, in other words a list of criteria. This checklist aims to search for answering the research questions of this study. Two main research questions are formulated within the scope of this thesis, as mentioned earlier. These research questions, as well as some sub-questions are as follows:

- Based on the literature and best-practice cases, how can a strong integration be ensured for public transportation systems in metropolitan cities that generally have multi modal systems; in other words what are the indicators of a successfully integrated public transport system?
- Based on Istanbul's transfer stations that are studied in this thesis, how successful is Istanbul with regard to integrated public transport?
    - What are its strengths and weaknesses?
    - Based on its weaknesses, is there room for progress?

Additionally, further sub-questions are identified in order to explore the case of Istanbul:

- How effective are the plan documents about public transport in delivering an integrated public transport service in Istanbul?
- How an integrated public transportation system is based in plan documents?
- Are there sufficient measures in plan documents to ensure an integrated public transport system?
- Is an integrated public transport (route/line integration, information integration, tariff/ticketing integration and schedule/headway integration) achieved in Istanbul according to literature and when compared to best cases from the world?

- Do Istanbul's public transportation future plans involve emphasizes in integration?

It is aimed to outline a general framework of an integrated public transport system in metropolitan cities and to assess, to what extent Istanbul achieves an integrated public transport system with these questions. The research also contains outcomes of interviews made with experts who work at public transport service provider institutions.

5.3. Methods of Analysis

The beginning point of this study are the multi-modal and multi-institutional public transport systems in cities which have population over millions. While making public transport investments, extending lines or constructing new ones, service quality and mobility improvement and meeting the need of ever-increasing population are always in the agenda. Integration contributes to those needs as experiences of world cases and the literature review have shown.

In the analysis, integration of Istanbul public transport system will be compared to the good practice cases which are examined in Chapter 3. The comparison mentioned will be made in four aspects: route/line integration, information integration, tariff/ticketing integration and schedule/headway integration. Yet, there can be some other differences between cases depending on planning background, public transport policies and/or public transport operators/institutions specifically.

Main data collection methods are collecting written documents and visual documents like photographs, which were taken during the field trips, observations on site, and interviews made with experts. Institutions and companies with regards to public transport in Istanbul have different and crucial responsibility areas. The interview questions have been produced by evaluating literature review, analyzing world cases and experiences on site visits. The questions are given below:

2- What is your opinion about the success level of the integration in Istanbul public transport systems?

   1.a. In which aspects is it successful? Are there short-comings?

3- What should be done in Istanbul in order to reinforce the integration of public transport systems?

   2.a. Are there any plan documents, actions or projects regarding the things referred to or told above?

   2.b. If yes, what are they?

   2.c. If yes, are they open to public or accessible?

   2.d. Is the Revision of Transfer Stations Project, which has been conducted since 2000, completed? At what stage is the project? Which stations are completed?

4- What are the most challenging factors in Istanbul to ensure an integrated public transport system? And what are the opportunities?

   3.a. In terms of the challenges: Are fragmented operators represent a challenging factor?

   3.b. In terms of opportunities: Cities having old MRT systems seem to have some disadvantages like long transfer times, i.e London. From this aspect, is it an opportunity for Istanbul not to complete the MRT backbone yet and having currently many new MRT constructions?

5- Is there any public transport mode which is designated as the most critical public transport mode for having a well-integrated line/route? Why?

6- Is the integration of marine transport modes with other public transport modes efficient?

   5.a. What are the ongoing works that are being carried out currently to enhance integration?

7- How are the decisions regarding paratransit modes oriented when the integration works are conducted? (For example, increasing or decreasing the lines, route changes or integration)

8- The Istanbul card (fare card) cannot be utilized at paratransit vehicles. Information about the paratransit lines or schedules are not included in major public transport information systems, i.e., “How do I get to?”. Do you consider these as deficiencies of the public transport integration in Istanbul?

9- How is the integration of bike lanes with rail and bus lines handled when a bicycle line is being planned?
10- What are the reasons behind the different fare structures and the absence of transfer reduced fees at Metrobus and Marmaray lines? Do you think this situation has a negative impact for passenger decisions about transfers?
11- There are schedule and headway differences between public transport modes. For example, the first and last journeys of buses and ferries are different. The headways are also different. Does it affect passengers' transfer experience negatively?
12- How can the transfer times be reduced in Istanbul? Is there any local/specific hampering factor?
13- Istanbul Metropolitan Municipality Strategic Plan (2015-2019) aims to integrate Istanbul's 39 districts' information systems. When is it planned to be accomplished?
14- Is the Istanbul Airport integrated with public transport system currently? What are future plans or thoughts about transporting people from/to Istanbul Airport?
15- Lastly, public transport services are run by different units and subsidiary corporations of the Istanbul Metropolitan Municipality. Is it a difficulty in order to ensure an integrated public transport system?
14.a. How is the coordination between public transport operators ensured?

As for the field research of Istanbul case, visits to Istanbul were carried out firstly on 19th and 20th of May (2018), secondly on 13th and 14th of October (2018), then on 21st, 22nd and 23rd of December (2018), 25th, 26th, 27th and 28th of April (2019) and lastly on 8th, 9th, and 10th of August (2019). It should be stressed here that various observations were made on site. For instance, in order to investigate the public transportation's line/route integration, some determined transfer stations were observed. The analysis of some determined interchange stations was meant to represent the integration of both one specific mode's lines and different modes' lines.

While the emphasis is line/route integration, the examples reveal specific experiences that rely on place context, historical background and number of modes or lines. These transfer stations are Şişli-Mecidiyeköy Transfer Station, Zeytinburnu Transfer Station, Yenikapı Transfer Station, Aksaray-Yusufpaşa Transfer Station and Kadıköy Transfer Station.

The reasons to select these transfer stations are as follows:

- First of all; these transfer stations have a variety of different public transport modes and are highly utilized.
- The transport master plan determines some interchange stations as those to be to redesigned. Two interchange stations are selected from among these stations. These are Şişli-Mecidiyeköy and Kadıköy stations.
- Likewise, the transport master plan have planned future rail transfer stations. Kadıköy, Yenikapı and Şişli-Mecidiyeköy are some of those determined rail transfer stations.
- The two other interchange stations have at least three different modes, new lines are linked to the transfer station recently. These stations are Aksaray-Yusufpaşa and Zeytinburnu.
- They are also selected according to individual experiences as a passenger.

These five stations are also observed in terms of waiting times, walking times between the modes and information at stations. These observations are given in Chapter 6.

The examples have been investigated in this manner:

- At first, public transport modes in given examples have been determined.
- Secondly integration of a specific mode's lines has been illustrated.
- Then, integration between different modes (including paratransit) have been investigated in the given example.
- Pedestrian access has been analyzed.
- Park&ride and bike&ride facilities have been presented.
- Lastly, the transfer station has been evaluated as a whole.

The aim is to describe the examples and draw some conclusions. In doing so, line/route integration in Istanbul could be more apparent. It could be queried if there are some deficiencies, a national character or some details that find expression in the location.

5.4. Case Study Selection

Istanbul is the chosen case of this study. There are several reasons to investigate Istanbul public transport integration. For instance; the population of the city, long-standing internal immigration since 1950s, diversity of transit modes and the level of mobility can be compared with best practice cases in the world. Istanbul also has many integration projects, which are generally unexampled in the country. In addition, having maritime transport facilities and diversity of rail transportation (metro, tramway, funicular, streetcar, Marmaray etc.) make Istanbul a good case to investigate the integration of public transportation. The integration projects' subject particularly is the metro network in the metropolitan area. Measures to fight against traffic congestion and serving public transit in the city at a high quality are always confronted issues of officials. For instance, journey speed in Istanbul highways can sometimes be 10-12 km/h in central districts (Ulaştırma Ana Planı Stratejisi, 2005, p.8-11).

Private car usage has been increasing at high rates since the 1970s. However, insufficiency of road system was clear even in the 1950s. Not only insufficiency of road system in Istanbul was the main problem, but there were even operations to remove existing rail lines and create a public transport system that was solely based on buses, dolmus and minibuses.

Today Istanbul has a great variety of public transportation modes some of which are unique in the country. According to IETT, Istanbul public transport has nearly 13 million daily passengers (https://www.iett.istanbul/tr/, last accessed: 24.12.2018, 13.04). 13 million travelers use 99.321 vehicles including wagons etc. The proportion of all kinds of vehicles including private service buses are given in Figure 5.1.

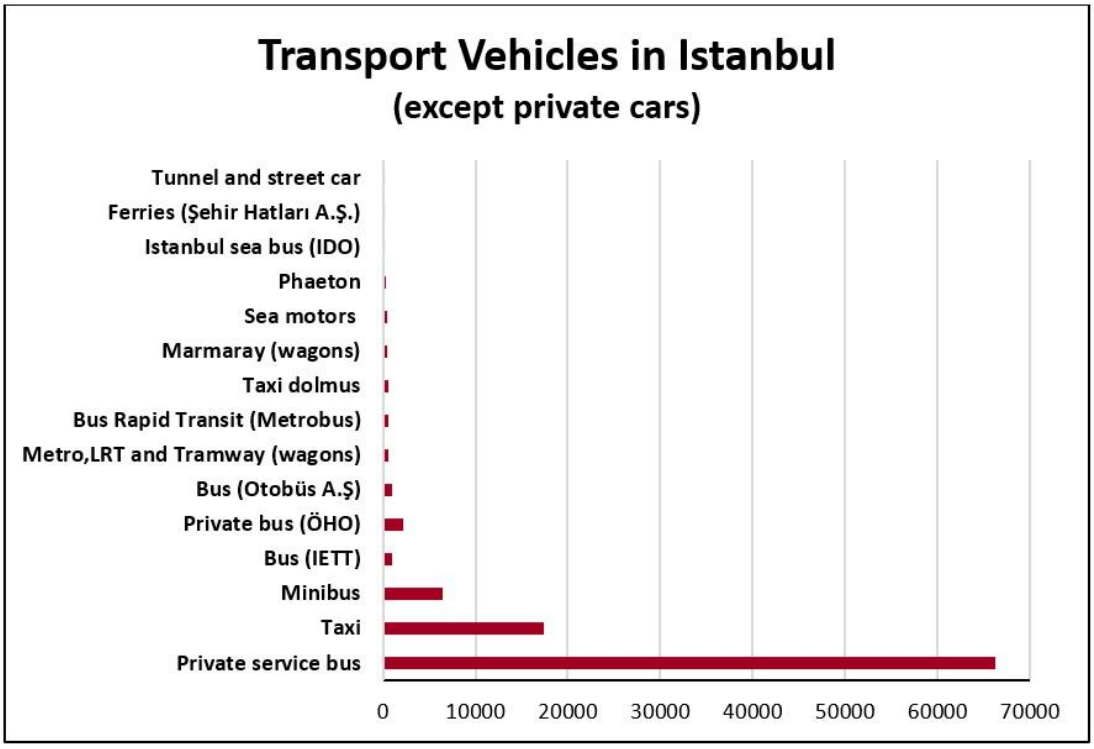


Figure 5.1. Transport Vehicles in Istanbul Except Privately Owned Automobiles

(Source: Author, based on the data obtained from https://tuhim.ibb.gov.tr/, last accessed: 24.12.2018, 13.20)

According to 2017 annual reports of IETT and Istanbul Metropolitan Municipality, Istanbul metropolitan area has 3 bus operators having 759 IETT buses, 175 minibus and 42 dolmus lines. Bus rapid transit (metrobus) line has a 52 km length and 44 stations. Total metro lines are 119,79 km and have 87 stations. Rail line network is 160,55 km and has 163 stations in total. In addition, 61 marine transport routes are used in 2017. There are also ongoing constructions of 16 metro lines (267 km), 1 tramway and 1 funicular line.

The Report of Master Plan for Istanbul Metropolitan Area Integrated Urban Transport (2011, p.201) have an approach considering the years 2009, 2014 and 2023. While "existing network" that is indicated in the report corresponds to the network in 2009, "main network" expresses the network in 2014 and ongoing constructions as of 2014. As for the "main plan network", it implies the 2023 network which is put into its final form considering the decisions of 1/100.000 scale Istanbul Regional Development

Plan. The significant feature of this plan is that it is shaped according to the decisions of spatial plans and its land use and demography predictions.

The Master Plan foresees network development plan and transportation demand management plan. Network development points out the future network stages which represent the years 2014, 2018 and 2023. Network includes transportation roads, rail systems, marine transport movements, freight movements and transition corridors between the Asian and European districts of the city. Transportation demand management plan points out the policies regarding traffic congestion, management and security. Public transport integration issue within master plan will be emphasized in Chapter 6.

In brief the Turkish case Istanbul is compared with good practice cases, which are examined in this study, in terms of public transport integration. It is aimed to conclude some integration principles of public transportation in metropolitan areas, and for the Turkish case; Istanbul in particular. For the purpose of analysis and comparison, a framework has been developed, consisting of a checklist derived from the literature and the analysis of good-practice cases in the world. This is described in following section.

5.5. The Analysis Framework: Checklist

This study aimed at developing an analysis and planning framework for successful integration of a public transport system. The framework is developed by the use of a checklist, i.e. questions. These questions are derived from the literature survey and from the analysis of the Singapore, London and Toronto cases, which have been examined in Chapter 3. The questions of the checklist are as follows:

13. Is there a transport authority that has full control over different public transport service providers?
14. Does the transport authority have control power on paratransit modes in terms of their schedules, fares and routes?
15. Is there a plan document for integrated transport?

16. Are issues of integration (line/route integration, information integration, tariff/ticketing integration, schedule/headway integration, integration with other modes and encompassed factors) clearly addressed/emphasized in plan documents?
17. Is there sufficient inter-modal integration?
18. Is there sufficient line integration between paratransit modes?
19. Are there any specific public transport line to enhance integration between existing lines (a circle line etc.)?
20. Is the line/route integration determined according to future interchange stations visioned in plan documents? (transport master plans, or strategies or other plans and written documents)
21. Are there well-designed transfer stations (short distance, disabled access)? Is there a design criterion or standard for transfer stations?
22. Do the plan document(s) contain policies or visions regarding parking, cycling and walking?
23. Is there any other strategy/document/commission/action regarding park&ride and bike&ride?
24. Are there park&ride facilities?
25. Are there bike&ride facilities?
26. Is there a smart card?
27. Is there fare integration between all public transport modes (fare barriers)?
28. Is there a transfer reduced fare (discount) between public transport modes?
29. Is there any city or region-specific fare solutions (on-street transfers in London to avoid additional fees of zonal fare structure or degressive increase rates of fares in Singapore to avoid negative financial outcomes of distance fares system)?
30. Is there a road pricing system (congestion charge, traffic charge etc.) in determined central and dense areas?
31. Is there fare integration with car parking?
32. Is there fare integration with bike/bike share?

33. Are there sufficient information tools (web-pages, information at stations/hubs, mobile device applications, displays and boards in specific locations in the city and information)?
34. Do the information tools have diverse and very detailed information (like waiting time, vehicle locations, fares, walking distances, headways, average travel time, real time parking availability, delays, maintenances etc.)?
35. Are the information tools understandable and easy to use?
36. Is there a unique standardized and real-time information system (independently of mode or operator-based systems)?
37. Is there a real-time communication webpage or phone number to respond the commuters' instant questions?
38. Are the different modes' schedules in parallel with each other with regard to starting and ending hours of operation?
39. Are the headways of schedules planned by taking account of other modes' time tables to minimize transfer times (coherence between operating hours of different modes)?
40. Are there any bus-based solutions or implementations to avoid time loss and to work schedules regular?
41. Is there any feeder or circle line determined to serve for a specific time period (peak hours, at night etc.)?
42. Is the frequency of services increased in certain times?
43. Do the walking distances between different modes at interchange stations take much time?

After the Istanbul case is investigated, a table is produced in Chapter 6. This checklist is modified as a table (see Table 6.9) in Chapter 6 by answering every question for each of the good practice cases and also for Istanbul. So, these questions are answered in Chapter 6. Hence, the situation of Istanbul case is examined, too.

CHAPTER 6

THE CASE STUDY ANALYSIS: ISTANBUL PUBLIC TRANSPORT SYSTEM

6.1. Introduction

The public transport integration in Istanbul is investigated in this chapter. It is aspired to reveal strengths and weaknesses of public transport integration in Istanbul in the form of the checklist described before, by the help of the comparison with Singapore, London and Toronto cases.

The analysis is basically divided into two main groups:

- Firstly, public transport systems in Istanbul are presented and investigated. This first main group involves planning background, public transport operators/institutions in Istanbul, public transport framework and policy documents in Istanbul and Istanbul's future plans with an emphasis on integration of public transportation.
- Lastly, integration of public transportation in Istanbul is investigated along the same lines as Singapore, London and Toronto cases, by focusing on route/line integration, information integration, tariff/ticketing integration and schedule/headway integration.

Before the analysis, Istanbul is introduced in this section to have some basic information about demography, spatial planning and transportation of the city in general terms.

The city of Istanbul, which has lands both in Europe and Asia continents, lies in the northwest of Turkey. It is located in Marmara Region which is a transition point between Balkan Peninsula (Europe) and Anatolia (Asia). Istanbul is the largest city by its population in the country.

Figure 6.1. Provinces of Istanbul

(Source: Author, based on google earth, official website of Istanbul Metropolitan Municipality and https://sehirharitasi.ibb.gov.tr/, last accessed: 20.11.2018, 19.05)

Istanbul's population in 2017 was 15.029.231 people according to the 'Population and Demography' data of Turkish Statistical Institute (TUIK). It also has a population growth rate above the country's average population growth. While population growth was 0,22% country wide between 1990 and 2000, Istanbul's population growth rate was 0,40% (Ulaştırma Ana Planı Stratejisi, 2005, p.8-3). According to population and annual average population growth rate table, Istanbul has 15.1% annual growth rate of population between 2016 and 2017. It is expected to have 13.6% annual average population growth rate between 2017 and 2023. Population density in 2017 was 2892 person/km^2.(http://www.tuik.gov.tr/, last accessed:21.11.2018, 12.20)

Istanbul's megacity characteristics, some of which are high density development together with lower density sprawl, large metropolitan growth area, and consequently large travel distances, reinforce high car ownership and congestion (Babalık-Sutcliffe, 2017, p.248). Figure 6.2 is an illustration of car ownership in Istanbul. Private cars per 1.000 people in Istanbul is higher by far than the country average. Moreover, rate of increase seems to be getting higher year after year.

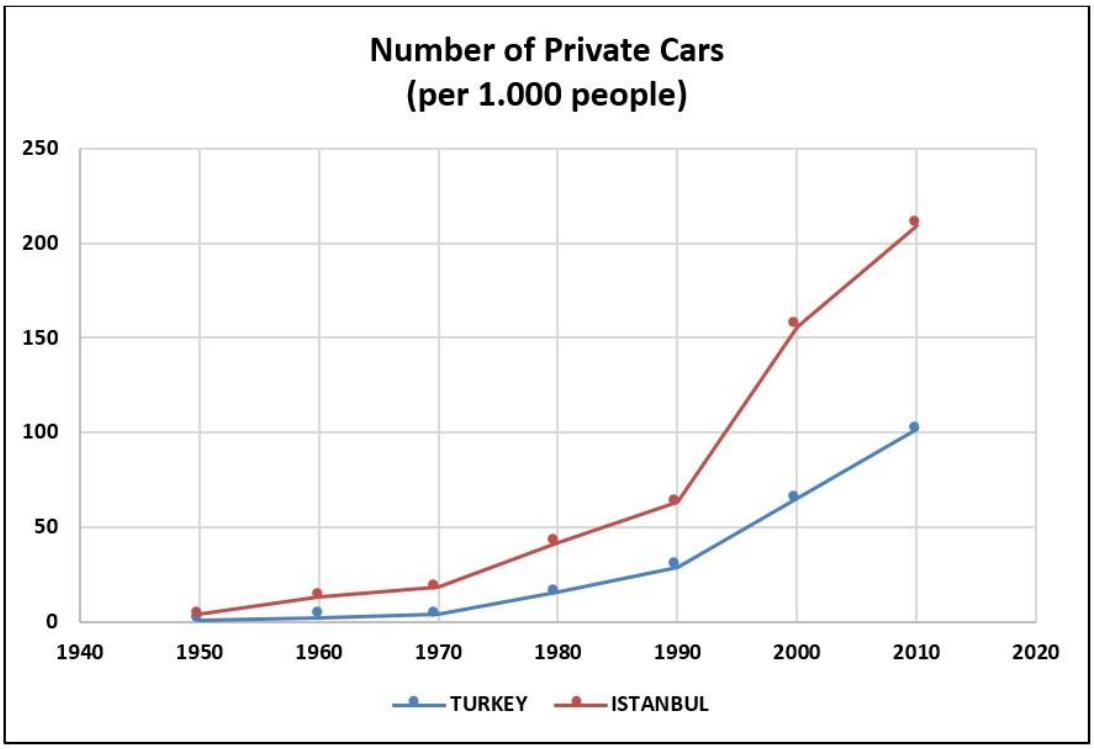


Figure 6.2. Private Car Numbers in Turkey and Istanbul

(Source: Ulaştırma Ana Planı Stratejisi, 2005, p.4-8)

As for the urban development and macroform of Istanbul; they are mainly determined by 1/100.000 scale Istanbul Regional Development Plan. Istanbul Regional Development Plan has come into force in 2009 by Istanbul Metropolitan Municipality. The plan is based upon Istanbul's role while creating a multicentered and developed Marmara Region. The main strategy of the plan is illustrated in Figure 6.3. The Regional Development Plan could also be seen in Figure 6.4. The macroform of the city is determined by forests in the northern part of the city, water basins and the bosphorus. Urban land is surrounded by (and includes) many ecological and biological conservation areas. That is why the plan proposes a linear development along the Marmara Sea coast in the southern part of the city. Moreover, there is a proposal to decrease strait (Istanbul Bosphorus) traffic by balancing population and employment opportunities in European and Asian divisions.

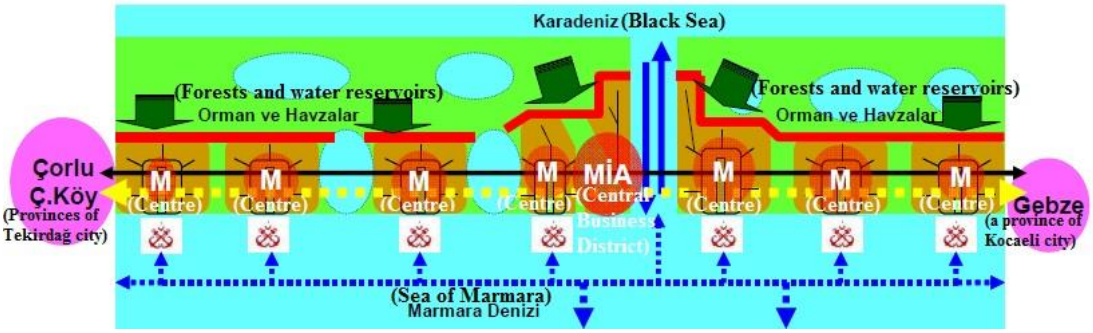


Figure 6.3. An Illustration of Istanbul Regional Development Plan's Development Strategy

(Source: http://www.ibb.gov.tr/, last accessed:21.11.2018, 18.04)

The linear development of the metropolitan area has an outcome on transportation. There are linear and parallel highways across the urban area. These highways are named as D-100 and TEM Highways. However, these circumstances have been changing currently with the construction of Yavuz Sultan Selim Bridge (the third bridge on the northern tip of the strait) and Istanbul Airport (the third and the largest airport of the city) in the northwest. The impact of these new investments on transportation scenarios depicted in transportation master plan will be examined in the following sections of the study. Istanbul Regional Development Plan can be seen in Figure 6.4.

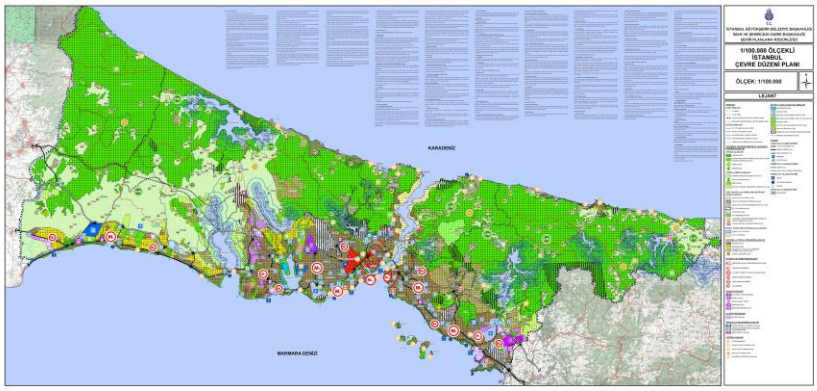


Figure 6.4. Istanbul Regional Development Plan, 2009

(Source: Istanbul Metropolitan Municipality)

6.2. Public Transport Systems in Istanbul

In this section, public transportation modes and riderships are demonstrated.

The public transportation modes operated in Istanbul are rapid transit (metro, regional rail), semi-rapid transit (bus rapid transit –*metrobus*-, light rail transit, tramway), street transit (bus, streetcar), waterborne modes (ferry, ferryboat, motorboat, water taxi), paratransit/feeder modes (*dolmus*, minibus, *taxi-dolmus*) and special modes like funicular, *tunnel*, cable car and aerial railway –*havaray*-.

As it can be noticed from Figure 6.5 walking represents 45% of all trips in Istanbul and public transport accounted for 28% of trips in 2017. The proportion of private car is 20%, while private bus services has 7% of all transport activity. Walking share is respectively high in overall transport when compared to cases from the world. However, only 3% of trips are carried out by marine systems. It is an explicit deficiency of the city as Istanbul has a high marine system potential. Figure 6.5 and Figure 6.6 demonstrate the public transport ridership and usage of public transport modes. It gives an outlook on vast majority of road systems.

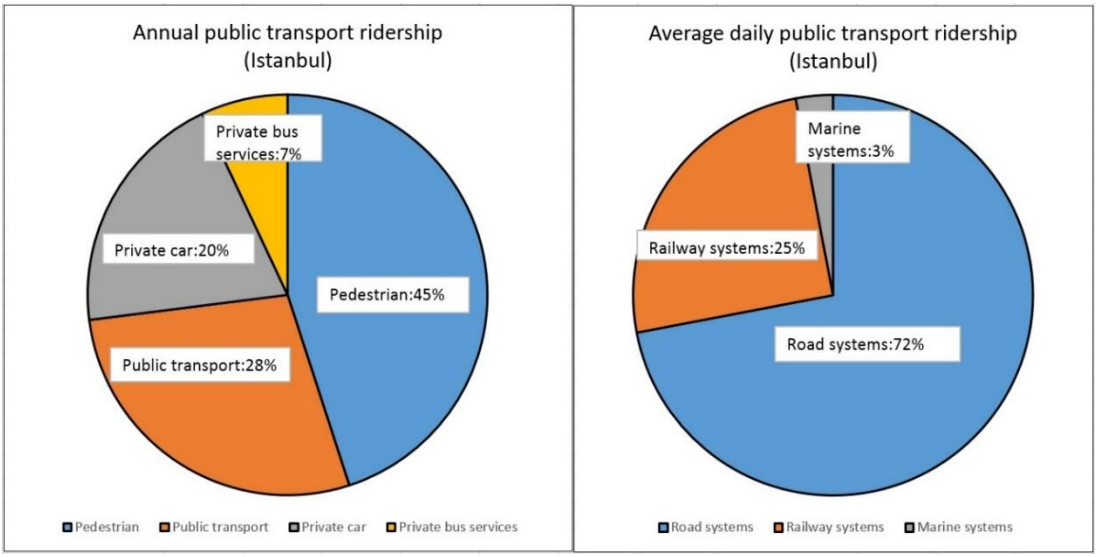


Figure 6.5. Public Transport Ridership of Istanbul in 2017

(Source: Author, based on the data obtained from Istanbul Annual Transport Report, 2017, p.17-22)

Although Istanbul is often considered to have good access to public transport, Figure 6.6 demonstrates that a large proportion of public transport ridership of Istanbul relies on bus network and minibus; a paratransit mode. In 2017, 36% of journeys in Istanbul were made by bus and 24.48% by minibus. “Metro in everyplace, metro to everyplace” project and commitment of Istanbul Metropolitan Municipality also demonstrates the deficiency of subway systems in the metropolitan area.

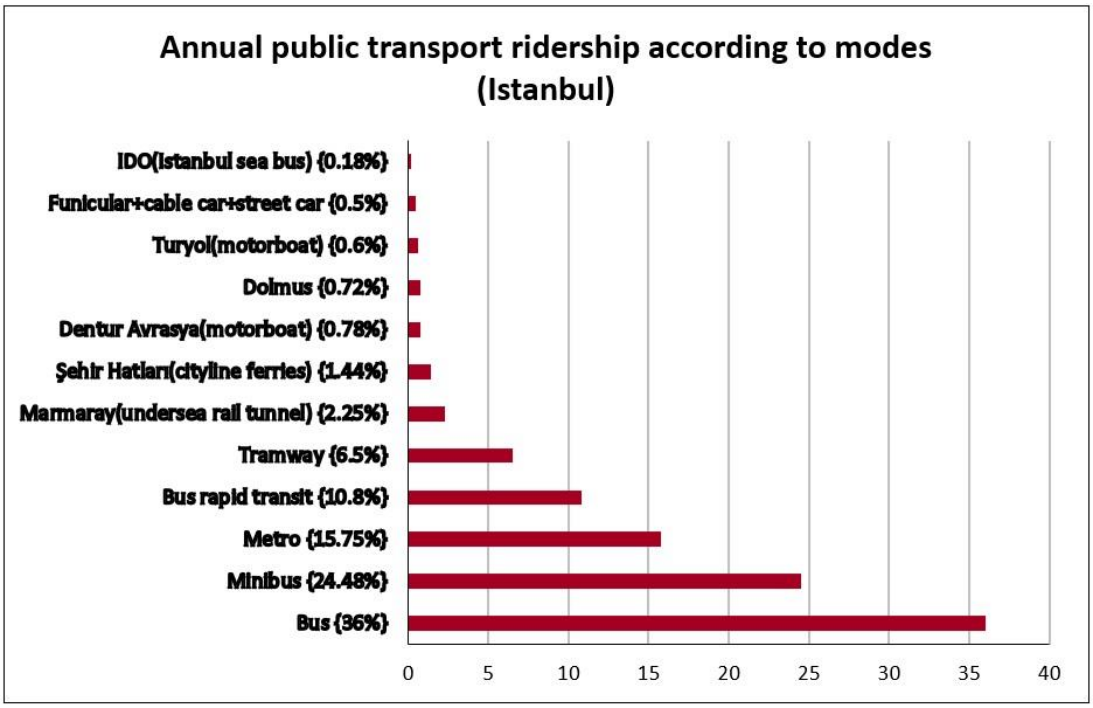


Figure 6.6. Istanbul’s Public Transport Ridership According to Modes in 2017

(Source: Istanbul Metropolitan Municipality Annual Transport Report, 2017, p.22-34)

MRT and BRT follows bus and minibus. However high paratransit ridership is worth-emphasizing. Because it is above all public transport modes except bus. Minibus and dolmus are widespread paratransit vehicles country wide. Their existence dates back to the 1940s. Their operations initially started due to the inability of municipality public transport services for the huge population growth (Babalık-Sutcliffe, 2017, p.250). They are still widely used vehicles. However, the comparison of modes’

ridership might demonstrate a progress in recent or upcoming years since many railway systems are operationalized and transfer stations are being revised.

6.2.1. Planning Background

This section of the study reviews historical development of public transport systems, the reasons to implement existing and planned public transport systems, and coordination of public transport planning and urban spatial/land use development plans.

Development and specific advances or work about public transport in Istanbul starting from the 1800s is given in Table 6.1 which is produced by abstracting the detailed information from various resources.

Table 6.1. *Public Transport Development in Istanbul*

(Sources: Tekeli, İ., 2009, p.21-79, https://www.iett.istanbul/, https://www.ibb.istanbul/, https://www.metro.istanbul/)

Time interval	**Existing situation and/or developments**
Before 1927	Pedestrians, small boats, ferries, tunnel operations, tramway, commuter train.
1927-1935	Regression on maritime transport, new tramway lines, beginning of private buses and taksi dolmus, construction of Ford car assembly plant.
1935-1940	Unification of Tunnel Operations and tramways, foundation of IETT, TCDD takes responsibility of commuter trains, increasing ridership, short decrease in car ownership due to II. World War.
1940-1945	Increasing ridership on maritime transport despite the reduced number of ferries, centralization of maritime transport institutions, growing of bus fleet, road maintenance works (Kırdar –former mayor and governor- operations).
1945-1950	Ongoing growing of bus fleet, increase of car ownership.
1950-1955	Decreasing ridership on tramway, increasing ridership in motor vehicles based on importation, new commuter trains on European side of the city, doubling amount of car ownership, beginning of dolmus ferries.
1955-1960	National deficit due to the payments, large number of road works (Menderes -former mayor- operations), growing of ferry fleet, deconstruction of tramway lines, increasing ridership both on commuter trains in European side of the city and buses, new type of public transport, minibuses, traffic congestion.
1960-1965	Deconstruction the rest of all tramway lines in the European part of the city, increasing ridership on ferryboats that carry motor vehicles, studies for trolleybus construction, Ford minibuses assembly plant, increasing ridership of minibuses that run between center and tenement areas.
1965-1970	Deconstruction of tramway lines in the Asian part of the city, increasing ridership on minibuses and buses, the first domestic automobile, road maintenance works.

1970-1975	Opening of the first strait bridge, arrangement of ferry lines and routes due to the strait bridge, increasing car ownership, production of Fiat and Renault automobiles in Turkey.
1975-1980	Municipal studies in order to preclude increasing car ownership and to develop public transportation via IETT studies, new ferries for ferry fleet, passenger transition from commuter trains to buses due to the extreme passenger numbers on commuter trains, increasing ridership of private service buses, increasing number of private motorboats.
1980-1985	Increasing ridership on public buses because of military government policies, increasing bus fleet, decreasing share of maritime transport.
1985-1990	Opening of the second strait bridge, application of discounted fare cards, 20%-25% discount on public transport fares to increase ridership
1990-1995	Opening of the light rail line (M1) Zeytinburnu-Bakırköy, increasing awareness against automobiles by IETT, extending of light rail transit line
1995-2000	Increasing ridership on buses, validation of the electronic fare card (akbil), validation of transport master plan
2000-2005	Establishment of Metropolitan Municipality's subsidiary companies, transfer fee integration of bus (IETT) and rail (Ulaşım A.Ş.) operator
2005-2010	Validation of Istanbul Regional Development Plan, creation of Ispark, operation of Taksim-Kabatas funicular line, opening of the first bus rapid transit line (metrobus) and removed minibüs lines in the same route, IBB Mobile Traffic application, smart transport studies of municipality, fare integration works, extending existing rail lines
2010-2015	Validation of Transport Master Plan, putting Marmaray tube crossing (strait's rail line) into service, extension of existing rail lines, construction of new rail lines
2015-2019	Opening of the third strait bridge and the third airport, emphasis on rail lines' extending and integration, integration of Marmaray with 2 commuter train lines

When the public transport development in Istanbul is reviewed, some instabilities are realized. For example, public transport investments are shaped according to changes about road systems and some specific executive interventions of mayors or politicians. Considering the road investments or automobile industries, car ownership gradually increases. While mayor operations focus on road maintenance works, road based public transport modes' ridership increase. Bus is the most explicit one of these examples. In parallel, minibuses have a long history in public transport in Istanbul. One starking action is the deconstruction of all tramway lines between 1955 and 1970, notwithstanding the congestion problem and high demand for other rail systems. This formation is a follower of mayors' road works. Officials' focus on road-based solutions could be easily noticed. IETT and TCDD have a positive effect on bus, tunnel, commuter train and street-car ridership or demand. Maritime transport does

not have a constant progress like other modes. Even though the ferry lines were arranged between 1970 and 1975, new ferries were added to the ferry fleet between 1975 and 1980. A discount on public transport fares between 1985 and 1990 had its effects, while maritime transport has always had a low ridership. This leads to an interpretation about the executions' and institutions' effects on ridership.

IETT and TCDD based modes have a relatively high ridership across the city, while there is not a strong lead institution about the overall public transport system. After the 1990s, focus on MRT, LRT and other railway systems could easily be noticed. Meanwhile, Istanbul Metropolitan Municipality raises as an executive strength starting from the 1990s, especially after 2000s. A negative feature of public transport history in Istanbul is that car ownership-based problems could not be analyzed, solved or faced for many years. Person or investment-based solutions are developed for short-term solutions. Even so, transport master plan was validated between 1995 and 2000, regional development plan in 2009 and a huge awareness about public transport appears after the 2000s. Especially rail lines have been one of the main focusses after 2005.

Tekeli (2009, p.79) states that tendencies and changes in transportation demonstrate the effect of developments regarding capital on transportation configuration within the urban area. It presents dominant transportation vehicles.
However; pedestrian share does not seem to be affected by changes. The lack of privately-owned automobiles for the majority of people was the fact in the past, and it was the reason for the reliance on walking (Babalık-Sutcliffe, 2017, p.248). However, today, pedestrians in Istanbul still present a high rate, as seen in Figure 6.7.

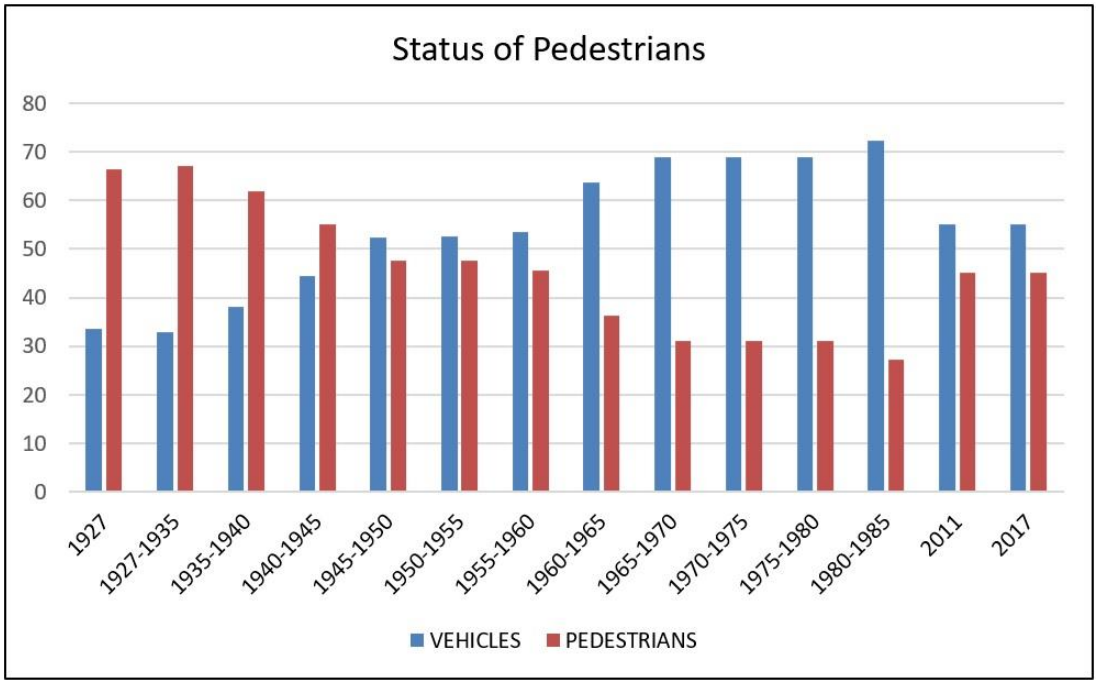


Figure 6.7. Status of Pedestrians within Overall Journeys

(Sources: https://tuhim.ibb.gov.tr/, Tekeli, İ., 2009, p.37-78)

Table 6.1. and Figure 6.7. give a general outline of public transport development. However, there are some other basic determinants for public transport systems. Spatial plan and transport plan documents are among them. There are also effects of institutions and large-scale projects.

The Figure 6.8 shows the relationship between spatial planning and transport master plans. On the right side of the figure, the factors that may have positive or negative effect can be seen. These factors are tendering projects of institutions, master plan's predetermined projects, demands and needs of customers and big scale projects which have shaped according to policy makers' visions. Effects of historical developments or changes shown in Table 6.1 are related to all of these. These factors together can complement the aims of transport master plan as well as having a negative effect on the plan.

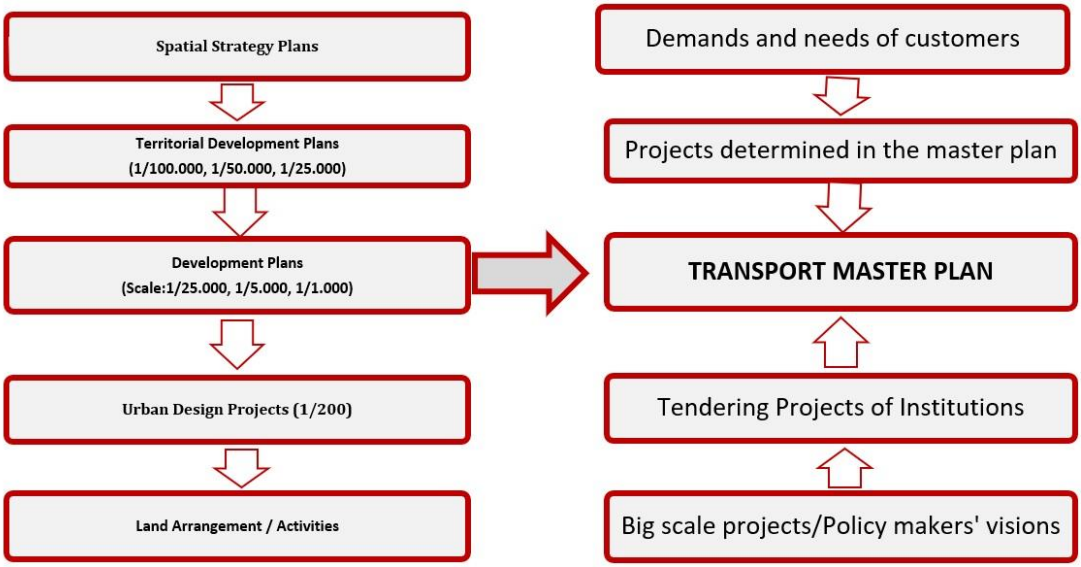


Figure 6.8. Coordination of Public Transport Planning and Urban Spatial/Land Use Development Plans

(Source: Author)

Transport plans are considered in keeping with spatial development plans. Transport activity is one of the basic activities to form urban development. The transport master plan has relationship with spatial plan hierarchy and complementary public transport plans and projects. Spatial integration of public transport systems is related with development plans and transport plans. That is because configuration of the land should take future demographic and development changes in spaces into account.

While public transport planning in Istanbul is regulated by Istanbul Metropolitan Municipality today, some of the public transport services are privatized. Privatization in Istanbul's public transport services is very much related to general privatization policies, which began with the privatizations of state economic enterprises in the 1980s. The Metropolitan Municipality has established subsidiary companies for specific public transport service delivery. For instance, the task for operating, planning, constructing and investing urban rail systems are given to a subsidiary, which is named Metro Istanbul A.Ş. (Metro Istanbul Corporation). Metro Istanbul A.Ş is not directly under the control of a public transit authority. It is under the department of resource control in organizational chart of the municipality.

It was described earlier that urban development of Istanbul has taken form according to its forests in the northern part of the city, water basins and the bosphorus. Istanbul Regional Development Plan pays regard to ecological and biological conservation areas. That is why there is limited development area. Linear development along the Marmara Sea coast in the southern part of the city is proposed. Creating a multicentered and developed Marmara Region is also another planning target. Commuter mobility in the city is provided with rail, marine and road transport. As it was illustrated previously, the vast majority of passenger activity is provided via roads or highways.

There is a crucial common goal of Istanbul Regional Development Plan and Transport Master Plan. It is the integration of public transport modes and the integration of transport focals like headquarter areas of logistics, organized industrial zones, airports, central business districts, and coach stations and intercity bus stations. Although the private automobile ownership is lower in Istanbul when compared to European cities, usage of private automobiles in transport is high, and this causes traffic congestion in many arterials (Can Yüce, 2013, p.109).

Current public transportation investments mainly focus on extending existing metro lines or constructing new metro lines across the urban area and decrease car ownership and hence preclude traffic congestion. Yet, it takes time to complement the planned metro lines. That's why the Istanbul Regional Development Plan offers bus rapid transit system along D100 and O1 Highways as a temporary solution for traffic congestion. The vision of the plan was making passengers use bus rapid transit system until the metro line on the same route is completed. Hence, the bus rapid transit system has been operated since 2007. Regardless of the fact that there is also a planned metro line along that route, the bus rapid transit in Istanbul is identified as a mode that yields appreciable mobility and as one of the most intensively used bus rapid transit systems in the world (Cervero, R., 2013, pp.3-9). When the metrobus line became permanent, design problems have occurred and integrating metrobus with other lines took time. Transfer stations like Şişli-Mecidiyeköy, which are examined in later sections of this

study (see 6.3.1), are good examples for that situation. That is why any public transport investment always has an effect on public transport integration.

There are other two significant transportation investments in Istanbul that diverge from spatial plans. Yavuz Sultan Selim Bridge (the third bridge on Istanbul strait) with its arterials and connections, and Istanbul Airport (the third and largest airport in Istanbul) are located on the northern site of the city. It is incompatible with spatial plans, which have policies to protect natural conservation areas in the north. It should be noted here that Istanbul is subject to central government involvement while making decisions about transport planning such as in the case of the before-mentioned mega projects (Babalık-Sutcliffe, 2016, p.266).

Public transport system projects should depend on a transport plan, which in turn depends on spatial plans. This way future problems and deficiencies can be avoided and future integrations can be well designed. Nevertheless, there are multifaceted reasons for implementing some public transport systems and projects, as seen in mega projects.

6.2.2. Public Transport Operators/Institutions in Istanbul

Istanbul public transportation was governed, planned and managed by various foreign companies until the IETT (Istanbul Electric Tramway and Tunnel Establishments) was created in 1939.

While IETT ran public transport services for a long period of time, recently, Istanbul has become one of the cities in Turkey that created quasi-governmental agencies, i.e. subsidiary companies, for the delivery of public transport services (Babalık-Sutcliffe, 2016, p.465).

These companies create a fragmented operational environment, in which the operators are as follows:

- IETT is a body under municipality and still provides bus, bus rapid transit and tunnel services. It is also responsible for management and monitoring/control of private bus transit services.

- There are totally 30 subsidiaries to Istanbul Metropolitan Municipality. Subsidiaries relating to public transport operations are Metro Istanbul A.Ş., Şehir Hatları A.Ş., Istanbul Otobüs A.Ş. and Ispark A.Ş. Table 6.2 clarifies the responsibility areas of public transit service providers in Istanbul.
- There are also private bus companies – in addition to subsidiaries.
- There are totally 17 different public transport operators, including paratransit, in Istanbul. There are no other cities that parallel Istanbul's diverse operators (Ulaştırma Ana Planı Stratejisi, 2005, p.8-7).
- Rail modes are run by TCDD, the municipality (IETT), and subsidiary of the municipality; Metro Istanbul A.Ş.
- Maritime transport is run by one subsidiary, Şehir Hatları A.Ş., and private companies. The private companies are İDO (İstanbul Deniz Otobüsleri Ticaret ve Sanayi A.Ş), Turyol, Dentur and private sea-taxi companies.
- Park&ride and bike&ride facilities are run by Ispark A.Ş, one of the subsidiaries.

Table 6.2 shows the public transport modes and their operators.

Table 6.2. *Public Transport Modes and the Operators in Istanbul*

Service	**Provider (Institution/Municipality/Subsidiary)**	**Provider (Private company)**
Bus, private bus services, bus rapid transit –*metrobüs*-, tunnel operations, street car	IETT (Municipality)	İstanbul Halk Otobüsleri A.Ş., private bus services
Rail modes (mass rapid transit, light rail transit, funicular, tramway, aerial railway) and cable car	TCDD, Metro Istanbul A.Ş (previously named as Istanbul Ulaşım A.Ş) (Subsidiary), IETT (Municipality)	-
Waterborne modes (ferries, motorboats etc.)	Şehir Hatları A.Ş (Subsidiary)	İDO (seabus), Turyol (motorboat), Dentur (motorboat), private sea taxi companies
Providing public transport and serve for special purposes (bus and private bus services, shuttle bus services, air taxi, car renting)	Istanbul Otobüs İşletmeleri A.Ş. (Subsidiary), Ispark A.Ş. (Subsidiary)	Private air taxi companies
Park&ride, bike&ride	Ispark A.Ş. (Subsidiary)	-

There is an interesting matter about subsidiaries of Istanbul. In spite of the fragmented organizational structure in Istanbul, Istanbul Metropolitan Municipality owns many of those subsidiary companies' share with proportions with more than 50%. It could lead to a strong control mechanism of Metropolitan Municipality on subsidiaries.

Apart from the subsidiaries, The Public Transportation Services Directorate within Istanbul Metropolitan Municipality was established in 2004. The directorate is composed of four offices which are mainly responsible for coordination between operators, controlling the services to comply with transportation master plan, determining tariff/ticketing, route/lines and public transport stations, integration of public transport modes, issuing route permits, creating the information to move to the UKOME (Transport Coordination Centre) and licensing procedures (https://tuhim.ibb.gov.tr/, last accessed:04.12.2018, 12.15). As for the UKOME, it is Transport Coordination Center which makes regulatory decisions and is responsible for the whole transport and traffic order in urban space.

Understanding public transport operations heavily depends on the organization chart of Istanbul Metropolitan Municipality. Figure 6.9 shows the departments regarding public transport within the Istanbul Metropolitan Municipality's organization chart.

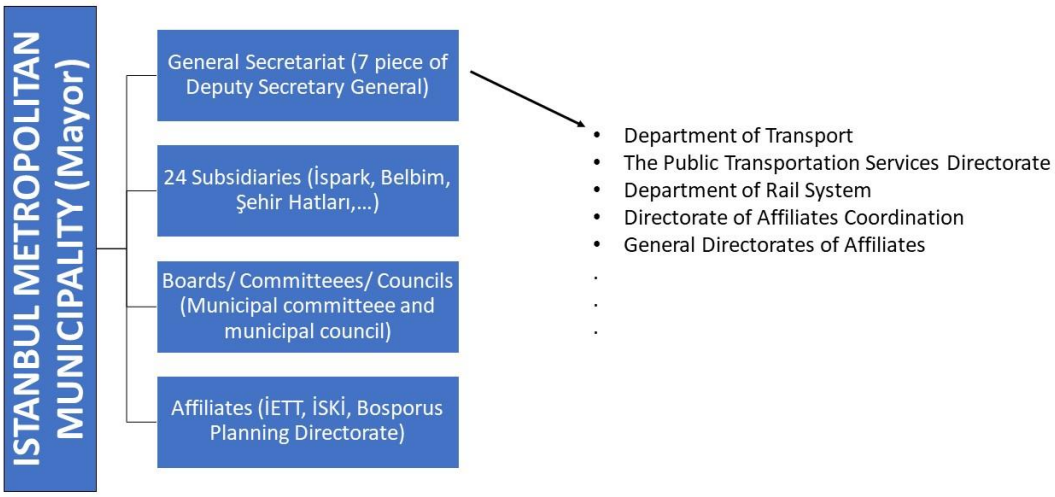


Figure 6.9. A Simplification of Istanbul Metropolitan Municipality's Organization Chart

(Source: https://www.ibb.istanbul/CorporateUnit/Chart, last accessed: 27.08.2019, 19.16)

There are several departments about public transport services under different general secretaries. Also, there are both subsidiary and affiliate operators.

The analysis about public transport operators in Istanbul is also supported with information gathered during the interviews made with experts. It is stated that understanding the transport structure in Istanbul is the key for any kind of public transport analysis due to the intricate and particular organization. Simplification of the organization charts about public transport in Istanbul involves three main structures:

1. Istanbul Metropolitan Municipality
2. IETT
3. Subsidiaries

It has been stated by an expert that it is a handicap to operate public transport services from three different sections and that the solution is a leading institution/department as a main transit authority, which should be placed within the Istanbul Metropolitan Municipality.

Otobüs A.Ş, which operate many bus lines across the city, is given as an example. Although IETT is the basic institution for bus services, IETT doesn't have a supervisory power on Otobüs A.Ş, since Otobüs A.Ş is supervised by another department which is named as General Directorates of Affiliates. That is why unity cannot be supplied in terms of operations and even bus stops.

To sum up, there is a range of different operators in Istanbul. If there is a diversity in public transport modes and operators in a city, performing an integrated public transport service could be tough. If planners and operators are fragmented, it is also a difficulty (Saraçoğlu, 2012, p.27). That is why, the interest equilibrium should primarily be for the good of public, in other words for the commuters (Acar, 2010, p.45).

An expert has clarified that there is a project conducted by Istanbul Metropolitan Municipality. It is named as Public Transport Administration System and proposes a head authority which determines the responsibilities and controls the activities of operators. He has also emphasized the legal difficulties like paratransit vehicles which are run by individuals. Along the same line, there is another project named as Public Transport Control System. It aims to build a control system which contains a scoring and penalty system for public transport operators, especially for paratransit.

An interpretation that there will be a better performance in cases of a single operator institution might not always be reasonable. That is because cases investigated in this study reveal that both London and Toronto are good practice cases for integrated public transport systems in spite of featuring a variety of different institutional organizations. That is why it would not be wrong to put the emphasis on the importance of the control mechanism for creating coordination between the institutions.

6.2.3. Public Transport Framework and Policy Documents in Istanbul

Public transport policies in Turkey with a special emphasis on integrated public transport has been investigated in Chapter 4. In this regard the five-year development plans, Council of Urbanization, Council of Transportation, Maritime and Communications are expressed in detail. In this section of the study, public transport framework and policy documents specific to Istanbul are investigated.

Istanbul gives shape to its public transport according to policy documents and planning background, although there are exceptions (large scale public transport projects that are constructed and developed depending on visions and strategies of policy makers).

Public transport policy documents in Istanbul are as follows:

- Master Plan for Istanbul Metropolitan Area Integrated Urban Transport (2011)
- Istanbul Metropolitan Municipality Strategic Plan (2015-2019)
- IETT Strategic Plan (2018-2022)
- Tenderings between responsible bodies

Master Plan for Istanbul Metropolitan Area Integrated Urban Transport (2011):

The main framework of public transportation in Istanbul is the transport master plan. The Transport Master Plan in Istanbul is named Master Plan for Istanbul Metropolitan Area Integrated Urban Transport. While the master plan report emphasizes that integration of land use plans and transport investments is one of the reasons to implement this master plan, supplying an integrated public transport system with all its modes is stated as one of the main attitudes of master plan. According to the report,

Istanbul hasn't got an efficient integration due to the transfer difficulties or handicaps. Some of the main transfer stations still do not have exclusive lanes for taxis, buses etc. This situation also causes traffic congestion.

The context of the Report of Master Plan for Istanbul Metropolitan Area Integrated Urban Transport is explained in previous sections (see 6.2.1 and 6.2.2) in broad terms. In brief, the Master Plan foresees network development plan and transportation demand management plan as it has been explained earlier.

An expert from The Public Transportation Services Directorate (Istanbul Metropolitan Municipality) has stated that the Master Plan for Istanbul Metropolitan Area Integrated Urban Transport foresees transport basins and surrounds these basins with feeder lines. The plan has three group of public transport modes. First one is named as main transport lines which refer to railway systems. The second one is named as feeder lines which refer to bus and minibus lines. The third one is named as collector and distributor lines which refer to lines connecting both basins and neighborhoods. The aim of this configuration is to develop an efficient system in which all the modes and lines are operated regularly and efficiently.

In this section, public transport integration in the plan will be analyzed. Firstly, tendering/constructing/planning of railway lines of the city are determined to be integrated with existing metro and other rail lines. For example, one of the designed lines, Kabataş-Beşiktaş-Şişli-Giyimkent-Bağcılar metro line, will be planned to connect seven different modes via just the two of its stations: Kabataş and Beşiktaş stations. Even though there are many programs and arrangements to increase integrated public transport lines, journey time in 2023 is expected to be 1.5-1.7 times as much as today's average journey time. This is identified with urban sprawl and distant counties like Silivri. The only part of the city that is expected to have less journey time is the European coast line. This is due to the planned future railway line along that area. Currently there are no rapid public transport modes there, and only conventional buses serving the area.

Secondly, ongoing projects about transport types and transfers since 2000, is further developed with a new project about the revision of transfer stations. Contents of the

tandem two projects are as follows: Transfer stations in urban sprawl areas will focus more on park&ride. Car flow from peripheries to central districts will be decreased via road charges just like in London case investigated in this study earlier. The design solutions will be ascertained in transfer stations in central business districts and other dense areas across the city.

Site selection and project design criteria for transfer/interchange stations are given in Table 6.3, which is produced according to the transport master plan.

Table 6.3. *Site Selection and Project Designing Criteria for Transfer/Interchange Stations*

(Source: Master Plan for Istanbul Metropolitan Area Integrated Urban Transport, 2011, p.337)

Site Selection Criteria	Project Designing Criteria	Additional Measures
-Easy access to public transport vehicles -Easy access to main arterials -Reasonable/tolerable access to access roads -Minimizing the noise and air pollution and other environmental effects -Finding a suitable land with adequate surface	-Consideration of traffic circulation -Easy access to all modes in the area -Evaluating the demand calculation (especially for peak hours) -Present and future traffic volume -Environmental effects -Land use	-Staging the transfer station projects -Pricing policies for park&ride facilities -Financial feasibility examinations

The crucial points as transfer stations are determined and projected to be redesigned in Istanbul. The design of these interchange stations is not completed yet. These stations, as mentioned in the master plan, are Üsküdar, Kabataş, Eminönü, Beşiktaş, Kadıköy, Şişli, Seyrantepe and Ayazağa. The two of these determined stations, which are Şişli and Kadıköy, are also investigated in this study in ensuing sections. These transfer stations are not expected to be similar with transport hubs in Singapore. Because there is a lack about land surface in Istanbul. In addition, transferring to another line in Istanbul is subject to predetermined transfer fees. That is why commuters do not have to be inside a hub to make their transfers. Instead of this, passengers could walk on streets or other designed paths like in London case.

Additionally, there are various studies/projects on transport demand management, which promote public transport integration. A study on determining the situation of car parks and car park planning for the transport systems integration is one of them. The main feature of this study is the determination of car park quantity according to

the future population and land use conjectures in the frame of spatial development plan and the determination of car park locations according to the envisioned public transport projects.

It is also stated in the master plan report that tariff/ticketing integration, including transfer fee arrangement, has been achieved in Istanbul via the fare arrangement works that have been varried out since 2006, and 2009 in particular.

Istanbul Metropolitan Municipality Strategic Plan (2015-2019): Istanbul Metropolitan Municipality Strategic Plan has strategies for public transport services management. The main aim is developing passenger-centered and sustainable transport centered new public transport systems, which are fast, economic, safe and comfortable.

In this regard, empowering the coordination between Municipality and the subsidiary companies, increasing public transport services, increasing the number of feeder lines, extending rail lines, reducing car dependency, constructing exclusive lanes for public transport vehicles, developing and updating the information systems in all of the 39 provinces, updating and improving white desk services to answer the needs of travelers, utilizing traffic management policies and improving road network to prevent congestion are the main proposals (Istanbul Metropolitan Municipality Strategic Plan, 2015-2019, p.47).

IETT Strategic Plan (2018-2022): IETT Strategic Plan has public transport policies about IETT operations. It is explained in the strategy document that IETT has produced its strategies according to some other strategies and plan documents like Istanbul Metropolitan Municipality Strategic Plan (2015-2019), Transport Master Plan Document (2011), Istanbul Regional Development Plan, The Ministry of Transport and Infrastructure's Smart Transport Systems Strategy (2014-2023) and Transport and Communication Strategy 2023. It also analyses the Trend Reports of the International Association of Public Transport (UITP) and examines world cases. Accordingly, several strategic aims are determined. One aim is building an integrated public transport management system. It includes a whole integration between IETT operations and other modes. This aim involves some goals about line/route integration

and schedule/headway integration. The other aim is developing smart transport technologies. This one is more about information integration and tariff/ticketing integration (IETT Strategic Plan, 55-128, retrieved from: https://www.iett.istanbul/tr/main/pages/iett-2018-2022-yil-stratejik-plani/12).

Methods to achieve determined goals are investigated in following sections.

Tenderings between responsible bodies: Not only the policy documents mentioned before, but also tenderings between the responsible bodies have some outcomes, like tenderings to construct bike-sharing systems. To put it more precisely, Isbike system in Istanbul, for example, is an outcome of a tendering between metropolitan municipality and a private firm. The private firm constructs bike-sharing lanes for free due to the requirement stated in the tendering document (Erçetin, C., 2014, p.112).

6.2.4. Istanbul's Future Plans with an Emphasis on Integration of Public Transportation

Looking at the basic patterns, there has been a road transport tendency in urban transportation until the 2000s. However, there are some recent developments to change this tendency towards railway systems. Increasing the rail lines in public transportation and spatial integration of rail lines with road and sea lines are the main works the officials and policy documents have concentrated on. That is why current public transport investments are mainly based on constructing mass rapid transit and light rail transit across the urban area (Saracoğlu, B., 2012, p.103). Annual reports of Metro Istanbul A.Ş and Metropolitan Municipality support this changing pattern with ridership shares. Mass rapid transit or the rail share in total ridership have increases gradually for the last 6-8 years.

The Report of Master Plan for Istanbul Metropolitan Area Integrated Urban Transport has been summarized previously. 2009, 2014 and 2023 are especially considered for specific public transport goals. Existing network corresponds to the network in 2009 in the master plan. Main network expresses the network in 2014 and ongoing constructions of 2014. Lastly, main plan network implies the 2023 network which is put into its final form considering the decisions of 1/100.000 scale Istanbul Regional

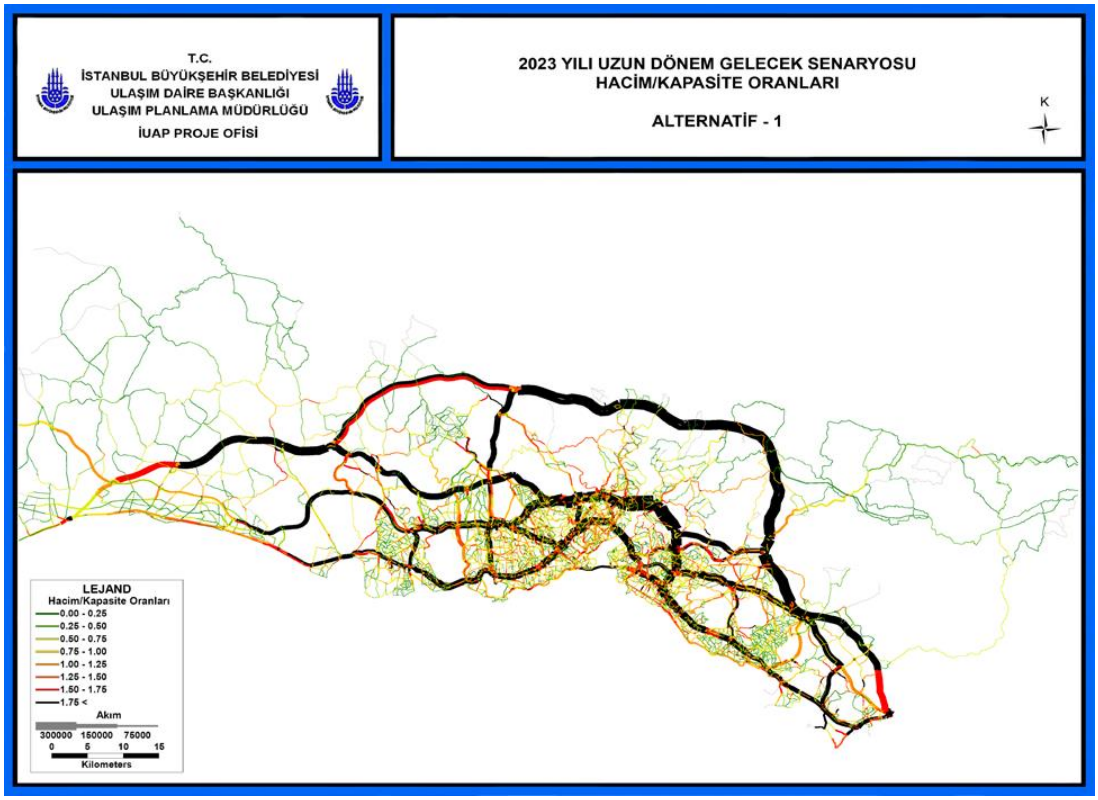
Development Plan. Public transport's final form in 2023 is not only planned according to the projects but also according to the passenger decisions.

Istanbul's future plans upon public transport integration are passenger-oriented. Future public transport routes and lines, which are planned by the master plan, are designed to attract passengers to public transport stations, and interchange stations in particular.

Some alternative metro lines are planned: Söğütlüçeşme- Kazlıçeşme, Kadıköy-Kazlıçeşme, Bostancı-Kazlıçeşme, Söğütlüçeşme-Gayrettepe, Ünalan-Mecidiyeköy and Söğütlüçeşme-İncirli lines. Nearly 50%-70% of the stations of these lines are planned to be integrated with other metro lines or other public transport modes. These alternative lines are ranked to be more productive. Productivity of lines are determined by their potential daily ridership and their effect on other modes' ridership rates.

The whole public transport network is based on three alternative scenarios, which can be seen in Figure 6.10. The three scenarios are as follows:

- The first alternative is about constructing ongoing metro lines and investing road transport to avoid extra expenses.
- The second alternative is to focus predominantly on metro lines.
- The third alternative is about a hybrid system that focuses both on rail and road transport lines.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İUAP PROJE OFİSİ
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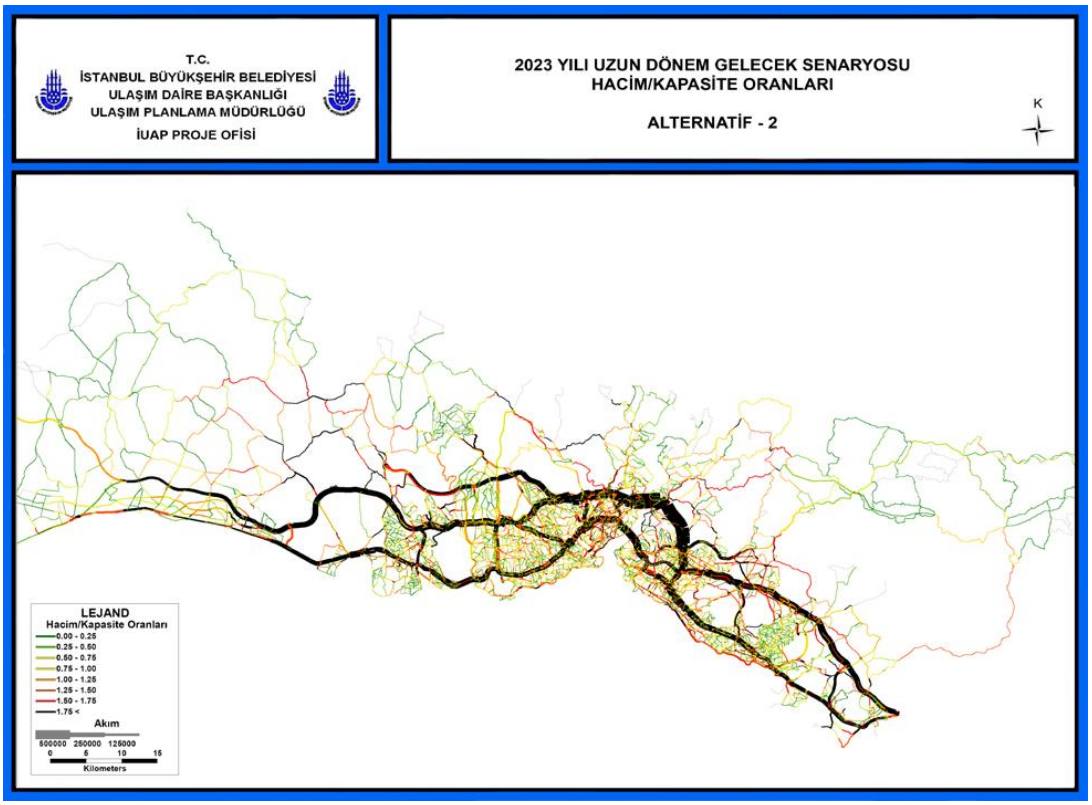
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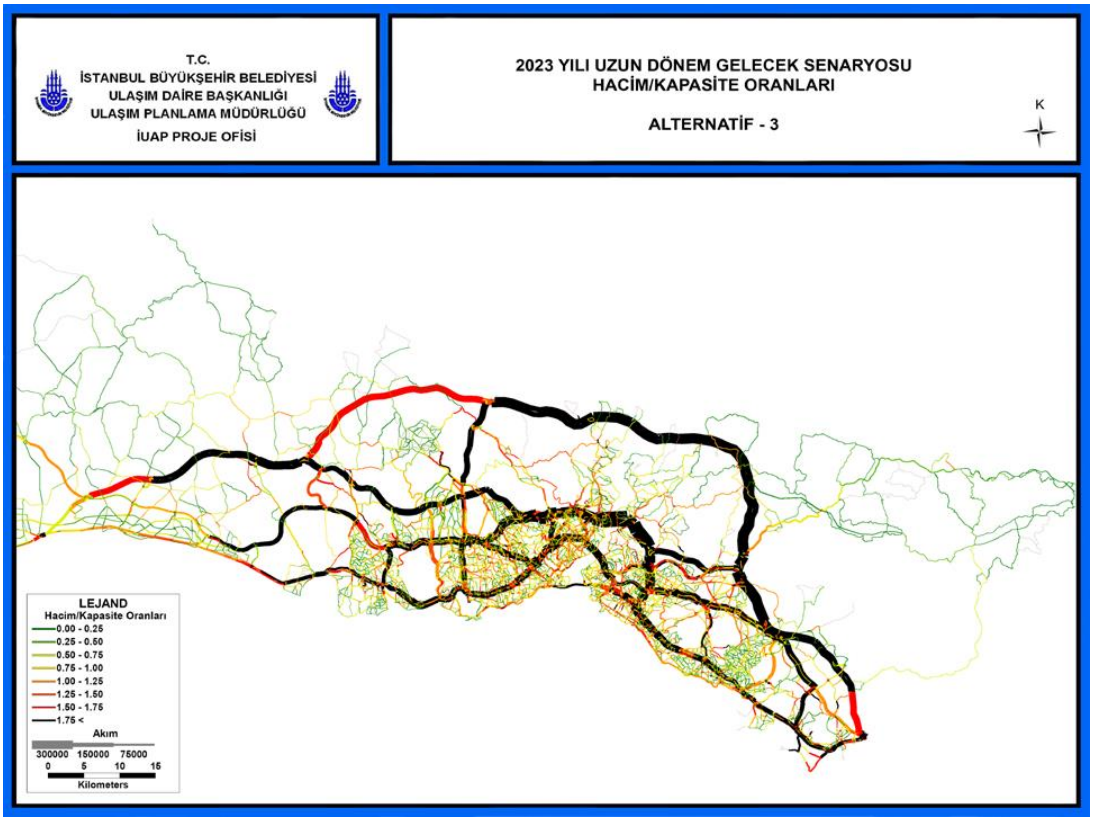


Figure 6.10. Public Transport Network Alternative Scenarios

(Source: The Report of Master Plan for Istanbul Metropolitan Area Integrated Urban Transport, 2011)

Irrespective of the general tendency, all of the three alternatives have the same expected public transport ridership; 35%. Mass rapid transit projects that are planned have a significant role for an integrated public transport system in Istanbul. This is because these planned railway projects have a crucial role to meet passenger mobility since the existing metro or railway lines/routes are not sufficient.

Until recently, the third alternative seems to have been executed. While the general tendency in public transport investments supports Alternative 2, big scale projects like the third airport and the third bridge on strait make the network head towards the third alternative.

An expert from Istanbul Metropolitan Municipality has clarified the integration approach of the Municipality with four items. These are line integration, time integration, headway integration and vehicle integration. They plan and conduct their

future projects according to those four integration items. The public transport system is aimed to be demand-oriented, efficient and feeder in the future. The fare system is planned to be changed to a distance-based system like Metrobus and Marmaray in Istanbul in the near future.

Future plans of Istanbul emphasize the integration between railway systems, road systems, maritime systems, bicycle systems and pedestrian systems. Inter-modal integration is the basic emphasis. Hence, public transport integration includes bicycle and pedestrians in future plans of Istanbul. It means that planning of integration is based also on park&ride, bike&ride facilities and a high rate of pedestrian mobility.

Integration will also be planned through transfer center areas. The transfer center areas are planned according to optimal walking distances and times. The transfer center term has some connotations about the transfer stations. The transfer stations are likely not to be hubs but to have wider areas which require passengers to walk. It can be deduced from here that this situation is because of the inefficiency of the land in Istanbul. There is also a study that started in 2010 and named "Revision of Transfer Centers", which was mentioned previously and will be elaborated in upcoming section.

6.3. Integration of Public Transportation in Istanbul

6.3.1. Route/Line Integration in Istanbul

As illustrated earlier, Istanbul has many public transport modes. They are rapid transit (metro, regional rail), semi rapid transit (bus rapid transit –*metrobus*-, light rail transit, tramway), street transit (bus, streetcar), waterborne modes (ferry, ferryboat, motorboat, water taxi), paratransit/feeder modes (*dolmus*, minibus, *taxi-dolmus*) and other modes (funicular, *tunnel*, cable car and aerial railway –*havaray*-).

Line/route integration in Istanbul is investigated in this part considering the determined transfer stations' situation. Briefly, line/route integration is considered in two ways:

1. Firstly; line/route integration of the public transport system in Istanbul is evaluated in a general perspective.

2. Secondly, five selected transfer stations in Istanbul are evaluated in detail in terms of line/route integration.

Master Plan for Istanbul Metropolitan Area Integrated Urban Transport (2011, p.42-95) addresses the importance of inter-modal integration to achieve the whole system integration. It is stated in the plan document that while there are so many different modes, there is not an efficient integration due to the poor transfer qualifications. The main tool is conducting 'Revision of Transfers' work. The scope of this work is as follows:

- Determining new transfer stations (located at proper size lands for parking facilities, walking distance to public transport stops, easy access to arterials, high demand, traffic circulation)
- Easy transfers via new railway lines which are supported by other modes,
- A well-integrated railway system,
- Taking advantage of maritime transport,
- Less cars in central areas by increasing park&ride facilities at urban periphery. (Master Plan for Istanbul Metropolitan Area Integrated Urban Transport, 2011, p.337)

MRT system is determined as the backbone for line/route integration in the plan. Future railway lines are expected to integrate into existing metro and other rail lines as well as other public transport modes. In the light of this aim, some alternative metro lines (Bostancı-Kazlıçeşme, Kadıköy-Kazlıçeşme, Söğütlüçeşme-Kazlıçeşme, Ünalan-Mecidiyeköy, Söğütlüçeşme-Gayrettepe, Söğütlüçeşme-İncirli) are determined. Also, some crucial transfer stations (Üsküdar, Kabataş, Eminönü, Beşiktaş, Kadıköy, Şişli, Seyrantepe and Ayazağa) are planned to be redesigned for efficient transfers synchronously.

Besides, IETT also declares its intent about achieving integration between different modes. It aims to extend existing BRT and MRT lines, temporary solutions like bus lanes by the time of extended BRT and MRT lines' constructions, transfer stations, increasing the capacity of vehicles (like utilizing bendy buses), increasing the number of feeder lines, night lines/routes, reactivating maritime transport, allocating

commercial services (food and beverage, shopping, etc.) at transfer/interchange stations, updating all the lines/routes in the light of new developments (IETT Strategic Plan, p.54-122).

During the interview made with an expert, who works for IETT, the significance of EN 13816: 2002 Service Quality Definition, Targeting and Measurement Standard (by European Commission) for transfer stations has been emphasized as a factor to enhance line/route integration. EN 13816 is a standard for defining and measuring quality of service in public transport service. It is intended to be used by public transport service providers. The expert has stated that this standard sets out a list of quality criteria, which improves mobility and accessibility, prevent accidents and ensures line/route integration but also information integration and schedule/headway integration. The expert has also explained the challenges for constructing transport hubs (e.g. in Singapore) as additional ticket or fares while transferring between different modes at hubs. That is because travelers are not inclined to pay extra during the journey. Besides a future hub in Istanbul cannot involve paratransit vehicles, even though it is a highly used mode in Istanbul. That is why Istanbul is said to need other specific solutions to enhance line/route integration. These solutions are much related with institutional integration. A head institution is stressed to be a key for line/route integration.

Additionally, Istanbul Metropolitan Municipality has introduced 32 free-transfer feeder lines. The routes of the lines are determined by analyzing ridership of new metro lines, demands of passengers and physical site visits. These lines aim to integrate into metro and bus lines by making transfers convenient for passengers. These transfers do not have a transfer reduced fee like the usual transfers. They are free of charge to attract passengers. It is seen that nearly all of them link new metro lines' stations with existing and highly used bus lines. MR5/Yenikapı İDO-Yenikapı Marmaray is one of these lines. Yenikapı station is also one of the transfer stations that investigated in this study (https://www.ibb.istanbul/, last accessed:14.03.2019, 22.16).

Babalık-Sutcliffe (2017, p.258) remarks the low-level ridership on some MRT lines in İstanbul. M3/Kirazlı-Olimpiyat-Başakşehir line is one of them. Likewise, Saracoğlu (2012, p.113-120) states that although mass and light rail transit are the most efficient public transport modes in terms of passenger numbers, mass rapid transit systems in Istanbul do not run with full capacity. Inefficient integration of rail transit with other modes is shown as the cause for it in both studies. Besides, examinations about interchange stations reveal the inefficiency of comfort, speed and continuity in spatial context. That is why passengers may not be willing to transfer between lines or modes. As a result of field survey in Istanbul, some negative features of transfers are reviewed in Istanbul's public transportation system as follows:

- Walking distances are long between the stations.
- Continual and secure connections do not exist for pedestrians.
- There are not secure, qualified, promotive and comfortable circulation spaces between stations.
- The information tools between the stations like guidance signs are inefficient.
- Some qualifications that are especially needed by disabled and elderly like moving walkways, escalators and access ramps are deficient in stations.

Nevertheless, MRT network in Istanbul is being extended and new lines/routes are being constructed. If these new routes are well integrated with each other and other modes, there will be a huge potential for railway system to increase the ridership.

Rubber-tyred public transport modes are easy integrated with other modes and with each other as road-based public transport has a more flexible configuration (Akı, 2012, 91). One other reason is the incentives for road investments for so many years. However, buses still are not well integrated with other modes due to the lack of spatial and time table integration.

One other significant point is the low level of maritime transport. This leads to an integration deficiency on maritime transport. Because waterborne modes are operated at limited routes and serve to a limited part of the city. Moreover, the routes are located on west-east line and routes parallel to the coast are limited (Saraçoğlu, 2012, p.104).

An expert from IETT has stated that integrated hubs; as in Singapore, are good examples for line/route integration. However, she has also explained that there are some difficulties about operation costs. While the passengers are not inclined to pay twice in a hub, operators need extra subvention to compensate "single-pay in hubs". This is stated as a difficulty for Istanbul. When achieving line/route integration in Istanbul integration of bus and rail systems are showed to be the initial and the most important thing. Because other modes are shaped themselves according to main railway bone and buses. When the inter-modal integration is evaluated, rail and maritime modes are well integrated while there are some integration problems regarding road transport. For example, there are some transfer stations like Eminönü and Kartal which are good examples for a well integration of maritime, railway and bus. However, one of the most challenging factors is the integration of paratransit. Paratransit and taxi are operated self-ordained in terms of both their stops and parking areas.

Park&ride and bike&ride facilities in Istanbul urban area should also be investigated within the scope of line/route integration. It should first of all be indicated that eventhough popularity is growing for bike share programs in Turkey, cycling is rare country-wide as a transportation mode (Babalık-Sutcliffe, 2017, p.250). Yılmaz and Gerçek (2014, p.216) interpret hampering factors for bicycle transportation in metropolitan urban areas, in the manner of insufficient land, priorities of decision-making mechanisms, congestion and crowdedness. There can be some other causes like insufficient infrastructure of old city centers, expropriation problems or costs. Although bicycle route and projects exist for Istanbul, they are generally disconnected from each other or public transportation stations and transfer points. According to the Master Plan, Bicycle route network is expected to develop across Üsküdar, Kadıköy, Maltepe and Kartal in the Anatolian division of the city and Zeytinburnu, Bakırköy and Avcılar districts in the European division of the city. Istanbul Metropolitan Municipality has been conducting a work about determining the existing parking areas and planning new parking areas in terms of public transport integration across Istanbul (Master Plan for Istanbul Metropolitan Area Integrated Urban Transport, 2011, p.333).

Also, an expert from IETT, with whom an interview was made, has indicated the study about bike lanes' integration with buses. As a first step of the study, 20 bike convenient buses are put into operation across the routes, in which the bike lanes and bus routes are parallel to each other. Similarly, Istanbul Metropolitan Municipality expert has stated that there are efforts to integrate cyclists with rail lines across the coastal line of the city. However, today bikes are seen and used generally for recreational purposes rather than as a transport vehicle.

Numerous parking areas exist in Istanbul. However, there are deficiencies, such as limited capacities in central areas, long distances from public transport stations and transfer stations. As for the bikeshare, it has 125 km length route and 1500 bicycles totally. Yet the routes are non-continuous (http://ispark.istanbul/projeler/isbike-akilli-bisiklet/, 01.04.2019, 22.15). Efficiency of the system is also related with safety and passenger appropriation.

To conclude, completed, ongoing or planned and aimed initiatives with regard to line/route integration in Istanbul are as follows:

- Continuous investments on MRT,
- Investments for new BRT routes,
- Making maritime transport efficient,
- Putting new night lines/routes in all modes into service,
- "Revision of transfers" work (new transfer stations, railway lines, parking areas and highly used maritime transport)
- Increasing the number of interchange stations,
- Provisional bus lines till the planned MRT lines are established,
- Integrating existing lines with new determined routes,
- Increasing the number of feeder lines/routes,
- Free-transfer feeder lines,
- Taking integration into consideration during the planning process,
- Rehabilitating existing lines/routes for an efficient system,
- New parking areas at transfer stations.

(Master Plan for Istanbul Metropolitan Area Integrated Urban Transport, 2011, IETT Strategic Plan, Istanbul Metropolitan Municipality Strategic Plan, 2015-2019)

This part of the study also shows how integration is applied in some determined transfer stations in Istanbul. The selection of the interchange stations is meant to represent the integration within a mode (railway etc.) and with different modes (inter-modal integration). The stations that were studied in this research are Şişli-Mecidiyeköy Transfer Station, Zeytinburnu Transfer Station, Yenikapı Transfer Station, Aksaray-Yusufpaşa Transfer Station and Kadıköy Transfer Station. While the emphasis is line/route integration, the examples reveal specific experiences that rely on place context, historical background and number of modes or lines. Meanwhile, a type of public transport might be dominant in one example while the other one is more balanced.

There are various reasons, which are set forth within the fifth chapter (methodology), to select these transfer stations. To recall, the reasons are as follows:

- Diversity of different public transport modes,
- Stations determined according to the transport master plan (redesigning interchange stations project, future rail transfer stations),
- Recent integration works,
- Utilization (highly used),
- Individual experiences.

The selected five stations have also observed in terms of waiting times, walking times between the modes and information at stations. Yet, these observations are given under relevant titles. The examples are investigated in this manner:

- At first, the location and general features of transfer station is explained,
- Secondly, the public transport modes in given examples are determined.
- Thirdly, integration of a specific mode's lines is illustrated.
- Then, integration between different modes (including paratransit) are investigated in this given example.
- Pedestrian access is revealed.

- Park&ride and bike&ride facilities are presented.
- Lastly, the transfer station is evaluated as a whole.

The aim is to describe the examples and draw some conclusions. In doing so, a better understanding of the line/route integration in Istanbul will be provided. It could be queried if there are some deficiencies, a national character or some details that find expression in the location.

6.3.1.1. Şişli-Mecidiyeköy Transfer Station

The first interchange station investigated in this study is Şişli-Mecidiyeköy. Şişli is one of the 39 districts of Istanbul and has a dense population today. Even though there were not many settlements and were only graveyards during the 17th century in Şişli, today it is one of the most central and densely populated districts in Istanbul. Significant features for today's Şişli are its neighboring areas, central business district character and being at a short haul ride to the first bridge of bosphorus (strait). Şişli-Mecidiyeköy station is one of the most frequented transfer stations with high ridership level in the city.

The modes that exist in Şişli-Mecidiyeköy transfer station are rapid transit (metro), semi rapid transit (BRT), street transit (bus) and nearly all paratransit modes (dolmus, minibus, taxi-dolmus). It should also be clarified that Şişli-Mecidiyeköy is the departure point of many of those operations. There is one metro line, one BRT line and many bus and paratransit lines at Şişli-Mecidiyeköy transfer station. Starting stations of various modes in Şişli-Mecidiyeköy transfer station can be seen in Figure 6.11.

There are many bus stations but two of them are the initial points of many bus lines. Transferring from a bus to another bus line takes time. Walking between the stops could be unsafe and uncomfortable due to the heavy traffic, vehicles and pedestrian traffic. Integration of metrobus with metro line is quite new. A subway underpass was constructed in 2014 to connect metrobus with metro line and bus stations in the north. The integration of bus rapid transit system was problematic before 2014 since the metrobus line was constructed and designed without the consideration of metro line

integration. Yet, there is a spatial integration of bus rapid transit line with metro line in Şişli-Mecidiyeköy currently. This development is a significant necessity since the BRT system and Şişli-Hacıosman (M1) line only integrate at Şişli-Mecidiyeköy transfer station (Akı, 2012, p.91) and the Gayrettepe/Zincirlikuyu station. There is a tunnel link that takes only 2 or 3 minutes by walk.

Having improved the integration between the Metrobus and the metro, the integration problem today in Şişli-Mecidiyeköy is about metro and metrobus lines' integration with conventional bus and paratransit lines. Paratransit lines in Şişli-Mecidiyeköy often operate between the European and Asian parts of the city. That is why Şişli-Mecidiyeköy transfer is the station that commuters can have a vehicle to nearly all parts of the city. Paratransit stations and some of the departure bus stations are segregated from metro and metrobus lines, spatially. For instance, transferring to paratransit vehicles take 5 to 10 minutes. Transferring to departure point of some bus lines, which run to Anatolian part, take 5 minutes. Pedestrian access between different modes is also shown in the Figure 6.11.

Figure 6.11. An Illustrative Map of Şişli-Mecidiyeköy Transfer Station

(Source: Author, based on site survey, Google Earth and Metro Istanbul Network Map)

Pedestrian access is ensured by on-street sidewalks and underground tunnels (between metro and BRT). However, traffic is heavy, there are many traffic lights and obstacles such as parked automobiles, selling stands, pavements' height differences, road works and crowded streets. Likewise, Dişli (2006, p.60-85) states that Şişli Mecidiyeköy is a vital point in Istanbul that is both a commercial and service center and is surrounded by dense housing areas. That is why it is a crucial transfer center. However, obstacles and unsafe pathways exist for pedestrians while transferring. The traffic and even bus congestion are also emphasized in the study. Walking between modes takes time and is unsafe. Although there are 5 determined transfer stops, they are distant from housing areas. That's why shuttle lines are suggested for feeding the stops. The other thing is the inadequacy of information between different modes and stops. Some photographs of pathways between public transport modes can be seen in the Figure 6.12.

Figure 6.12. Sisli-Mecidiyekoy Transfer Station

(photographs taken by author on 26th of April, 2019)

There are on street park&ride facilities around Şişli-Mecidiyeköy transfer station which are operated by Ispark; a subsidiary of Istanbul Metropolitan Municipality. However, they are located at distant points which takes 10-15 minutes from MRT and

BRT line and they have nearly 15-20 car capacities on average. As for the nearest bike&ride station (isbike operated by Ispark), it is 8 km away in Beşiktaş.

While Şişli-Mecidiyeköy has been designated as one of the most significant transfer stations in Istanbul, transfers from/to bus and paratransit lines are not efficient. Pedestrian access needs to be enhanced. Parking facilities are not adequate, distant from stations and there are no bike&ride facilities. Likewise, there is not an exclusive lane for buses or bikes. One of the reasons for an inefficient transfer might be the lack of land. It is a densely constructed area and there is limited available land. That is why transfer solutions are tried to be solved generally through underground passages. Yet, there is a limited usage. Because majority of passengers using underground pass are the MRT and BRT passengers. Pedestrian pass should be enhanced in terms of accessibility, safety and time management for street level modes.

6.3.1.2. Zeytinburnu Transfer Station

The second interchange station investigated in this study is Zeytinburnu transfer station. Zeytinburnu is one of the 39 districts of Istanbul and has a dense population today. Zeytinburnu district is adjacent to the Golden Horn (historical peninsula). The district lies between Bakırköy and Fatih districts. It is one of the main urban areas around which the urban settlements started to sprawl in the 1950s. Today it is also the name of a significant transfer station that has a diversity of public transport modes. Zeytinburnu is also a planned cruise port location in Regional Development Plan of Istanbul (Master Plan for Istanbul Metropolitan Area Integrated Urban Transport, 2011, p.8 and p.157).

The modes that exist in Zeytinburnu transfer station are rapid transit (Marmaray), semi-rapid transit (bus rapid transit –*metrobus*-, light rail transit, tramway), street transit (bus) and paratransit modes (minibus). Modes at Zeytinburnu transfer station can be seen in the Figure 6.13.

Figure 6.13. An Illustrative Map of Zeytinburnu Transfer Station

(Source: Author, based on site survey, Google Earth and Metro Istanbul Network Map)

There is a wide area in Zeytinburnu transfer station for bus operations. It is not only the starting and ending location of many bus routes but also includes intermediary stops of some bus routes. Paratransit vehicles are located just next to the bus area. Zeytinburnu is also the initial point for many paratransit routes. Bus, paratransit, tramway, light rail transit and metrobus stops are located across a 300 m length line. That's why transferring between these modes does not take much time. They are linked via a continuous foot bridge which was completed in 2016. There were heavy passenger loads at other stations (like Merter metrobus and LRT station) that are located near Zeytinburnu transfer station during the footbridge construction in 2016. Zeytinburnu metrobus and metro stops had been closed temporarily in that date. However, currently there is a spatial integration of nearly all public transport modes at Zeytinburnu transfer station. Today, walking between different modes is safe, comfortable and accessible. The whole footbridge is equipped with elevators and designed for disabled access. Moreover, the Ispark parking space is also located just next to the footbridge which integrates metrobus, light rail transit, tramway, bus and paratransit. For example, transferring from metrobus to LRT takes only 2 and

transferring from metrobus to tramway takes only 3 minutes. The most distant public transport modes at Zeytinburnu transfer station are metrobus and bus. Even so the distance between these modes is nearly 300 meters and pedestrian transfer between these modes takes maximum 5 minutes.

Saracoglu (2012, p.101) states that the high ridership on M1A-Yenikapı/Atatürk Airport LRT can be explained with the the integration of LRT with other modes at Zeytinburnu transfer station. There is only one mode that is distant and separate spatially from the before-mentioned integrated modes. It is Zeytinburnu Marmaray station. As stated earlier, Marmaray stations had not been operated for many years due to the integration studies. Zeytinburnu Marmaray station was initially one of the commuter line stations. However, the two commuter train lines in the city are united with Marmaray and the united system as a whole is named as Marmaray. So, currently Zeytinburnu Marmaray station is being operated. But it is located about 2.950 metres away from other modes. That's why walking from or to Zeytinburnu Marmaray station is nearly unfeasible (at least for transfer purposes).

Therefore, the most distinct deficiency of Zeytinburnu transfer station is the line/route integration with Marmaray rail line. Nonetheless, bus and paratransit lines provide access to Marmaray line. When all the modes in Zeytinburnu station are taken into consideration, Zeytinburnu seems to fulfill the criteria about integration unlike Şişli-Mecidiyeköy transfer station. It can be regarded as a more successful transfer station which accomplished line/route integration. Distances and walking times between different modes are shown in the Figure 6.13. The photographs of footbridge pass between various modes can be seen in the Figure 6.14.

Figure 6.14. Zeytinburnu Transfer Station

(photographs taken by author on 25th of April, 2019)

Pedestrian access is ensured by the before-mentioned footbridge which links all of the modes except Marmaray. Consequently, there are no obstacles and barriers like vehicle traffic, traffic lights, automobile parkings or other road-based problems. Transitions are fast since the footbridge is designed as ramp platforms rather than staircases. Zeytinburnu can be considered as a better integrated interchange station when compared to Şişli-Mecidiyeköy transfer station. Pedestrian access between different modes is also shown in the Figure 6.13.

There are two main high capacity parking areas that exist in Zeytinburnu transfer station. One of them is an underground parking lot which is located just next to the footbridge at the station. It has a 242 cars capacity. The other one is open air parking lot and is located just next to the bus area. It has a capacity of 128 cars. Also, there are nearly fifteen on street park&ride facilities near Zeytinburnu transfer station which are operated by Ispark; a subsidiary of Istanbul Metropolitan Municipality. These on-street parking areas have generally 50 cars capacity. An exclusive bike lane has not been observed at Zeytinburnu transfer station. Yet, there is an isbike bike station which

has 15 bikes. It is located next to the 128-car capacity parking lot which is next to the bus and paratransit vehicles.

Zeytinburnu can also be identified as one of the interchange stations that has an inter-modal integration. Integration is achieved via a long footbridge which makes passengers transfer between public transport modes that settle across the abutments of the footbridge. Parking facilities are also next to the footbridge. Abutments of the footbridge are equipped with pedestrian ramps, elevators and moving stairways. Apart from the Marmaray case, all of the walking distances are short. Besides, transferring process is not subject to vehicle traffic.

6.3.1.3. Yenikapı Transfer Station

The third interchange station investigated in this study is Yenikapı. The significant difference of Yenikapı is that it is located in the Golden Horn, also named as historical peninsula which is a conservation area. Historical peninsula is 15.910.168 m^2. It was announced in 1995 as first degree urban archeological site. This area also has Istanbul's four Historical Zones (The Blue Mosque Urban Archeological Site, Suleymaniye Protected Area, Zeyrek Protected Area and Istanbul Land Fortifications) which are announced in Unesco's World Heritage List. Therefore, spatial integration at Yenikapı station should be evaluated considering these protected statuses of the area.

There are various public transport modes in Yenikapı. They are rapid transit (metro, Marmaray), semi rapid transit (LRT), street transit (bus), waterborne modes (ferryboat and sea bus) and paratransit modes (dolmus, minibus). It should also be stated that Yenikapı is the departure point of M1a/Yenikapı-Ataturk Airport LRT, M1b/Yenikapı-Kirazlı Bağcılar-Halkalı MRT extension line, M2/Yenikapı-Hacıosman MRT line and Marmaray line. It can be seen in the Figure 6.15.

One significant feature of Yenikapı station is that it is near the bosphorus and it has a ferryboat and sea bus pier which is operated by a private company; İDO. Yenikapı is a frequently used transfer station with high ridership level, because there are nearly eight different public transport modes and there are park and ride facilities that have

high capacities. Starting stations of various modes at Yenikapı transfer station can be seen in the Figure 6.15.

Figure 6.15. An Illustrative Map of Yenikapı Transfer Station

(Source: Author, based on site survey, Google Earth and Metro Istanbul Network Map)

Pedestrian access is ensured by on-street sidewalks, pedestrianized areas and underground tunnels (between metro and Marmaray). Pedestrianized areas might result in efficient transfers. However, there are various obstacles for pedestrians while transferring from/to waterborne modes, bus and paratransit, and there is an inconvenient and unsafe pass between Yenikapı pier and Yenikapı Marmaray. First of all, there are many stairs, which are not convenient for disabled passengers and passengers with bicycles or prams. The other obstacles are pavements' height differences, selling stands, and ongoing road works. Some photographs of pedestrian access can be seen in Figure 6.15. Archaeological findings in the area had been shown as the reason to postpone the opening of the line for usage, but it should not become a reason for an inefficient transfer. Saracoglu (2012, p.151) also describes the transfer obstacles and shortcomings in historical peninsula as roads or highways with high traffic volume in the area and inefficient and unsafe walking paths and bicycle links.

An expert from Istanbul Metropolitan Municipality has also stated that Yenikapı is a problematical transfer station since it has diverse operators, and there are physical transfer handicaps, which hinders line/route integration and schedule/headway integration, and there is not enough information around and at this transfer station.

Figure 6.16. Yenikapı Transfer Station

(photographs taken by author on 27th of April, 2019)

There are four main high capacity parking areas that exist in Yenikapı transfer station. All of them are open air parking lots. Two of them are located next to the Marmaray and metro station and have 200 and 300 cars capacities. The third one is located just next to the Yenikapı İDO pier and has a capacity of 200 cars. The last and the largest one is located on Yenikapı filling area and has 600 cars capacity. Yenikapı is a transfer station which has the maximum capacity of parking facilities. The reason could be the advantage of land acquisitions by the filling of areas on the waterfront.

Yenikapı is also the initial point of Yenikapı-Zeytinburnu bike lane. Zeytinburnu is also the initial point of Zeytinburnu-Bakırköy-Avcılar lane planned in Transportation master plan. Yet, it had not been completed yet. If the bike lane is implemented, Yenikapı would be a convenient station for bike&ride as well as park&ride. Isbike has

three bicycle parking areas in Yenikapı. They have a total of 37 parking racks and 5 bicycles for hiring.

While Yenikapı is evaluated in terms of line/route integration, it should be stated that Yenikapı is subject to ongoing integration studies. There is a continual work in the area. There are Yenikapı sea filling works, integration of Marmaray with existing Aksaray tramway station and metro station, construction of Euroasia Tunnel Highway and revision of Yenikapı İDO pier. It might be a positive development for line/route integration in the area. Yet, pedestrian pathways are unsafe and uneven. Walking between modes takes time and is unsafe. Pedestrian access should be enhanced in these transitional integration studies. Historical feature and protected status of the area might result in relatively slow improvement in underground integration works. Yet there is a positive feature of the area that is the available land.

6.3.1.4. Aksaray-Yusufpaşa Transfer Station

The fourth interchange station investigated in this study is Aksaray and Yusufpaşa, located in the Golden Horn just as Yenikapı transfer station. They have almost 900-1000 m distance to Yenikapı. Aksaray and Yusufpaşa are principally two different stations. However, both Aksaray metro lines (M1a and M1b), tram line, bus lines, paratransit lines (minibus) and Yusufpaşa tram line, bus lines and paratransit (taxi-dolmus) line's stations are attracting passengers. There is a continual passenger circulation between Aksaray and Yusufpaşa. Because they have different modes and/or routes. For example, Yusufpaşa tramway stop is closer to Aksaray metro station when compared to Aksaray tramway stop. So, Aksaray and Yusufpaşa are functioning as an integration hub together. It is a similar situation with Şişli-Mecidiyeköy. But, Şişli-Mecidiyeköy is a single and common named station.

Aksaray and Yusufpaşa are the two different stations which have so many different and various public transport modes and always have a passenger circulation between them. That is why these two stations are investigated together in this study. Edwards (2011, p.17) expresses that conversion of a singular transport system to a transfer station requires adjustments to the urban realm. Aksaray-Yusufpaşa example is one of

those transfer hubs that has been converted in recent years. Spatial adjustments are effective on the usage of this transfer interchange.

There are various public transport modes in Aksaray-Yusufpaşa transfer station. There are rapid transit (M1b/Yenikapı- Kirazlı metro line), semi rapid transit (M1a/Yenikapı-Ataturk Airport LRT line, T1/Kabataş-Bağcılar tramway line), street transit (bus) and paratransit modes (minibus) in Aksaray. It should also be stated that Aksaray is the departure point of some minibüs lines. There are semi rapid transit (T1/Kabataş-Bağcılar tramway line), street transit (bus) and paratransit lines (taxi-dolmus) in Yusufpaşa. The public transport modes in Aksaray and Yusufpaşa can be seen in the Figure 6.17. It should also be stated that there are also passenger transitions between Yenikapı transfer station and Aksaray-Yenikapı transfer station due to the diversity of public transport modes. Modes in Aksaray-Yusufpaşa transfer station, pedestrian access and distances between public transport modes can be seen in the Figure 6.17.

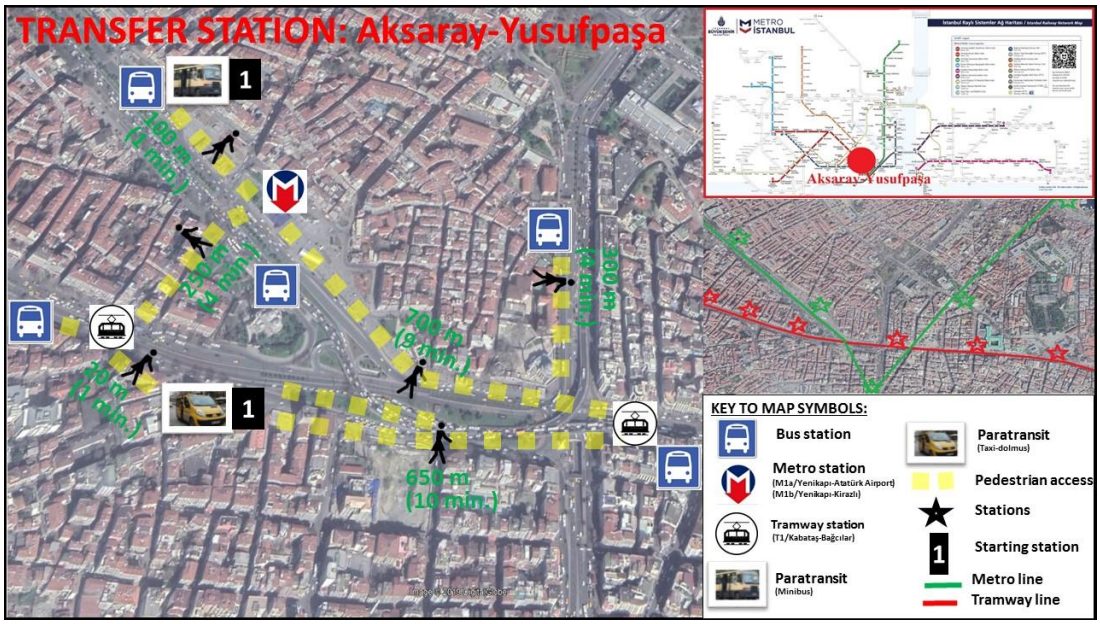


Figure 6.17. An Illustrative Map of Aksaray-Yusufpaşa Transfer Station

(Source: Author, based on site survey, Google Earth and Metro Istanbul Network Map)

Pedestrian access in Aksaray-Yusufpaşa transfer station is ensured by on-street sidewalks. Just as in Şişli-Mecidiyeköy and Yenikapı transfer stations, traffic is heavy around Aksaray-Yusufpaşa transfer station, too. There are various obstacles for pedestrians while transferring from/to tramway line and metro line. There are narrow, heavy and unsafe pathways especially between Yusufpaşa tramway station and Aksaray metro line and between Aksaray tramway line and Aksaray metro line. Although there are ramps located along the walkway, walking route is not convenient for disabled passengers and passengers with bicycles or prams. The pavement wideness differentiates along the walking path. There are many traffic lights and a heavy vehicle traffic. The other obstacles are pavements' height differences, selling stands, ongoing road works and ongoing building restorations, inconvenient underground passes, which take a certain amount of walking time and are cluttered with selling units. Figure 6.18 involves some photographs about on-street sidewalks at Aksaray-Yusufpaşa transfer station.

Figure 6.18. Aksaray-Yusufpaşa Transfer Station

(photographs taken by author on 27th of April, 2019)

There are on street park&ride facilities operated by Ispark at Aksaray-Yusufpaşa transfer station just as in Şişli-Mecidiyeköy transfer station. However, they have low capacities. They have a capacity ranging from 32 cars to 45 cars. On the other hand, there are three high capacity parking areas at Yenikapı. They have a total of 580 parking areas. However, they are at relatively distant points, and it takes 15 minutes from LRT and tramway stations. As for the nearest bike&ride station (isbike operated by Ispark), it is also located at Yenikapı transfer station and is approximately 850 meters away.

Figure 6.19 also demonstrates the inefficiency of integration between Aksaray tramway station and Aksaray metro station. Saracoğlu (2012) expresses that 800 meters length does not only reflect the long distance but also present a challenge for passengers with suitcases. This was particularly important since Airport passengers were directed to this interchange before the new Airport opened in the northwest. However, it is still important since there are still passengers with suitcases using the intercity bus terminal in the vicinity. The lack of under or over ground tunnels are also other inefficiencies. As a conclusion, the line/route integration is not achieved and public transport modes are not run in a way that support each other (Saracoglu, 2012, p.126).

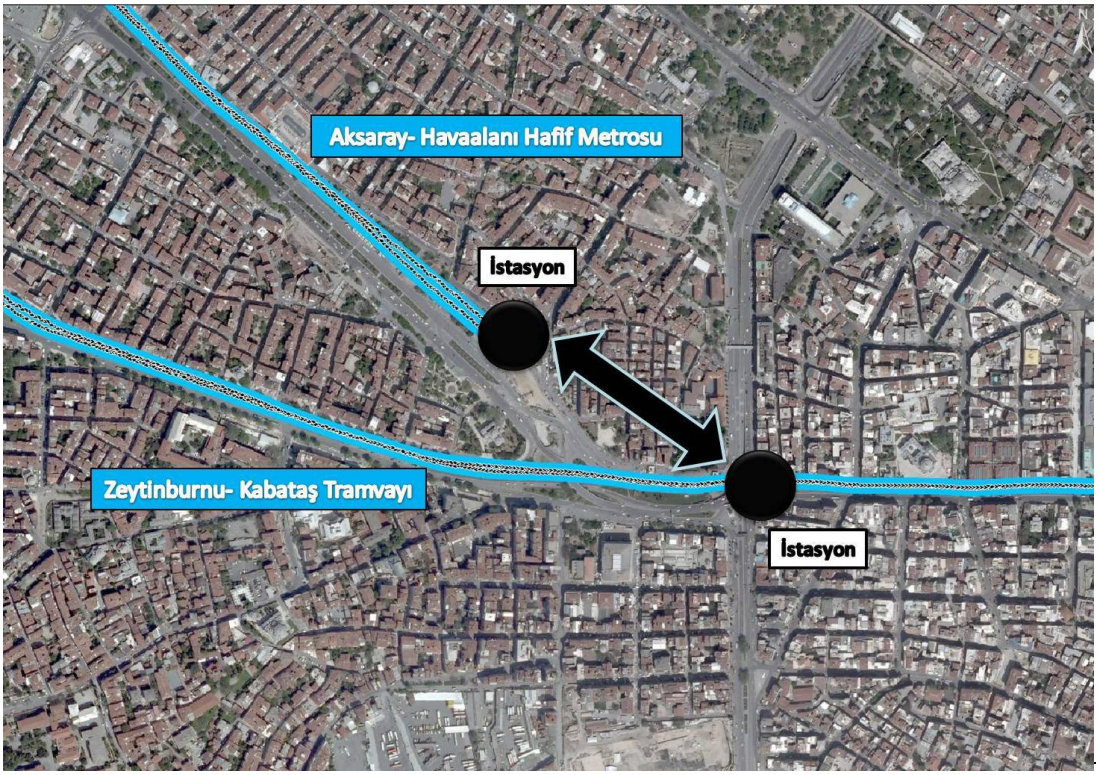


Figure 6.19. Integration of Railway Systems at Aksaray Station

(Source: Saracoglu, B., 2012, p.126)

While Aksaray and Yusufpaşa are functioning as a transport hub in golden horn in Istanbul, integration of lines/routes are not efficient enough. Pedestrian pathways are unsafe and uneven. Walking between modes take time due to those physical obstacles. Pedestrian access needs to be enhanced. Historical feature and protected status of the area are the same as Yenikapı transfer station. However, Aksaray-Yusufpaşa transfer station is located at a more densely constructed area and has a lower possibility for creating new spaces for spatial adjustments.

6.3.1.5. Kadıköy Transfer Station

The final interchange station investigated in this study is Kadıköy, which is a well-known district of Istanbul. It is generally shown as the center of Asian part of Istanbul. Population, geographic features, its position on the strait, historical background, financial mobility and population generate the importance of the district. Kadıköy is one of the main transfer locations in terms of public transportation. Kadıköy in the

Anatolian part, is similar with Şişli-Mecidiyeköy province in the European part in terms of being a center for interchange. Kadıköy is identified as one of the interchange stations that has an inter-modal integration and is a conventional transport center. Kadıköy-Haydarpaşa is also a planned cruise port location in Regional Development Plan of Istanbul (Master Plan for Istanbul Metropolitan Area Integrated Urban Transport, 2011, p.93).

The public transport modes in Kadıköy are rapid transit (metro, Marmaray, regional rail), semi rapid transit (BRT), street transit (bus and street car), waterborne modes (ferry, ferryboat and motorboat), national rail (TCDD rail head for interurban and long-distances) and paratransit modes (dolmus, minibus, taxi-dolmus). In addition to having nearly all modes, Kadıköy is the departure point of many of those operations; bus, metro, metrobüs and paratransit. It should be stressed here that Kadıköy has two wide bus areas. Because many bus routes start from or ends at Kadıköy pier station. Kadıköy is also the initial point of Kadıköy-Pendik bike lane which has a 10 km lenght. There are one metro line, one BRT line, one commuter line, six quays, many bus and paratransit lines at Kadıköy transfer station. Starting stations of various modes in Kadıköy transfer station can be seen in the Figure 6.20.

BusLab Istanbul Project, 2014 was about integrating IETT lines better to other lines across Kadıköy-Kartal MRT route. This study also reveals the important location of Kadıköy due to connecting both Asian part's districts with each other and Asian part to European part. It has information upon the modal integration at Kadıköy station. It is stated that Kadıköy has a relatively successful line/route integration when compared to other stations of the line, because the maximum distance between the modes are 750 meters (p.3-5). It should be noted that this is quite a high distance and not ideal for providing quick and convenient transfers.

Yet there are some new developments in and around Kadıköy station like Marmaray rail line. Transferring from a bus line to another bus line is efficient because of the closely located bus stations. These two areas are 17.000 m^2 totally and departure point of many buses that operate across the city. Despite the fact that bus, metro, ferry, streetcar, regional rail and paratransit vehicles are closely located and do not cause

time-loss while transferring, bus rapid transit and Marmaray stations are distant from those modes and transferring to/from bus rapid transit and Marmaray takes nearly 15-20 minutes. The terrane to BRT and Mamaray is also rugged. However, some bus lines exist in that corridor. Akı (2012, p.90) states that Istanbul BRT system has a weak integration with rail lines at the Anatolian part of the city. Integration of Kadıköy-Kartal metro line with BRT line is not put through Kadıköy station. Uzunçayır station is planned to be the transfer station to integrate Kadıköy metro line and BRT line. Also, a line/route integration work is being conducted recently in Kadıköy. Ayrılık Çeşmesi station of Marmaray had been closed temporarily due to the integration work of Marmaray and the before-mentioned commuter train and bus rapid transit system in Söğütlüçeşme stations. Recently the integration work was completed and commuter train is being operated since March, 2019. Recently, 2 commuter train lines are united with Marmaray and the united system as a whole is named Marmaray. However, while Marmaray is now well integrated with the BRT at Söğütlüçeşme station, the distance to Kadıköy station is not provided at this location. Kadıköy is subject to integration studies and ongoing new lines, like Şişli-Mecidiyeköy. Walking times between different modes is also shown in the Figure 6.20.

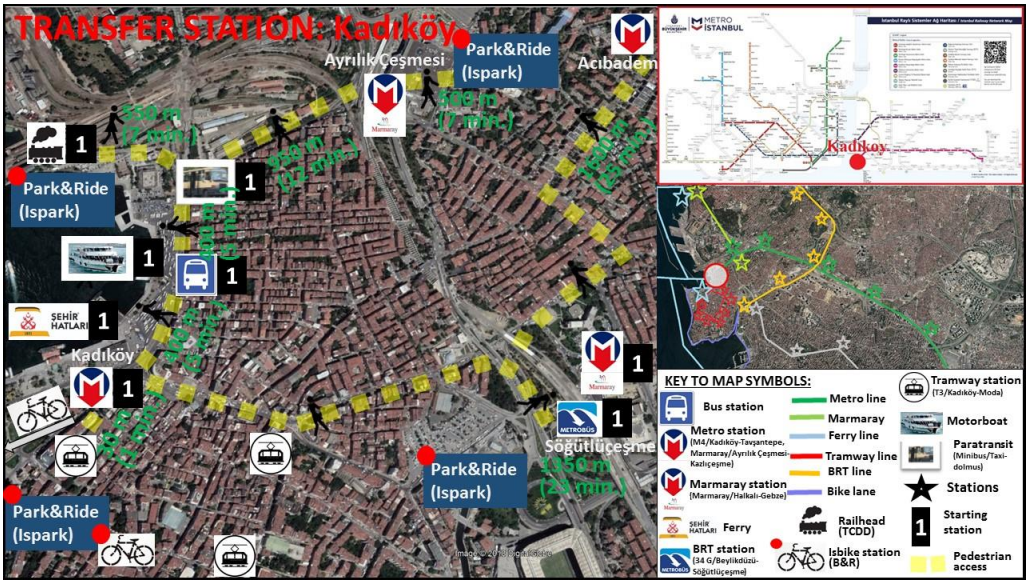


Figure 6.20. An Illustrative Map of Kadıköy Transfer Station

(Source: Author, based on site survey, Google Earth and Metro Istanbul Network Map)

Pedestrian access is ensured by on-street sidewalks. There are no underground tunnels. Although the traffic is heavy just as in Şişli-Mecidiyeköy transfer station, there is available land for pedestrians. Pavements are wider, there is efficient land owing to sea filling area. The negative feature is the long distance and the rugged surface while transferring from or to BRT and Marmaray (Söğütlüçeşme station). Bus, metro, ferry, streetcar, regional rail and paratransit vehicles are located at coastal band. The coastal band is a huge sea filling area and restricted for motor vehicles. That is why there are no significant obstacles, such as motorized traffic or parked cars, as in the case of Şişli-Mecidiyeköy. The huge sea-filling area is used by pedestrians. Pedestrian access between different modes is also shown in the Figure 6.20.

Figure 6.21. Kadıköy Transfer Station

(photographs taken by author on 28th of April, 2019)

There are nearly twenty on street park&ride facilities around Kadıköy transfer station which are operated by Ispark, the subsidiary of Istanbul Metropolitan Municipality. These on-street parking areas have a capacity range from 15 cars to 60 cars. Also, high capacity parking areas exist in Kadıköy. There are seven high capacity parking areas

which can accommodate 100 to 1350 cars. Three of them are located next to the quays on shore line. The other four are located next to Marmaray, BRT, and isbike route.

As mentioned before, Kadıköy is also the initial point (see Figure 6.21) of Kadıköy-Pendik bike lane which has a 10 km length. It is one of the bicycle routes (Üsküdar-Kadıköy-Maltepe-Kartal in Anatolian part and Zeytinburnu-Bakırköy-Avcılar in European part) that are determined in transport master plan. Kadıköy-Pendik route is planned to extend also to Üsküdar district. However, it has not been implemented yet. The bike lane in Kadıköy has been planned and implemented in contrast to the planned Bakırköy-Yenikapı bike lane which was described in Yenikapı-Aksaray transfer station investigation in this study.

Kadıköy is identified as one of the interchange stations that has an inter-modal integration and is a conventional transport center in Transport Master Plan. Integration is achieved in terms of some determined modes. Yet the integration is being implemented still and some modes' integration needs to be enhanced. Nevertheless, pedestrian access is more successful than Şişli-Mecidiyeköy transfer station; there are high capacity parking areas; isbike route integrates with public transport modes and there is sufficient land for spatial reorganizations.

It should be known that, no matter how technologically advanced and comfortable public transport vehicles are, if there are poor information, queues at ticket barriers or long waiting times, public transport cannot attract travelers. To put it in detail, although some interchange stations from Istanbul are investigated in this section of the study in terms of their line/route integration; it should be noticed that line/route integration is something that becomes meaningful with other components of integration. That is why the stations are also investigated in terms of information integration, tariff/ticketing integration and schedule/headway integration in the upcoming sections.

6.3.2. Tariff/Ticketing Integration in Istanbul

Istanbul has a single electronic fare collection card named Istanbul card, which was formerly named as Akbil, a system that was used from 1995 to 2009. Istanbul card is

valid for all modes except for paratransit vehicles like dolmus and minibuses at present. Fare collection system was initially introduced on light rail systems and buses for payment. Later on, it was used on ferries and commuter trains.

A comprehensive tariff/ticketing integration study was carried out in recent years by the Metropolitan Municipality. The Report of Master Plan for Istanbul Metropolitan Area Integrated Urban Transport underlines the arrangement in ticketing system for tariff/ticketing integration in Istanbul public transport system. Tariff/ticketing integration is a need in Istanbul in that there are usually multi modal journeys in Istanbul. One trip is generally composed of more than one public transport mode and/or operator (p.63).

There are many studies about how tariff/ticketing integration is achieved and about how it is evidenced. Sharaby and Shiftan (2012, pp.63-70) present the shift from historically complex per-boarding system to a simple five-zone fare system with free transfers in Haifa, Israel. They evaluate the impact of fare integration on transit ridership and find that single ticket sales increase 25%, total passenger trips increase 7.7% and boarding numbers increase 18.6% in following year of the fare reform. FitzRoy and Smith (1998) found that demand and ridership in Freiburg/Germany has increased at unprecedented level in the 1980s due to the introduction of new payment system. Low cost travel card allows passengers to travel across the region and is valid for all operators. Ungemah, Rivers and Anderson (2006, pp.31-32) found that a new-flat-rate price program increase the demand even for vanpools belonging to one transportation management association in Atlanta, Georgia.

In the light of these information, The Report of Master Plan for Istanbul Metropolitan Area Integrated Urban Transport's inputs about pricing arrangement can be verified or falsified. According to this, Istanbul's public transport demand and ridership before and after the arrangement should be analyzed.

Istanbul card was put into service in 2009. An investigation upon public transport ridership before and after the year 2009 is therefore necessary. Figure 6.22 is produced by utilizing the data of IETT annual reports and Metro Istanbul A.Ş. website. It shows the annual ridership between 2004 and 2017. There is not an increase in public

transport utilization (IETT services) following the years of the before-mentioned pricing arrangement. As a matter of fact, that there is a fair amount of decrease in ridership between 2010 and 2013. However, Metro Istanbul A.Ş lines and Metrobus system has a continual increase after 2010. even though transfer reduced fares are not valid for metrobus, it has an increasing share, too.

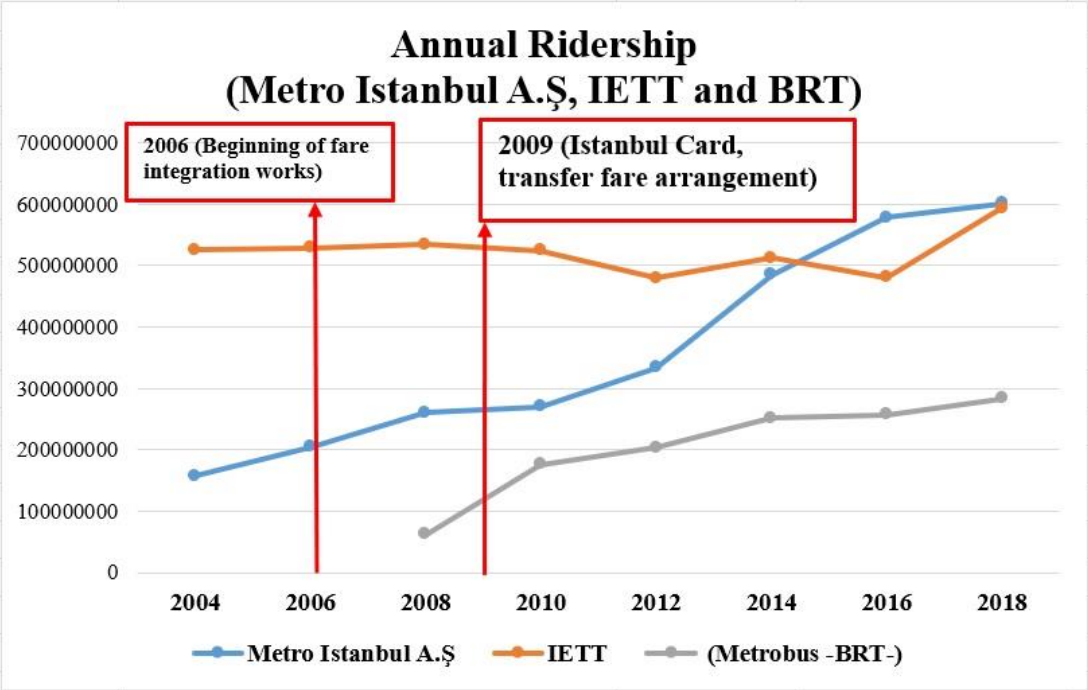


Figure 6.22. Public Transport Utilization: Annual Ridership of Metro Istanbul A.Ş, IETT and BRT Lines

(Source: Author, based on the data retrieved from Annual reports of IETT, https://www.metro.istanbul/, last accessed: 19.07.2019)

That is why Istanbul card and transfer fare arrangements in 2009 seem to have affected the ridership shares of many metro, tramway, funicular lines and metrobus. As for the decrease in IETT share, this is analyzed further in the following parts of the study by looking into other operators' new lines and other factors.

While Figure 6.22 illustrates the ridership changes, Table 6.4 involves the annual ticket numbers of sale systems. Sharp increase in Istanbul card starting from 2009 and decrease in "Akbil" and "Jeton" can clearly be noticed, as expected. Akbil has not

been used since 2015 and token has not been used much. By the light of these numbers, it can be said that an integrated ticketing system is nearly achieved by Istanbul Card arrangement although it doesn't lead to an increase on ridership.

Table 6.4. *Annual Ticket Numbers of Ticket Sale Systems*

(Source: 2011, 2012 and 2017 annual reports of Istanbul Metropolitan Municipality)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
İstanbul kart/ Istanbul card	890	40.497	191.628.060 ↑	779.904.861 ↑	1.369.372.550 ↑	1.468.863.361	1.761.108.721	1.877.131.139	1.805.056.147	1.929.340.670
Jeton/ Token	146.210.455	123.802.151	132.574.883	107.430.392 ↓	74.141.314 ↓	36.836.052 ↓	32.191.900	18.537.562	11.135.020	1.770.094
Sınırlı kullanım bilet/ Limited use	13.245.275	5.536.777	3.637.556 ↓	22.395.320 ↑	16.235.888 ↓	8.593.245 ↓	8.513.069	6.161.386	4.409.830	9.156.908
Akbil/ previous smart ticket	961.731.730	984.894.742	840.644.352 ↓	417.476.241 ↓	91.414.489 ↓	60.797.134	43.140.004	0	0	0

However, an integrated ticketing system solely does not mean that the tariff system is integrated. Because there are various modes run by different operators. Every mode has its own time-table. Although Istanbul card can be used for all transit modes except for some paratransit modes (minibus, dolmus, taxi-dolmus), pricing differences and transfer fees should also be investigated. For example, Table 6.5 shows the Istanbul card fares and transfer reduced fees. Table 6.6 and Table 6.7 show the tariff difference of bus rapid transit (metrobus) system, and Marmaray line from other modes. Even though payment could be made with Istanbul card in metrobus (bus rapid transit) and Marmaray systems, ticketing of metrobus and Marmaray system is different from the general tariff of Istanbul card.

Table 6.5. *Istanbul Card Fares*

(Source: https://www.iett.istanbul/tr/, last accessed:06.07.2019)

Istanbul card	1st ride	1st transfer	2nd transfer	3rd transfer	4th transfer	5th transfer	Monthly blue card (200 pass)
Full-fare	2,60 TL	1,85 TL	1,40 TL	0,90 TL	0,90 TL	0,90 TL	205 TL
Teachers'card/ Social card	1,85 TL	1,10 TL	0,85 TL	0,55 TL	0,55 TL	0,55 TL	125 TL
Student card	1,25 TL	0,55 TL	0,50 TL	0,45 TL	0,45 TL	0,45 TL	40 TL

Metrobus has a distance-based fare unlike other modes. BRT fares can be seen in Table 6.6. The reason for this is the length of the metrobus system. Istanbul does not have a sectional or a zonal fare structure. But metrobus has 52 km length and one passenger enters the route with only one pass. That is why a distance-based fare structure is determined for this mode by the operator (IETT) to cope with negative economic outcomes of long-distance rides. The IETT expert has expressed that BRT fare structure has many logical reasons behind it just as 24-hour service, exclusive BRT lanes, which removes congestion for its passengers, headway length, and other advantages.

As for the transfers, there is discount while transferring from metrobus to other modes but there is no discount while transferring from other modes to metrobus. The form of payment has a difference in metrobus. Passengers also should validate their fare cards on refund machines while leaving stations in order to get distance surcharge. Public transport fares do not differentiate from each other according to the hours of the day. Yet, metrobus also has a difference about hours, too. The distance-based fare system of metrobus is not performed between the hours 00.00 and 06.00 a.m. A full fare amount is valid between these hours.

Table 6.6. *Metrobus Fares*

(Source: www.iett.gov.tr, last accessed: 22.08.2019)

BRT (Metrobus) fares/Distance based				
Numbers of stations travelled	**Full-fare**	**Teachers'card/ Social card**	**Student card**	**Monthly blue card (200 pass)**
1-3	1,95 TL	1,45 TL	1,10 TL	1 pass
4-9	3,00 TL	1,85 TL	1,20 TL	2 pass
10-15	3,25 TL	1,90 TL	1,25 TL	2 pass
16-21	3,40 TL	2,00 TL	1,25 TL	2 pass
22-27	3,50 TL	2,00 TL	1,25 TL	2 pass
28-33	3,60 TL	2,10 TL	1,25 TL	2 pass
34+	3,85 TL	2,10 TL	1,25 TL	2 pass

Metrobus has a distance-based fare unlike other modes. The reason for this is the length of metrobus system. Istanbul hasn't got a sectional or a zonal fare structure. But metrobus has 52 km length and one passenger enters the route with only one pass. That's why a distance-based fare structure is determined for this mode by the operator (IETT) to cope with negative economic outcomes of long distance rides. As for the transfers; there is discount while transferring from metrobus to other modes but there is no discount while transferring from other modes to metrobus. The form of payment has a difference in metrobus. Passengers also should validate their fare cards on refund machines while leaving stations in order to get distance surcharge. Public transport fares don't differentiate from each other according to the hours of the day. Yet, metrobus also has a difference about hours, too. The distance-based fare system of metrobus is not performed between the hours 00.00 and 06.00 a.m. That's why full fare amount is valid between these hours.

Table 6.7 shows the tariff of Marmaray. Marmaray also has a distance-based fare system like the BRT. However, there are different reasons for the implementation of distance-based fare structure in metrobus and Marmaray. Metrobus operator is IETT which also operates bus, private bus, tunnel operations and street cars. IETT is implementing flat fare structure for other modes, in general. Yet, it aims to cope with negative economic outcomes of long-distance rides via distance based fare structure

in metrobus and some specific bus lines. IETT has these fare exceptions in long distance routes. In other words, the operator's approach is the reason for the fare exceptions. Hence, Metrobus difference is because of the distance of the route. However, Marmaray has a different reason. Marmaray is operated by TCDD. Distance based fare structure is implemented for all of the modes operated by TCDD in Istanbul. Namely, operator does not determine some specific routes for a different fare implementation. All operations of TCDD differ from the overall tariff system of Istanbul. That is to say, Marmaray's fare difference is because of the operator itself.

Marmaray has 76,3 km length in total and one passenger enters the route with only one pass. Marmaray in fact is a tube crossing that has 13,3 km length and 4 stations, which are Sirkeci, Üsküdar, Ayrılıkçeşmesi and Söğütlüçeşme. However, the operator's two commuter train lines are integrated with Marmaray tube crossing. Harmonization and amelioration work has been conducted to integrate Marmaray and two commuter train lines. The first commuter train was named as Haydarpaşa commuter train line and operated between Haydarpaşa and Gebze stations in the Anatolian part of the city. The other commuter train was named as Istanbul commuter train line and operated between Sirkeci and Halkalı stations in European part of the city. Eventually TCDD has united its three lines and named it as Marmaray. This integration and singularity started to run in 2019. As for the transfers, it is the same as metrobus. There is discount while transferring from Marmaray to other modes but there is no discount while transferring from other modes to Marmaray. Passengers should also validate their fare cards on refund machines while leaving stations in order to get distance surcharge just like in Metrobus.

Table 6.7. *Marmaray Fares*

(Source: http://www.marmaray.gov.tr/, last accessed: 11.04.2019, 19.23)

Marmaray fares/Distance based			
Numbers of Stations Travelled	**Full-fare**	**Teachers'card/ Social card**	**Student card**
1-7	2,60 TL	1,85 TL	1,25 TL
8-14	3,25 TL	2,30 TL	1,55 TL
15-21	3,80 TL	2,70 TL	1,80 TL
22-28	4,40 TL	3,15 TL	2,10 TL
29-35	5,20 TL	3,70 TL	2,50 TL
36-43	5,70 TL	4,00 TL	2,75 TL

Besides, some bus lines have different ticketing. Buses that operate between Anatolian and European parts, double-decker buses and airport shuttle buses have higher fares.

As it can be seen, the public transport system in Istanbul has different tariffs. When the distance-based fare structure; which is applied on metrobus and Marmaray, is evaluated to be applied on another mode like MRT, some challenges could occur. Because the distance-based fare system necessitates validating fare cards on refund machines while leaving stations in order to get distance surcharge. However, this implementation has a high cost when the number of all MRT stations are taken into account. The high infrastructure cost could be an entanglement. With this aspect, some differences could seem to have logical reasons.

Fare collection types differentiate according to public transport mode. For example, high capacity modes like MRT and BRT have off-board fare collection. Yet, it is a necessity when the crowd and speed are taken into consideration in Istanbul.

The Istanbul card cannot be utilized on paratransit vehicles. This situation is explained as the most significant difficulty in terms of tariff/ticketing integration in Istanbul by experts. Ukome decision is showed to be the necessity to reinforce paratransit modes. Policies are also needed for the adaptation process.

One of the subsidiary companies of metropolitan municipality; Belbim A.Ş., has had an approximation and improvement work about Istanbul Card. Recently Istanbul card can be used in one of the cities in Black Sea Region, Artvin too. Besides, Artvin card

can also be used in Istanbul. There was also a project about a bank card which can be used in public transport vehicles and functions just as Istanbul card. This project is not only practiced in Istanbul. Nearly 15 other cities or districts in Turkey has practiced it too. It is understood that Istanbul is trying to achieve not only the payment system integration within the urban area, but also some other attempts to widen the area of Istanbul card. Fare card is also in-use for portable toilets in the city that are run by the municipality and for 1.832 car parking areas.

However there seems to be still some lack of Istanbul card about integration within the Istanbul metropolitan area. Istanbul card cannot be used at paratransit vehicles like dolmus, minibus and taxi-dolmus.

An expert, who works for IETT, has stated that subvention is significant for long routes with more expenses. That is because the operator cannot compensate the expenses of long routes or some modes with high expenses. For example, if metrobus is expected to have a flat fare structure, the operator of it needs to have more subvention support from Istanbul Metropolitan Municipality. On the other hand, the expert, who works for Istanbul Metropolitan Municipality, has stated that subventions are not accurate solutions since public transport service must not have an expectancy about revenue. However, Istanbul Metropolitan Municipality has been planning to constitute a distance-based system for public transport system in Istanbul, which is used by Metrobus and Marmaray currently.

Güngör and Öztürk (2017, p.74-84) have analyzed the usage of Istanbul card in Ispark car parking areas. Ispark is one of the subsidiary companies of Istanbul Metropolitan Municipality and Istanbul card can be used to pay in Ispark areas recently. According to the study, 49% of traffic load in Istanbul is caused by short term parkings or drivers searching for a parking area. Questionnaire of the study reveals that integrating Istanbul card to Ispark parking areas leads to time savings and park&ride for 92% of drivers. This study shows the importance of tariff/ticketing integration not only for getting into a vehicle payment but also for the whole journey process. Apart from this study, Şimşek (2016, p.58) has investigated the integration of railway systems in Istanbul with other modes, making 506 questionnaires. It has been found that 95% of

the people, who use private car, would prefer public transport vehicles if there is a station near home and there are comfortable public transport vehicles.

As a conclusion; completed, ongoing or planned initiatives with regard to tariff/ticketing integration in Istanbul are as follows:

- Istanbul card arrangement,
- Istanbul card's various usage purposes (parking, taxi, etc.),
- Transfer reduced fees up to five transfers,
- Smart transport technology studies,
- A planned taxation system (IETT's proposal: taxing public transport investment areas and using the revenue for new public transport investments).

6.3.3. Information Integration in Istanbul

The public transport information in Istanbul is supplied by Istanbul Metropolitan Municipality. There are e-services and applications developed by the municipality and/or subsidiaries to inform commuters. Istanbul Şehir Haritası (Istanbul City Map), IBB CepTrafik (Istanbul Metropolitan Municipality –IBB- Mobile Traffic), MobIETT and Nasıl Giderim? (How do I get to?) are widely used and known e-services.

Istanbul Electric Tramway and Tunnel Establishments's -IETT- website about public transportation; "How do I get to?", produces possible pathways by using public transport vehicles between two specific points in the city.

While Istanbul card is the payment card for public transport systems in Istanbul and is about tariff/ticketing integration, it is also used by Istanbul Metropolitan Municipality as a tool to gain more information. Officials aim at better planning and better service via the help of information which is provided by Istanbul card. That's why the single fare collection card can also be presented as an indirect factor to supply information integration. Then again, Istanbul card as a mobile application enable commuters to review all the journey history in detail.

IETT aims developing smart technology systems to build up a demand-oriented system via White Desk which answers the traveler demands. It also aims at developing a digital transport system via dynamic and real-time information (departure times,

vehicle locations, headway lengths, schedules, tariffs, elevators and lift at stations, parking facilities at stations, location of vehicles etc.) systems (such as IBB White Desk, YardımIETT, MobIETT) which will be updated or installed, providing data support to provinces' information systems, installing information screens at stations as well as vehicles, using live help at MobIETT application to enhance real-time information. (IETT Strategic Plan, p.54)

While there is a diversity of web-based information sources about Istanbul's transport, Istanbul Metropolitan Municipality has a study to integrate all of those applications centrally within one application to integrate web-based information sources.

Figure 6.23 shows how to reach Istanbul Archeology Museum (Point B) from the Beykoz Korusu Station (Point A) by utilizing public transit vehicles by using "How do I get to?" website. There are four possible options for this example. There is information about public transport modes and walking distances, waiting times, fares, time of travel, transfer times. Thus, a commuter can have information about routes/lines, tariff/ticketing and schedule/headway integration. A commuter can choose the fastest route, trip with less transfer or walking as well as metro trip preferentially.

The tabs in the application and website are journey planner, fare calculator, system maps, drivers&motorcyclists, line book, travel smart, releases etc.

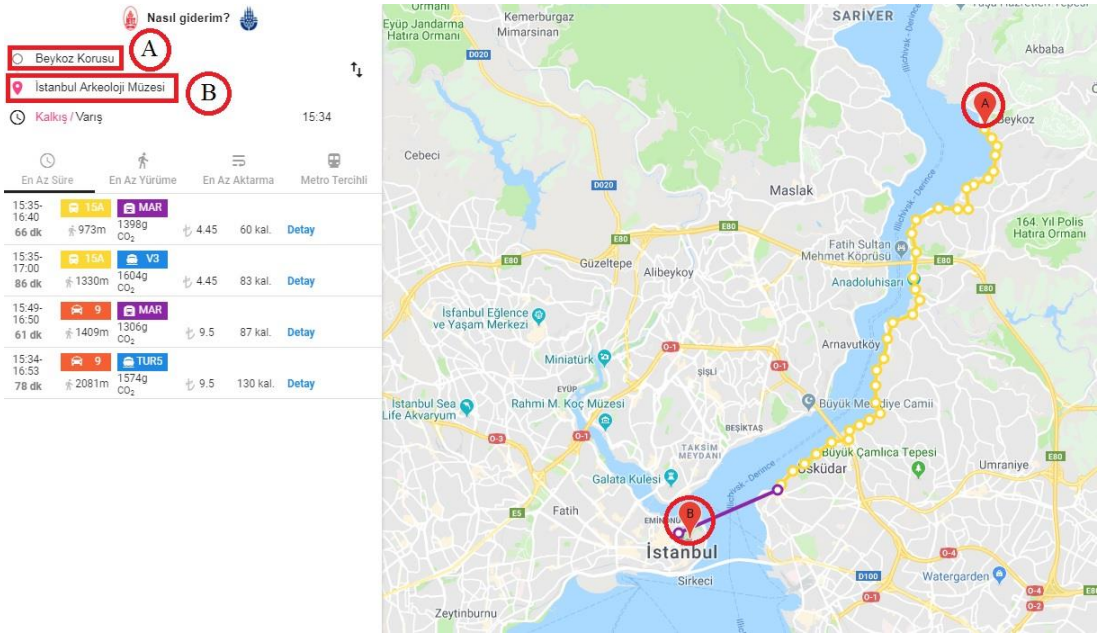


Figure 6.23. Options to Get B Point from A Point in Istanbul

(Source: http://harita.iett.gov.tr/, last accessed:03.01.2019, 20.55)

The information system informs passengers not only about possible pathways but also carbon emissions and the calories burned for each trip choice. There is another significant feature of this website. When a passenger chooses a pathway preferentially with metro line, the website does not present only one option. The thing is that the metro-preferred trip is also planned according to trip times. It means that one option or the preference of the commuter has its own sub-options by taking time factor in consideration (Figure 6.24).

It can be noticed from Figure 6.24 that metro preferred trip between two points also include sub-options within it. The passenger who prefers using a metro line, can also choose bus line (Line 15 or Line 15A for this example) due to time differences.

It can be said that an integrated information system is accessible for commuters in Istanbul. Istanbul's public transport trip planner website might be a good example for an integrated information. Because it integrates information components that are public transportation mode, headway length, type of line, schedules. Yet, there is one shortcoming about this information provider. Excluding paratransit modes from this information provider can be presented as a deficiency of the system.

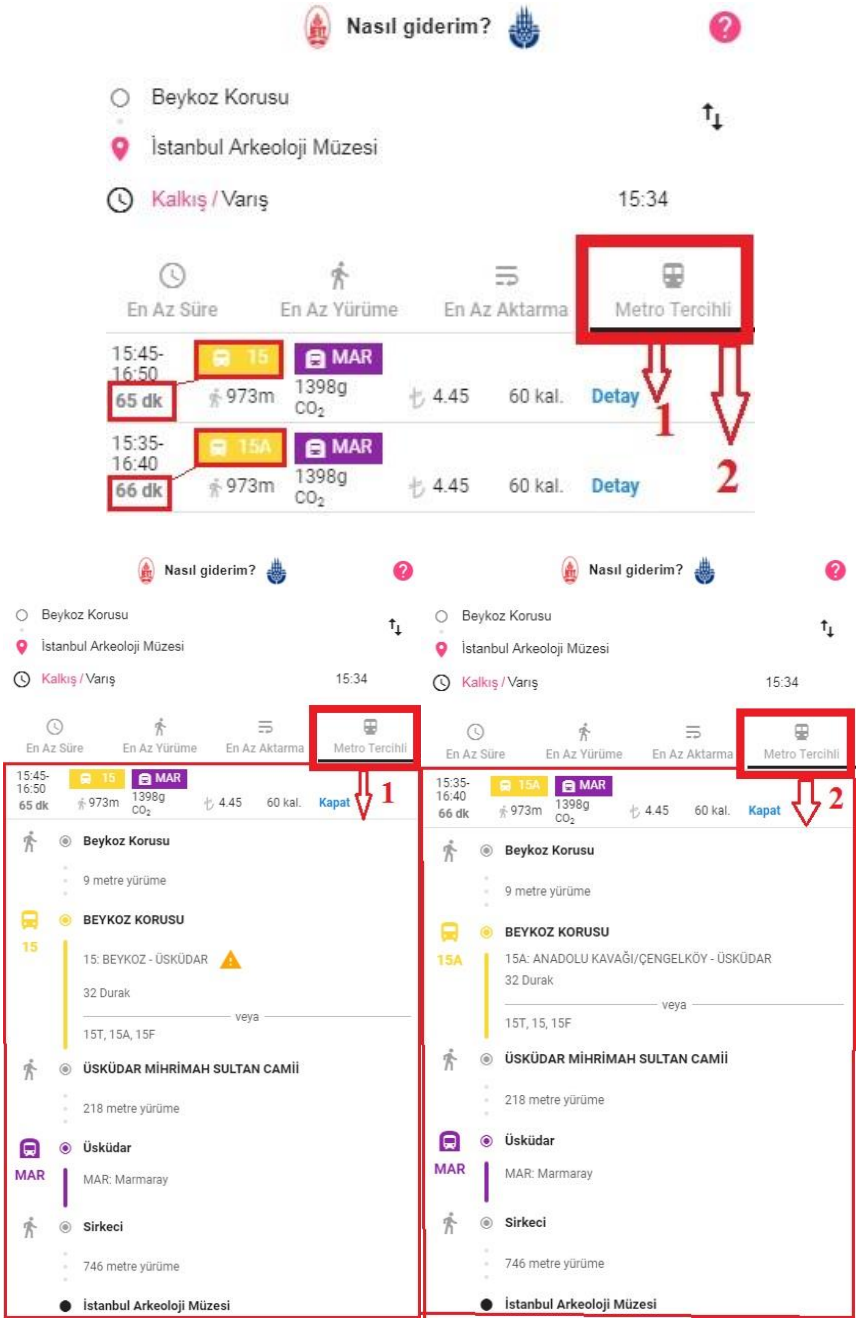


Figure 6.24. Two Possible Pathways (Metro Preferred) between Beykoz Korusu Station and Istanbul Archeology Museum Station

(Source: http://harita.iett.gov.tr/, last accessed:03.01.2019, 20.55)

Apparently, Istanbul public transportation has made a huge progress about information especially electronically. Besides, smart bus stops allow passengers learn headway and waiting times. However, the smart bus stop project has not been fully implemented yet. IETT has implemented the first smart bus stop at Yıldız Technical University bus stop. It can be seen in Figure 6.25.

Figure 6.25. The First IETT Smart Bus Stop in 2016

(Source: https://www.webtekno.com/, last accessed: 07.05.2019, 21.27)

The smart bus stop concept aims to contain digital information board that supplies information about bus operations both visually and auditory, as well as featuring fare card machine, charging equipment for battery-operated disabled chairs and free wifi connection. It produces the energy via solar panels on it.

During the field work, transfer stations that were studied in this research in Istanbul showed that bus stops have not been revised as smart bus stops yet. But IETT implements the smart bus stops firstly on electronical environment via its MobIETT application. Although smart bus stops have been accomplished electronically, not all bus stops have electronic information boards yet. Besides, every bus station hasn't got a unique information board across the city. Observing the transfer stations, which are

investigated in terms of line/route integration previously, information integration is tried to be evaluated in the following figures.

Figure 6.26 illustrates the information at bus stations which are located at transfer stations investigated in this study. Firstly, some bus stations have electronic information boards (on the right side of the figure) that show waiting times, vehicle locations and transfers (to which public transport mode a passenger can transfer on the route of the bus). But some of the stations do not have electronic information boards. Most of the bus stations (on the left side of the figure) have information about bus routes (on a map) and bus schedules. Not all bus stops have been standardized yet in terms of information integration.

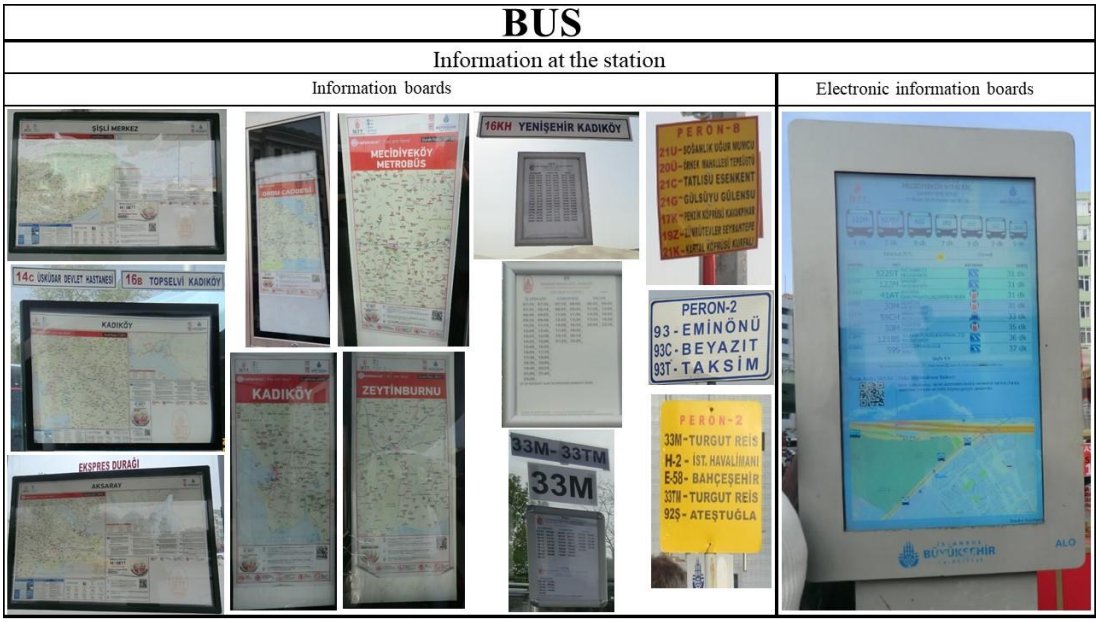


Figure 6.26. Information at Bus Stations

(photographs by author)

As for Figure 6.27 it illustrates the information around and at metro stations which are located at transfer stations, investigated in this study. The metro system across the city has a unique and standardized information system. Yet, the information which guides passengers to metro stations has not been standardized. Namely, information around the metro stations do not have a unique concept.

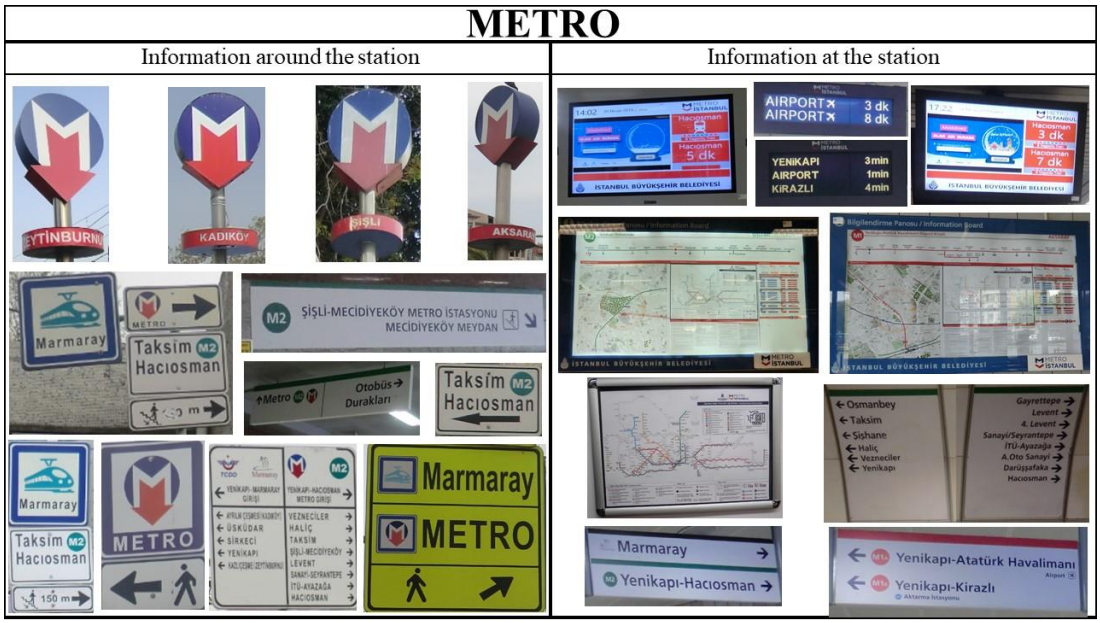


Figure 6.27. Information at and around Metro Stations

(photographs by author)

Figure 6.28 illustrates the information at paratransit stops. The information boards are not standardized at paratransit stops. Some of the paratransit stops have informative maps about routes just as at bus stops, while some of them have only information on destination location of the paratransit vehicles. Furthermore, some of the paratransit stops (i.e. Zeytinburnu paratransit stop) do not have any information board. They only have destination location on paratransit vehicles.

Figure 6.28. Information at and around Paratransit Stops

(photographs by author)

As a conclusion, public transport system does not have a unique and standardized information system at stations. Yet, some modes have standardized their information system within that specific mode like metro and tramway. On the other hand, there are many studies being conducted and projects being planned by public transport operators recently.

To sum up; studies on information integration in Istanbul are as follows:

- Developing a digital and integrated information system for both public transport commuters, pedestrians and drivers,
- Smart transport technologies studies (to constitute a demand-oriented public transport system via operators' full information access)
- Updating the information system in 39 districts of the city,
- Smart Bus Stops Project,
- Input support for districts, to answer White desk recourses faster and fastening all information systems,

- Producing informative visuals about electronic tickets and Istanbul card machines. (IETT Strategic Plan, Master Plan for Istanbul Metropolitan Area Integrated Urban Transport, 2011, Istanbul Metropolitan Municipality Strategic Plan, 2015-2019).

6.3.4. Schedule/Headway Integration in Istanbul

London and Toronto cases portray as good examples having many different transit providers. Istanbul has various transit operators, too. As it has been expressed in Chapter 3, Toronto has a more diversified and complicated public transportation system than London due to the regulations and arrangements of Toronto Transit Commission, frequent changings on schedules and headways, maximum waiting time arrangement (5 min) of Toronto Transit Commission. It hereby is tried to investigate Istanbul public transport's schedule/headway integration. Some comparisons are also made to have a clear view of Istanbul within the best practice world cases.

Table 6.8. *Headways of Different Public Transport Modes for Peak Hours*

(Source: https://tuhim.ibb.gov.tr/, last accessed: 06.08.2019)

	Metro lines						**Tramway lines**		**Tube crossing of strait**
	M1 line	M2 line	M3 line	M4 line	M5 line	M6 line	T1 line	T1 line	Marmaray line
Headways for peak hours (minutes)	2,5	2,8	5	4,35	8	9	2	4	5
	Funicular Lines		**Streetcar Lines**		**Cablecar Lines**		**Bus Rapid Transit**	**Bus Lines**	**Bus Lines**
	F1 line	F2 line	T2 line	T3 line	TF1 line	TF2 line	Metrobus line	(Minumum)	(Maximum)
Headways for peak hours (minutes)	5	3	15	10	10	10	1/4	3	180 or more

Arrangement of schedules and headways are dependent on operators. Table 6.8 illustrates the different public transport modes' headway lengths at peak hours of the day. While some lines' headway lengths are in concordance with each other, there is not a total harmony between all of them.

Average initial operating hours of buses are between 5.30 a.m. and 7.00 a.m., while metro, funicular and tramway lines' operating hours, which are between 6 a.m. and 12.p.m., are the same and constant. Apart from these, cable cars operate between 8 a.m. and 11 p.m. BRT (metrobus) lines operate 24 hours having inconstant headways changing from ¼ minutes at peak hours to 4-8 minutes at night between 1.00 a.m-5 a.m. It can be deduced from here that headway integration is not succeeded fully. However, the main business areas and housing areas are linked to each other via frequent departured buses in addition to early departured mass rapid transit lines.

There are several studies of institutions about schedule/headway integration.

IETT has some proposals to achieve schedule/headway integration. Increasing night lines/routes similar to world cases' practices, privileged public transport lanes on roads, increasing the number and frequency of feeder lines, evaluating the existing lines are some of them (IETT Strategic Plan, 56).

IETT also has a project which is named Updating Public Transport Model and Producing Simulations for Main Route Feedings (Toplu Ulaşım Modelinin Güncellenmesi ve Ana Hat Besleme Hat Simülasyonlarının Oluşturulması). This project aims to update locations of bus stops, schedules and headways by evaluating all trips for 24 hours of a day. The aim is related with minimizing the transfer times and directing passengers to high capacity vehicles. The aim of the project shows us the awareness of officials about surplus number of passengers in the city. Although the project is about public transport modes run by IETT; it seems to effect other public transport modes by its arrangements. That is because arrangements to make commuters use high capacity modes can have a positive effect on waiting times since high capacity modes generally have less waiting times. Yet the effect can be limited.

Istanbul Metropolitan Municipality augments ticket barriers at busy stations. It is aimed to shorten the waiting times of passengers (Istanbul Metropolitan Municipality Annual Transport Report 2017, p.41).

An expert, with whom an interview was made, has stated that there is a remarkable amount of challenges to ensure schedule/headway integration in Istanbul. The main ones are physical shortages, spatial handicaps, ticket turnstiles, which are located at

different storeys of transfer stations and the lack of schedule coherence between operators. Many of these difficulties are linked with the relationship between spatial plans and transportation plans in Turkey. That is because late implementation of transportation plans (when compared to spatial plans) paves the way for problems about spatial arrangements of public transport stations within the urban area. This causes longer walking paths for travelers during inter-modal transfers. Two experts have stated that moving walkways can reduce transfer times at transfer stations. The experts have also clarified that there is a need for twenty-four-hour public transport at main corridors, and that there are efforts to implement it. The difference of maritime transport's schedules and headways are associated to the lack of technological arrangements and sprawled piers within a same area. For example, there are nearly 10 different piers at Eminönü station even though one efficient pier can operate all of their services. That is why Istanbul Metropolitan Municipality has efforts to operate maritime transport centrally from one pier at transfer stations. To support this decision, it has also approximation efforts for maritime vehicles and piers to provide faster operation. Another expert has stated that there have been many recent maritime lines for operation; however, policy makers decided to end up their operations due to the high costs of maritime transport and low passenger numbers. However, any new public transport line needs time to increase its passenger numbers. That is why it has been stated that new maritime transport lines should not be evaluated in one-year period since it increases its passenger numbers with time.

Paratransit operations have been stated by all experts as the main problem for ensuring schedule/headway integration. They are still needed to be controlled and operated for proper routes and hours. They should not operate as rivals of other modes, and paratransit routes. They might offer advantages for night line services.

Istanbul Metropolitan Municipality makes service changes via UKOME decisions. UKOME is the acronym of Transport Coordination Center. UKOME is responsible for the whole transport and traffic order coordination within the urban area. The urban area is determined by the Nr. 5216 Law: "Law for Metropolitan Municipalities".

Public Transport Services Directorate within the Metropolitan Municipality coordinates with Transport Coordination Center.

To summarize, Istanbul has an intricate decision-making process. Yet, it can be identified as a city to make progress in schedule/headway integration within the recent years. There are also numerous ongoing studies about paratransit lines and vehicles. The positive feature of Istanbul about schedule/headway integration is that passengers can give voice to Public Transport Services Directorate (via website, call number 153, White desk etc.) about their complaints, proposal or suggestions to arrange tariffs and new routes.

As a conclusion; completed, ongoing or planned initiatives with regard to schedule/headway integration in Istanbul are as follows:

- Augmenting ticket barriers at busy stations to preclude time loss,
- Updating Public Transport Model and Producing Simulations for Main Route Feedings (IETT Project),
- Enhancing night lines/routes,
- Implementing night services similarly with successful cities from the world,
- Activating and increasing the maritime transport,
- Constituting private lanes for public transport vehicles.

6.3.5. Main Findings of the Analysis

Istanbul is the most populated city in Turkey and has the widest range of public transport modes in the country. The last 20 years have been the timeframe many mass rapid transit and other new modes have been projected and constructed. There are still many projects on public transport. That’s why integration of different modes at interchange stations is always on the agenda. Even so, integration is not solely a matter of lines’ and routes’ integration. Other components of integration have to be achieved to increase public transport ridership. Tariff/ticketing integration is also kept on the agenda by Istanbul Metropolitan Municipality.

There is a progression in public transport usage and pedestrian rates. In 2017, pedestrian share climbs 45% which is a higher rate than early 2000s, public transport has 28% and private car share reduces. Accessibility of pedestrians can be further increased by integrating lines and routes efficiently. Line and route integration works effect the ridership since line/route integration effects commuters' behavior in the catchment area. Public transport integration should be achieved for Istanbul metropolitan area since the population has always been increasing and urban sprawl has still been continuing.

Istanbul public transport integration in general terms and under recent circumstances seems to have progressed over the past twenty years; and even more so especially in the past ten years. Even though general characteristics of transport is more inclined to private cars, latest tendencies are shaped by increasing traffic load that causes severe traffic problems. Therefore, public transport ridership and pedestrian share has increased after the 2000s. This situation is a favorable trend for Istanbul. Because private car ownership (Figure 6.2) has always been high in Istanbul when compared to country average. This situation has created many problems for urban transport and had a kind of suspensive effect for public transport investments.

The analysis of Istanbul, and particularly the detailed analysis of selected stations showed that one of the reasons for an inefficient spatial planning of public transport integration in transfer stations can be because of lack of land or density of buildings. That is because mass rapid transit or other modes' infrastructure are comparatively new in Istanbul. That is why interchange stations are being constructed on already built-up areas. This situation can also be linked to a high share of walking.

Some public transport modes have a steady and low ridership share like maritime transport. Low ridership of maritime transport in the city is linked to fragmented operators according to the final report of Transport Master Plan Strategy. According to this report, Türkiye Denizcilik İşletmeleri A.Ş (TDİ) had a lot of negative features like old and slow fleet, huge number of employees, expenses etc. The report proposed a monopoly institution rather than complicated and fragmented operators (2005, p.7.3-24) and this proposal was partially actualized with TDİ becoming a general directorate

of the Ministry of Transport. TDİ operations has been run by Şehir Hatları A.Ş since 2010; however, ridership of maritime transport has not increased.

There is not one and only cause for the low ridership of maritime transport. Waterborne modes' schedules and headways are not well aligned with other modes. For this reason, schedule/headway integration is a crucial point in order to capture passengers from other modes. This situation will also reduce traffic load on strait bridges.

Integration of paratransit systems into the entire public transportation system and integration works is still inadequate. For example; all of bus and metrobus vehicles are equipped with GPS –global positioning system- tracking technology, GPS tools couldn't install in all of the minibus and dolmus vehicles yet. 78% of dolmus and 92% of minibus vehicles have that GPS system at present (Annual Report of Istanbul Metropolitan Municipality, 2017). Likewise, while some public transport stations and the transfer stations are designed as smart stops, paratransit modes do not have explicit timetables or tariffs. They also do not allow passengers use general payment card and hereby lower transfer fees. Besides, passengers cannot have information about their transit journeys that includes paratransit vehicles, although there are a wide-ranging information systems, applications and websites. Furthermore, departure points of paratransit services can be distant from transfer stations. This circumstance is experienced in Şişli-Mecidiyeköy and Aksaray transfer stations. The situation of distance makes a journey more time-consuming and uncomfortable to transfer to another mode's vehicle.

Moreover, not all public transport modes and vehicles have a unique and real-time information tool at stations. For example, while some bus stations have electronic information boards, some of them do not have this.

Istanbul Ulaşım A.Ş (named as Metro Istanbul A.Ş recently) became a member of The International Association of Public Transport (UITP) in 2005. This membership has some connotations about public transport improvements and integration in that the organization is promoting sustainable mobility and bring together all public stakeholders from 96 countries. It aims to put all sustainable transport actions into

practice: public transport systems that consume less energy, passenger and environment friendly public transport services, efficient use of urban land. Then it is expected for Istanbul to make some improvements in vehicles or transfer stations in terms of efficient land-use. When Istanbul is evaluated as part of this organization, it can be seen that Istanbul has studied more upon fare policies, bus rapid transit technologies, heavy road traffic, growing population and hence mass rapid transit solutions. That is why Istanbul's membership in The International Association of Public Transport has shed light on tariff/ticketing integration.

Although public transport ridership has not increased in the first years (2009) of tariff/ticketing integration, it steadily increased in later years after 2013. The delay would probably be due to comprehensive and radical Istanbul card transformation. The transformation includes fragmented operators, ticket machines, diversity of modes and millions of passengers that change their fare cards.

Looking into the analysis results, Istanbul has not fully achieved the tariff/ticketing integration. While the smart card can be used in all public transport modes, BRT system has a distinct tariff and transfer reduced fare is not valid at BRT mode. There are also many bus lines, which have longer routes, that have higher fares. This leads to a complicated fare system. Fare structure is not clear, because it has many exceptions, which are determined according to mode or route length.

Nevertheless, Istanbul also has some advantages in the tariff/ticketing integration. Validity of a unique fare card is one of them. Parking facilities could be paid with fare payment card. Güngör and Öztürk (2017, p.81-83) reveal that all of the 118 Ispark parking areas with barriers and 250 roadside parking areas allow commuters to pay with Istanbul card. Tariff/ticketing integration seems to be well developed in Ispark parking areas, but, priority in tariff/ticketing integration should be about the whole system. While Istanbul card usage is tried to be widened, clarity of the fare system has some confusing specifications together with the exceptions in fare policies as described above.

Bike&ride facilities in Istanbul have not advanced much since the bicycle master plan has not been completed and implemented yet. Nevertheless, Kadıköy and Yenikapı

interchange stations are convenient for Isbike planned bike lanes, because they have already good infrastructure for park and ride utility.

Field analysis showed that in general, Kadıköy and Yenikapı-Aksaray transfer stations are more feasible for spatial arrangements than Şişli-Mecidiyeköy. Although Yenikapı and Aksaray stations are located within the historical conservation area, recent filling areas on the sea create new space. Şişli-Mecidiyeköy station can be characterised as one of the most problematic transfer stations to make spatial arrangements. Because the land is insufficient in Şişli-Mecidiyeköy and the area is built-up densely. Although Yenikapı and Aksaray stations are located within the historical and protected area, they seem to be more appropriate for new landscape arrangements.

Istanbul has been experiencing longer average public transport journey times than other metropolitan areas in the world. It is identified with distant districts like Silivri, according to the Land Transport Master Plan Report. It appears that master plan focusses on the distant districts' inclusiveness in calculations. Nevertheless, the population of Silivri is nearly 1% of the Istanbul's population and there is solely one public transport mode operated in Silivri. It is not expected to have extremely high passenger numbers. Therefore, relating the long journey times to a distant district might not be logical. Instead, an inefficient line/route integration and schedule/headway integration create longer journeys. Apparently, schedule/headway integration needs to be provided to decrease journey times and preclude differences between modes.

In order to compare the public transport integration in Istanbul with the integration in Singapore, London and Toronto cases, some common criteria in the light of case study investigations from the world have been reviewed firstly in Chapter 2 and 3. Then, in Chapter 5 the checklist within Table 6.9 has been produced, bringing together outcomes of literature survey and the analysis of the Singapore, London and Toronto cases. Hence, the comparison of Istanbul case with the three world cases is shown in Table 6.9. It aims to show Istanbul case's situation when it is compared to world cases and universal approaches that are derived from the literature.

Table 6.9. *The Analysis of Case Study; Istanbul and World Cases Singapore, London and Toronto*

ISSUE	QUESTIONS	SINGAPORE	LONDON	TORONTO	ISTANBUL
Integration	Is there a transport authority that has full control over different public transport service providers?	Land Transport Authority (LTA) (Ministry of Transport) (only buses are operated by a fragmented operator)	Transport for London (TfL) (created by Greater London Authority Act 1999)	The Toronto Transit Commission (TTC), Metrolinx Agency (Regional Authority in GTHA)	Istanbul Metropolitan Municipality
Integration	Does the transport authority control power on paratransit modes in terms of their schedules, fares and routes?	Land Transport Authority (LTA) (But there isn't a fare integration with paratransit)	Transport for London (TfL)	The Toronto Transit Commission (TTC)	Istanbul Metropolitan Municipality (Public Transport Services Directorate and Transport Department)
Integration	Is there a plan document for integrated transport?	Land Transport Master Plan (2013-2030)	New Mobility Transportation Master Plan: Smart Moves (2030)	The Big Move: GTHA Regional Transportation Plan (2013)	Master Plan for Istanbul Metropolitan Area Integrated Urban Transport (2011)
Integration	Are issues of integration (line/route integration, information integration, tariff/ticketing integration, schedule/headway integration, integration with other modes and encompassed factors) clearly addressed/emphasized in plan documents?	✔	✔	✔	✔
Route/Line Integration	Is there sufficient inter-modal integration?	✔	✔	**X**	**X**
Route/Line Integration	Is there sufficient line integration between paratransit modes?	✔	✔	**X**	✔
Route/Line Integration	Are there any specific public transport line to enhance integration between existing lines (a circle line etc.)?	CCL6 Circle Line	Orbital Rail Line	Eglinton Crosstown Light Rail System	**X**
Route/Line Integration	Is the line/route integration determined according to future interchange stations visioned in plan documents? (transport master plans, or strategies or other plans and written documents)	✔	✔	✔	✔
Route/Line Integration	Are there well-designed transfer stations (short distance, disabled access)? Is there a design criteria or standards for transfer stations?	Integrated Transport Hubs, Bus Hubs, Walk2Ride	**X**	Integrated multicarrier bus terminals	Revision of Transfers
Route/Line Integration	Do the plan document(s) contain policies or visions regarding parking, cycling and walking?	✔	✔	✔	✔

Route/Line Integration	Is there any other strategy/document/commission/action regarding park&ride and bike&ride?	The Active Mobility Plan and Act	Bicycle Master Plan (2007), Mayor's Transport Strategy	Metrolinx 2015-2020 and 2017-22 Five Year Strategies, The Transit City Plan, Toronto Bike Plan, TTC Ridership Growth Strategy, Toronto Walking Growth Strategy.	**X**
Route/Line Integration	Are there park&ride facilities?	✔	✔	✔	✔
Route/Line Integration	Are there bike&ride facilities?	✔	✔	✔	✔
Tariff/ Ticketing Integration	Is there a smart card?	Concession cards	Oyster card	Presto card	Istanbul card
Tariff/ Ticketing Integration	Is there a fare integration between all public transport modes (fare barrier inquiry)?	**X** (The ticket prices vary by service type)	**X** (there are fare differences between modes)	**X** (there are fare differences stem from the operator)	**X** (there are fare differences between modes)
Tariff/ Ticketing Integration	Is there a transfer reduced fare (discount) between public transport modes?	✔	✔	✔ (Transfers are free of charge)	✔ (but except BRT)
Tariff/ Ticketing Integration	Is there any city or region-specific fare solutions?	'Degressive increase rates on fares' in order to avoid negative financial outcomes of distance fares system	'On-street transfers' in order to avoid additional fees of zonal fare structure	Fare and Service Integration Strategy, Development and Selection of a Regional Fare Structure, co-fare agreements between operators, transfer acceptance.	Some determined free-feeder bus lines
Tariff/ Ticketing Integration	Is there a road pricing system (congestion charge, traffic charge etc.) in determined central and dense areas?	ERP (Electronic Road Pricing)	London Congestion Charge	**X** (on the agenda)	**X** (not on the agenda)
Tariff/ Ticketing Integration	Is there fare integration with car parking?	**X** (There is a separate park&ride card and season parking card.)	✔	**X**	✔
Tariff/ Ticketing Integration	Is there fare integration with bike/bike share?	✔	**X**	**X**	**X**
Information Integration	Are there sufficient information tools (web-pages, information at stations/hubs, mobile device applications, displays and boards in specific locations in the city and information)?	How2Go, MyTransport.sg.	TfL Oyster, Citymapper London, iBus.	Triplinx (Collaborative initiative between Metrolinx and other transit providers across GTHA)	NasılGiderim, MOBIETT, Yardım IETT, City Map, IBB Mobile Traffic

Information Integration	Do the information tools have diverse and very detailed information (like waiting time, vehicle locations, fares, walking distances, headways, average travel time, real time parking availability, delays, maintenances etc.)?	✔	✔	✔	✔
Information Integration	Are the information tools understandable and easy to use?	✔	✔	✔	✔
Information Integration	Is there a unique standardized and real-time information system (independently of mode or operator-based systems)?	**X** (information tools vary by public transport mode)	**X**	**X**	**X**
Information Integration	Is there a real-time communication webpage or phone number to respond the commuters' instant questions?	**X (**feedback)	24/7 open textphone, message and calls.	TTC Text Messaging to 898882.	24/7 open Phone Line 153, text messaging to 1530.
Schedule/ Headway Integration	Do the different modes' schedules are in parallel with each other with regard to starting and ending hours of operation?	**X**	**X**	✔	**X**
Schedule/ Headway Integration	Are the headways of schedules planned by taking account of other modes' time tables to minimize transfer times (coherence between operating hours of different modes)?	**X** (buses might be different)	**X** (It changes according to public transport mode.)	✔	**X** (the railway systems are in parallel. Yet, services are generally frequent)
Schedule/ Headway Integration	Are there any bus-based solutions or implementations to avoid time loss and to work schedules regular?	Mandatory Give Way to Buses Scheme (since 2008), Bus Signal Priority Scheme (since 2009), Private B traffic signals	Automated bus lanes, variable pricing offering (choice management by real-time information)	Transit City Bus Plan (more frequent bus service, special lanes and BRT implementation)	Extending BRT, more frequent services
Schedule/ Headway Integration	Is there any feeder or circle line determined to serve for a specific time period (peak hours, at night etc.)?	Feeder bus lines	Circle lines	Blue Night Network (15 bus and streetcar lines)	11-night lines, 5 express lines
Schedule/ Headway Integration	Is frequency of services increased in some time?	Nearly 10 regular updates in a year	Frequency increases on key routes by London Bus Initiative and regular rearrangements via consultations with users	10 service changes in a year by TTC	Frequency increases at peak hours
Schedule/ Headway Integration	Do the walking distances between different modes at interchange stations take much time?	**X**	✔	**X**	✔

As it is seen in Table 6.9 all of the cases have some deficiencies or points to be improved as well as potentials. The check-list involves many questions regarding four

integration components. That's why findings of the checklist will be analyzed in terms of line/route integration, tariff/ticketing integration, information integration, and schedule/headway integration.

- Route/Line Integration: Singapore and London portray as good examples for line/route integration. However, Toronto and Istanbul have some deficiencies regarding line/route integration. Inter-modal integration is not efficient in Istanbul due to the space-based problems, late infrastructures, fragmented operators' unconnected investments, paratransit factor, low accessibility of some transfer stations, ongoing spatial arrangements and weak pedestrian access. While the world cases have already constituted their public transport basis with their MRT systems, Istanbul has recently been investing to complete the MRT backbone across the city. While the late development causes some problems it could also have a potential for a well schedule/headway and an advanced line/route integration. Considering London's old railway system, Istanbul could have a potential to present well designed transfers which have less walking times and high accessibility. Besides, although the four cities have the main plan documents for integrated transport and issues of integration are clearly emphasized in plan documents, Istanbul does not have other supportive documents, such as the Active Mobility Plan and Act in Singapore or TTC Ridership Growth Strategy and Walking Growth Strategy in Toronto. While the world cases have designed-based transfer stations, Istanbul has been trying to revise the existing transfer stations. Istanbul displays a problem-solving or problem-postponing attitude, while for example Singapore display a problem-preventer attitude while planning transfer stations. This situation leads to a question of whether Istanbul has not fulfilled the plan documents' necessities. The other factor for a weak line/route integration in Istanbul is paratransit, because late public transport investments cause paratransit ridership on the same corridors. Some paratransit routes are competing with public transport vehicles on the same route. While the paratransit routes are re-arranged after the MRT or BRT systems are accomplished on a corridor by

Metropolitan Municipality, they compete with public transport vehicles due to the lack of spatial integration in transfers. Moreover, world cases have determined circle or orbital rail lines across the city to enhance line/route integration. There are no circle lines in Istanbul. Nevertheless, paratransit modes seem to fill the gap. Paratransit vehicles operate at corridors where public transport service is inadequate or not well-arranged. It can be said that although there is not a circle line operated by public transport operators, so many circle lines are operated by paratransit vehicles. While buses are well integrated within the system, the inter-modal integration is weak at transfer stations in Istanbul. Lack of space is one of the reasons differentiating from the world cases. As it has been explored via transfer stations (Şişli-Mecidiyeköy, Zeytinburnu, Yenikapı, Aksaray-Yusufpaşa and Kadıköy transfer stations) in Istanbul, pedestrian circulation problems, motor vehicle-oriented spatial arrangements, narrow sidewalks, unsafe or long walking paths, lack of cycling or parking facilities are some reasons for it.

- Tariff/Ticketing Integration: First of all, tariff/ticketing of Istanbul public transport system is different in comparison to world cases. Singapore has a distance based, London and Toronto have zone-based fare systems. Istanbul has a flat fare structure in general terms. However, there are some mode or route-based fare differences too. This situation leads to a confusing tariff/ticketing system. For example, metrobus and Marmaray have their own tariffs, and some bus routes have different tariffs too. However, all of the world cases have some fare differences, too. For example, ticket prices vary by service type in Singapore; there are mode-based fare differences in London and operator-based fare differences in Toronto. Istanbul has had a huge progress since the introduction of Istanbul smart fare card. The smart card can be used for all modes. Moreover, transfers are subject to reduced fares (except for metrobus and paratransit). Istanbul has been experiencing its own space-based fare solutions regarding transfers like other world cases. One deficiency with regard to tariff/ticketing integration in Istanbul is that Istanbul card cannot

be used in paratransit vehicles. Notwithstanding the regulative power of Istanbul Metropolitan Municipality in terms of paratransit routes, vehicles and fares, paratransit services are operated by vehicle-based agreements with Municipality. Owners are not willing to accept the smart fare cards instead of cash payments.

- Information Integration: Web-based information is supplied by Istanbul Metropolitan Municipality. While some operators have their own information systems for passengers, Istanbul Metropolitan Municipality has centralized web pages or mobile phone applications that inform people about their journey with detailed information. In terms of information integration, Toronto has some deficiencies due to the fragmented operators. Operators' information systems could provide different information about journey prices, etc. When compared to world cases, Istanbul has a well web-based information. However, lack of information at or around the stations is the basic problem for an integrated information system. The other deficiency is that paratransit routes are not included in information systems. Not all of the world cases have a unique, standardized and real-time information at stations. Nevertheless, world cases have some mode-based information systems. Istanbul have differentiated and deficient information at stations and on vehicles. The potential regarding information integration in Istanbul is the new fleet of almost all modes across the city. A standardized information system could be easily installed. This could be an advantage for an integrated information.
- Schedule/Headway Integration: When the world cases are examined, it is seen that service schedules in all three world cases are updated regularly nearly 10-12 times in a year. As for Istanbul, schedules are not regularly changed or revised. But service frequency is increased at peak hours. Updates are not regular and they are route- or mode-based. For example, increasing ridership at weekend requires officials to increase car numbers at MRT systems. While 4 carriage metro vehicles operate on weekdays, 6 or 8 carriage metro vehicles operate at weekends. When the headways of four cases are examined, only

Toronto public transport headways are planned by taking account of all modes. Generally, a certain mode has a united headway length and starting and ending times of operation are in accordance with that mode's lines. But starting and ending times have mode-based differences. The most distinct modes in terms of schedule/headway integration in Istanbul are waterborne modes. The headways have long periods, operation hours start later than all other modes in general. Istanbul has two short-comings with regard to schedule/headway integration. First, different modes' schedules are not planned jointly. Second, accuracy of bus schedules is not guaranteed due to the traffic congestion. While the schedule/headway integration is evaluated, Istanbul's population difference should be emphasized too. Because Istanbul public transport commuters are more crowded than any other case. Passengers could avoid using public transport because of the lack of schedule/headway integration. Because the lack of schedule/headway integration causes time loss. And time loss results in passengers not choosing the services in catchment areas of public transport services. Just like the other components of integration, paratransit services in Istanbul are not integrated to public transport modes' schedules or headways either.

One other difference of Istanbul is seen with regards to bus priority schemes, which may have an effect on schedules and reliability, but actually refer to a wider policy issue. Singapore, London and Toronto have exclusive bus lanes, bus priority schemes and private bus traffic signals to enhance the reliability of bus service schedules. However, Istanbul has not been implementing any of these bus priority schemes. Only the BRT service has reliable schedules within rubber-tyred vehicles. Babalık-Sutcliffe (2017) states that restriction of car use within some central urban areas is a way for restructuring and modernizing public transport services in the city. It is one of the requirements for addressing such mobility problems as private car usage, congestion and parking area shortages (p.248). Singapore and London have precautionary arrangements in central areas of the city. These two cities have road pricing in central areas to discourage car usage and tackle traffic congestion. Thus, reliability of

schedules is enhanced, and public transport is encouraged while car usage is restricted. Toronto has been studying to realize a road pricing system too. However, Istanbul does not have a road pricing system in central areas on the agenda yet. There are no effective car restriction policies either.

So far, the checklist drills down into a number of useful implications. The situation of the Istanbul case is revealed by the help of checklist which is produced via literature review and good practice cases from the world. In addition, the recent years' developments could also give us some implications about riderships. In this way, graphics about the public transport ridership are also produced to have some arguments of how mode shares or new lines affect the other mode's ridership shares. For example, Figure 6.29 demonstrates the annual ridership of BRT and IETT. Although BRT is a mode and is operated by IETT, they are given in the same graphic. Because BRT line has a significant effect on IETT and other operators' operations due to the high level of BRT passengers.

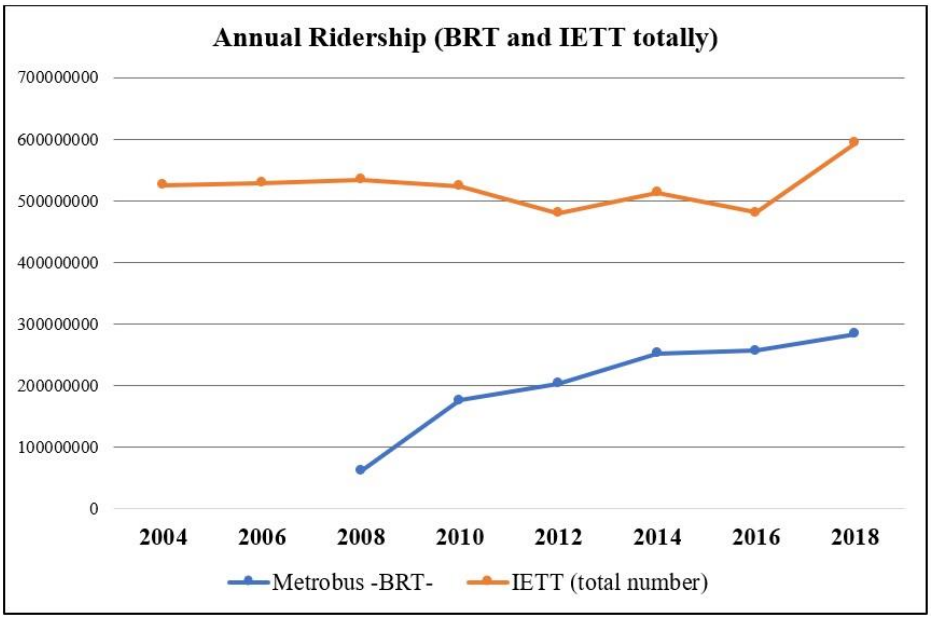


Figure 6.29. Annual Ridership of BRT and the BRT's Operator IETT

(Source: Author, based on the data obtained from https://www.iett.istanbul/, last accessed:07.08.2019)

With only a handful exceptions, BRT ridership has been growing since 2008. It is stagnated only between 2014 and 2016. A particular feature of BRT line should be addressed here. BRT line has been extended since 2007 when it started to be operated. It was nearly an 18 km length line in 2007. After the four and the last stage, which was completed in 2012, it is today a 52 km length line. However, its ridership increase could not affect the falling of IETT ridership. IETT ridership has stagnated between 2004 and 2008. Then it started to fall in 2008 till 2012. Figure 6.29 might not be meaningful on its own. But when it is evaluated with Figure 6.30 it could lead to meaningful inferences. It can be said that opening of the first BRT line in 2007 leads to a fall in total number of IETT ridership. Within the same years there is an increase in M2/Yenikapı Hacıosman MRT line, T4/Topkapı-Mescid-i Selam Tramway line and T1/Bağcılar-Kabataş Tramway line, which are operated by another operator, Metro Istanbul A.Ş. As a matter of fact, the BRT line has a lot of transfer stations that allow passengers to transfer to M2, T4 and T1 lines. This situation can explain the fall of IETT ridership when the BRT starts its operations. Passengers who use IETT modes might have transferred to metro and tramway lines that are operated by another operator.

Along the same line, Figure 6.30 has more useful connotations on how some evolvements or developments in public transport network affect the ridership shares between modes as well as operators. The annual ridership of Metro Istanbul A.Ş operations from 2004 to 2017 can be seen in Figure 6.30.

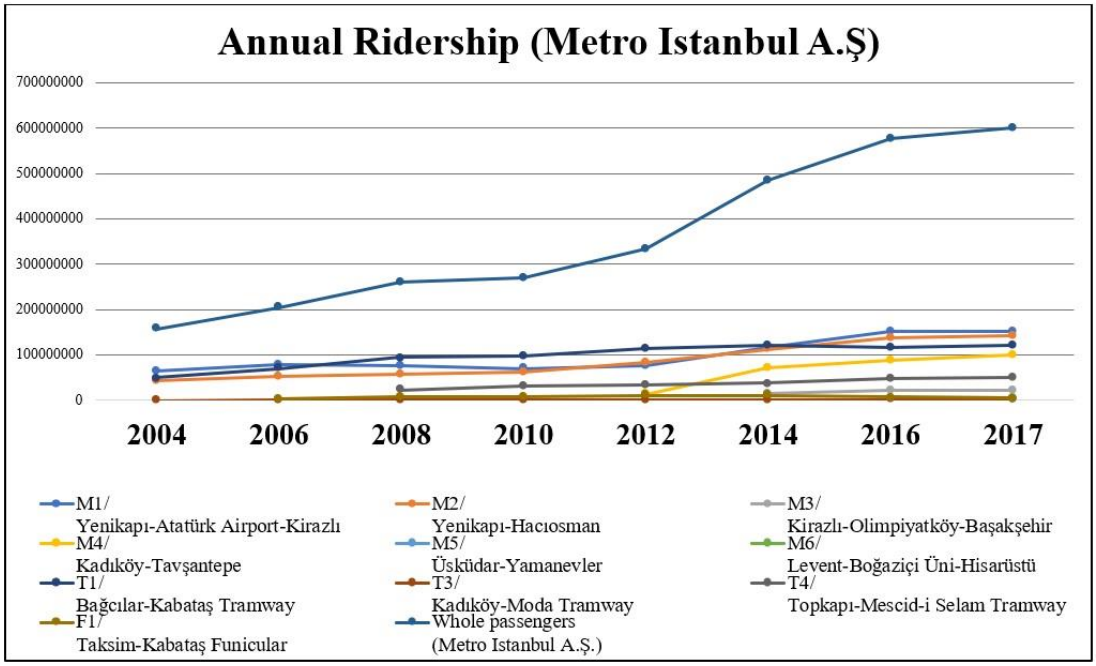


Figure 6.30. Metro Istanbul A.Ş Annual Ridership Changes According to Modes

(Source: Author, based on the data obtained from https://www.iett.istanbul/, last accessed:07.08.2019)

Implications of the Metro Istanbul A.Ş's annual ridership between 2004 and 2017 leads to the analogies below:

- 2006: Opening of Kabataş Station as a part of T1/Bağcılar-Kabataş tramway line = Opening of F1/Taksim-Kabataş Funicular line = An increased ridership on T1/Bağcılar-Kabataş tramway line.
- 2008: US based Global Economic Crisis = Stagnated ridership in total number of passengers.
- 2008: Extension of metrobus line from Topkapı to Zincirlikuyu = Integration with M2/Taksim-4.Levent (recently named as M2/Yenikapı-Hacıosman) = A fair amount of increase in ridership of M2 line.
- 2009: Istanbul fare card = Increased ridership in following years.
- 2012: Positive effect of M2/Yenikapı-Hacıosman extension and M4/Kartal-Kadıköy Line on total number of ridership.

- 2012: Opening of M4/Kadıköy-Kartal = Integration with T3/Kadıköy-Moda Tramway Line = An increased ridership on T3/Kadıköy-Moda Tramway Line.
- 2013: Opening of Marmaray line = A new alternative for strait passes = Rivalry with metrobus line = Decrease in metrobus share in 2014.
- 2014: Yenikapı-Haliç extension of M2/Yenikapı-Hacıosman = Decreasing ridership share of T1/Bağcılar-Kabataş Tramway line (parallel routes)
- 2016-2018: There are no new MRT lines at the European part but new MRT lines at the Anatolian part (Extension of M4/Kadıköy-Tavşantepe in 2016, M5/Üsküdar-Çekmeköy in 2017 and 2018).

All the various factors above show that there are different reasons behind the ridership share fluctuations. There is not only a rivalry of lines but also a feeding of lines. If convenient transfers are built when a new line is planned, it fosters the already existing line. In addition, integrated fare systems and structures, fare cards valid on all modes, information systems and their integration with each other, and schedules and integration across modes all play a role.

CHAPTER 7

CONCLUSION

7.1. Summary of the Research

Public transport integration has been the focus of this study. The two main research questions of the study were how to ensure integration in metropolitan cities' public transport systems which have multi-modal systems and whether or not Istanbul public transport system reveals a successful example of integration.

In order to assess success, the thesis developed an analysis framework based on a list of criteria derived from the literature. The review of the literature has shown that there are many efforts in most of the urban areas to cope with urban transportation problem. These efforts aim to achieve a sustainable and efficient urban transportation systems. Sustainable transport policies involve inter-modal network of multi-modal public transport systems and concentrations on alternatives to automobiles. These policies promote environmentally friendly settlements and public transport friendly urban areas as actions to combat climate change and to create sustainable transport. In recent decades, many studies have been carried out, many scientific reports have been published, many national and international reports have been prepared by committees, policies and guidelines for more sustainable, environmentally friendly and energy-efficient transport systems have been outlined, and they all point to the importance of public transport systems. In order to constitute efficient transport systems, public transport systems and services must be enhanced in urban areas. Public transport systems are the focus of contemporary transport policies.

At the same time, urban population has been increasing in the world, creating a need to meet the increasing mobility demand. Public transport is the most efficient way to

satisfy the demand in the event of high levels of mobility. These endeavors highlight that public transport systems have a crucial role to play in urban areas.

An advanced public transport system needs to have an integrated system. Many studies show that integration is the significant factor for passenger behaviour as there could always be a tendency for using privately owned automobiles. An integrated system increases the number of passengers who prefer using public transport systems.

This study has aimed at developing a framework for planning and operating an integrated public transport system. This framework was developed through the literature review and analysis of good practice cases from different parts of the world, with the aim of assessing the situation of Istanbul's current public transport system. While the literature review has helped to draw a conceptual framework for an integrated public transport system, three different cases have enhanced our understanding of how an integrated public transport system is achieved in practice and what challenges exist. The aim here was developing a set of criteria. Hence a table of criteria was developed via literature review and experiences of the three good practice cases. It was then applied to Istanbul.

The three cases from different continents of the world have guided the principal approach for the analysis of the case from Turkey. Thus, it was targeted to assess whether or not and to what extent Istanbul has an integrated public transport system in current conditions via an analysis of Singapore, London and Toronto cases as well as the outcomes of the literature review. Two main research questions were formulated in the direction of the aim of the study. These questions were:

1-Based on the literature and best-practice cases, how can a strong integration be ensured for public transportation systems in metropolitan cities that generally have multi modal systems; in other words what are the indicators of a successfully integrated public transport system?

2-Based on Istanbul's transfer stations that are studied in this thesis, how successful is Istanbul with regard to integrated public transport?

2.1- What are its strengths and weaknesses?

2.2- Based on its weaknesses, is there room for progress?

There were also five secondary questions, which were:

1-How effective are the plan documents about public transport in delivering an integrated public transport service in Istanbul?

2-Are there sufficient measures in plan documents to ensure an integrated public transport system?

3-Is an integrated public transport system (route/line integration, information integration, tariff/ticketing integration and schedule/headway integration) achieved in Istanbul according to literature and when compared to best cases from the world?

4-Do Istanbul's public transportation future plans involve emphasises in integration?

5-Based on the analysis framework, how can Istanbul's public transport system be improved in terms of integration?

6-Based on the research results, what policies and recommendations can be made for public transport integration in Turkish cities and cities worldwide?

In order to provide better understanding of the Turkish case, public transport policies at national level in Turkey have also been investigated. Although these documents are not prepared specifically on the theme of integrated public transport systems, they have some connotations, goals and reflections about integrated public transport. They have been investigated by focusing on integrated public transport, with the expectation to obtain information on how public transport policies are shaped for the country since nation-wide policies have effects on implementations in cities. Moreover, public transport policy documents in Istanbul have also been analyzed. These involve specific aims for integration when compared to national transport policies.

For a better understanding of the current situation and implementations, five transfer stations have been determined in Istanbul and investigated in terms of public transport

integration aspects. Field research has been carried out via observations on some determined transfer stations. They are Şişli-Mecidiyeköy Transfer Station, Zeytinburnu Transfer Station, Yenikapı Transfer Station, Aksaray-Yusufpaşa Transfer Station and Kadıköy Transfer Station. Spatial maps have been produced, showing public transport modes, pedestrian circulation directions, distances between modes, transfer times between different modes, bicycle racks and parking lots. These maps have also been supported by visuals of the stations to shed light on public transport integration.

Besides, interviews were also carried out with experts in Istanbul from different institutions/cooperations, which are the providers of public transport service across the city. These interviews were helpful in finding answers to some of the research questions and in understanding the experiences in planning and operating public transport systems in Istanbul.

7.2. Main Findings of the Research

In this part, Istanbul's public transport integration aspects are analyzed firstly. The analysis is made via findings of the checklist. Then, a discussion about Istanbul's current and future situation is carried out by focusing on the main issues from the site survey and interviews made with experts.

This research has shown that there are four main components of integration in public transport: line/route integration; tariff/ticketing integration; information integration; and scheduling integration. Findings with regards to these four aspects are described below, and the findings of the analysis made via the checklist are presented. Then, a discussion about Istanbul's current and future situation is made by focusing on the main findings from the site survey and interviews.

Route/Line Integration:

- Istanbul has plan documents for integrated transport and issues of integration are clearly emphasized within these documents. However, it has been seen that world cases confront with integration issues in a better and more effective way

through their supportive legislations, plans and action documents, such as the Active Mobility Plan and Act in Singapore or TTC Ridership Growth Strategy and Walking Growth Strategy in Toronto.

- Inter-modal integration does not seem to be efficient in Istanbul due to the space-based problems, late infrastructures, fragmented operators' unconnected investments, paratransit factor, low accessibility of some transfer stations, ongoing spatial arrangements and weak pedestrian access.
- While the world cases generally have already constituted their public transport basis with their Mass rapid Transit (MRT) systems as the backbone, Istanbul has recently been investing to complete the MRT system across the city. From this point of view, Istanbul have some deficiencies regarding line/route integration. Nevertheless, it might be an opportunity for Istanbul in terms of planning stations with the issue of integration and transfer in mind. In addition, the city can make use of new technologies for MRT infrastructure and new design approaches for efficiently designed transfer stations. It might also lead to a well schedule/headway via less walking times and less and predictable transfer times.
- Having said that, design of transfer stations so far have not been successful. While the world cases have designed-based transfer stations, Istanbul has been trying to revise the existing stations to create transfer stations. According to the literature review well-designed transfer stations and safe and convenient walking paths are required for an efficient and successful line/route integration (Babalık-Sutcliffe, 2017, p.189-190, Edwards, 2011, p.1-20, Grava, 2013, p.385, Vuchic, 2005, p.215). When the transfer stations analyzed within this study are reviewed, they seem to have some deficiencies like featuring unsafe, inconvenient or time-consuming pedestrian pathways. Istanbul seems to have a problem-solving attitude, rather than a problem-preventing attitude regarding the planning and design of transfer stations.
- The other factor for a weak line/route integration in Istanbul is the weak integration of paratransit with public transport modes. The literature review

shows that integration with nonpublic transit modes (Öncü, M.A., 2007, pp.18-20, Sharaby and Shiftan 2012, pp.63-64) is also crucial. However, late public transport investments cause competing paratransit routes on the same route with public transport. While the paratransit routes have been re-arranged after the MRT and BRT systems were accomplished on a corridor by the Metropolitan Municipality, they still do not operate in a way to compliment the MRT and BRT, but instead compete with public transport vehicles. This is due to both the lack of spatial integration and lack of fare integration in transfers, as described below.

- World cases have developed circle or orbital rail lines across the city to enhance line/route integration. There are no such similar circle lines in Istanbul. Nevertheless, paratransit modes seem to fill the gap. Although certain paratransit lines still compete with other public transport services as mentioned above, there also some paratransit lines that operate at corridors where public transport service is inadequate or not well-arranged. It can be said that although there is not a circle line operated by public transport operators, many circle lines are operated by paratransit vehicles.
- While buses are well integrated within the system, the inter-modal integration is weak at transfer stations in Istanbul. Lack of space is one of the reasons differentiating from the world cases. As it has been observed at transfer stations (Şişli-Mecidiyeköy, Zeytinburnu, Yenikapı, Aksaray-Yusufpaşa and Kadıköy transfer stations) in Istanbul, pedestrian circulation problems, motor vehicle-oriented spatial arrangements, narrow sidewalks, unsafe or long walking paths, lack of cycling or parking facilities are some reasons for this problem.

Tariff/Ticketing Integration:

- Istanbul public transport system's tariff/ticketing is different from the world cases. Singapore has a distance based, London and Toronto have

zone-based fare systems while Istanbul has a flat fare structure (with the exception of BRT as described below).

- The BRT in Istanbul causes peculiarities in the fare structure and system: it has a distance-based fare structure; however, having this structure only for the BRT and not for any other rail or bus systems causes a fragmented operational environment rather than an integrated one. Furthermore, when passengers transfer from BRT to rail or other bus modes there is a reduced transfer fare, whereas in transferring from rail and other bus modes to BRT passengers pay the full fare. Therefore, the BRT case presents a shortcoming for fare and tariffs, i.e. lack of a regular and coherent system-wide implementation.
- Public transport ridership in Istanbul increased in the years following the introduction of Istanbul card, a smart card allowing transfer fares. The positive outcomes of Istanbul's fare card regulation and arrangement are also supported by the literature review, since many sources state that structure of fares, economic measures, and use of fare smart cards have an effect on captivating travelers to public transport and lead to an integrated tariff/ticketing system (Goldman and Gorham, 2006, p.267, Sinha, 2003, p.334-340, Vuchic, 2005, p.376-377).
- Istanbul has had a huge progress since the introduction of Istanbul smart fare card, because this card can be used for all modes, including privately operated buses (but excluding paratransit). With the help of this card, transfers are encouraged since they are subject to reduced fares (except for the BRT Metrobus as mentioned above and paratransit). One deficiency with regard to tariff/ticketing integration in Istanbul is that Istanbul card cannot be used in paratransit vehicles. Notwithstanding the regulative power of Istanbul Metropolitan Municipality in terms of paratransit routes, vehicles and fares; paratransit services are operated by vehicle-based agreements with Municipality. Owners are not willing to accept the smart fare cards instead of cash payments.

- There are some mode or route based fare differences in Istanbul, some of which have already been described. This situation leads to a confusing tariff/ticketing system. For example, Metrobus and Marmaray have their own tariffs, and some bus routes have their own tariffs. However; all of the world cases have some fare differences, too. For example; ticket prices vary by service type in Singapore, there are mode-based fare differences in London and operator-based fare differences in Toronto.

Information Integration:

- Web-based information is supplied by Istanbul Metropolitan Municipality. While some operators have their own information systems for passengers, Istanbul Metropolitan Municipality has centralized web pages or applications that inform people about their journey with detailed information.
- Istanbul seems to have a well web-based information system, comparable to the world cases, and better performing than some of the world cases: for example, Toronto has some deficiencies due to the fragmented operators, which different operators' information systems providing different information about journey prices etc.
- However, lack of information at or around some of the stations is a basic problem for an integrated information system in Istanbul.
- Information integration is generally achieved within a mode in Istanbul in terms of web-based information systems. However, there are some deficiencies with regards to information at or around the stations and on vehicles. For example, each mode has its own information system. However, there are differences between different modes. This finding is supported by the site surveys and five transfer stations which are studied within the context of this research. Nonetheless, there are some current studies regarding an integrated information system across Istanbul, conducted by operators. For example, IETT has an aim and project to develop and update the information systems of the 39 provinces of Istanbul. When this project is accomplished,

web-based information systems are expected to be created, supported by spatial information. It could also have positive implications on schedule/headway integration.

- Not all of the world cases have a unique, standardized and real-time information at stations. Nevertheless, world cases have some mode-based information systems. Paratransit routes in Istanbul are not included in web-based information systems. The information within paratransit modes are also not integrated, unlike the other modes.
- Istanbul has differentiated and deficient information at stations and on vehicles. The potential regarding information integration in Istanbul is the new fleet of almost all modes across the city. A standardized information system could be easily installed. This could be an advantage for an integrated information.

Schedule/Headway Integration:

- Schedules of all three world cases are updated regularly nearly 10-12 times in a year. As for Istanbul, schedules are not regularly changed or revised. But service frequency is increased at peak hours. Updates are not regular but route or mode-based interventions are made. For example, increasing ridership at weekends force officials to increase car numbers at MRT systems. While 4 carriage metro vehicles operate on weekdays, 6 or 8 carriage metro vehicles operate at weekends.
- When the headways of four cases are examined, only Toronto public transport headways are planned by taking account of all modes. Generally, a certain mode has a united headway length and starting and ending times of operation are in accordance with that mode's lines. But starting and ending times have mode-based differences. The most distinct modes in terms of schedule/headway integration in Istanbul are waterborne modes. The headways have long periods, and operation hours start later than all other modes in general.

- Istanbul has two short-comings with regard to schedule/headway integration. First, different modes' schedules are not planned jointly. Second, accuracy of bus schedules is not guaranteed due to the traffic congestion. One other difference of Istanbul is seen here, too. Singapore, London and Toronto have exclusive bus lanes, bus priority schemes and private bus traffic signals to enhance the reliability of bus service schedules. However, Istanbul has not been implementing bus lanes extensively. Only the BRT service has reliable schedules within rubber-tyred vehicles.
- Singapore and London have precautionary arrangements in central areas of the city. These two cities have road pricing schemes in central areas to avoid traffic congestion and to discourage car use. Thus, reliability of schedules are enhanced. Toronto has plans to implement a road pricing system, too. However, Istanbul does not have a road pricing system in central areas on the agenda yet. The city does not have car restriction policies either to discourage car use and encourage public transport.
- When the schedule/headway integration is evaluated, Istanbul's population difference should be emphasized too. Because Istanbul public transport commuters are more crowded than any other case. Passengers could avoid using public transport because of the lack of schedule/headway integration, because this causes time loss. And time loss results in a decrease in ridership in catchment areas of public transport services.
- Paratransit services are not integrated to public transport modes' schedules or headway. Paratransit services also do not have centrally planned schedules. They do not allow passengers to use the city-wide payment card and benefit from lower transfer fees. Besides, passengers cannot have information about their transit journeys on general web-based information systems. Moreover, departure points of paratransit services can be distant from transfer stations.

Apart from the discussions above, there is also another significant point which has an effect on integration aspects. It is the institutional structure of the public transport service. As literature review shows integration also encompasses integrating transport

considerations into the decision making. There is a more strategic form of integration in practice. Integration of policy instruments for greater performance achievement from the overall strategy, horizontal integration between agencies, spatial integration between local authorities and vertical integration between local/regional/national/supranational administrations are also emphasized (Givoni and Banister, 2010, May, A.D., Kelly, C. and Shepherd, S.P., 2006, pp. 320-321). Although Istanbul has a lead institution that coordinates and from some points regulates the public transport operators, there are various actions and initiatives of operators that are independent from each other. At this point, the importance of the controller and coordinator role of Istanbul Metropolitan Municipality should be emphasized. However, if operators keep up with other operators' ongoing and future studies, they could also have some coordination with each other, because every institution internalize its own policy and action aims better. The lead institution might not be effective for each step of the operators' visions.

In the light of Istanbul case study analysis there are some other considerations that are listed below:

- Istanbul is the most populated city in Turkey and has the widest range of public transport modes. The system has been still developing with many projects on public transport for the last 20 years. That is why integration of different modes and creation of interchange stations are always on the agenda. Istanbul has already had a huge progress for the last decades in terms of public transport integration and always increases its public transport ridership. This situation should and can become an opportunity for the future public transport integration. Revealing the incomplete or imperfect points can lead to a better vision for the future system.
- Recent tendencies are shaped by increasing traffic load and associated problems in Istanbul. Although there is significant levels of private car usage, public transport ridership and pedestrian shares have been increasing since the 2000s. In 2017, pedestrian share increased to 45% of all trips, which is a higher

rate than that in the early 2000s. Public transport trips have become 28% of all trips and private car share has reduced.

- Large scale projects regarding Istanbul transportation has an effect directly on the public transport in the city. Large scale projects' public transport integration is also another significant necessity since these projects are often planned by the central government and require the local government to adapt its public transport services accordingly. Istanbul differs from world cases from this angle. Some other negative factors are lack of land or density of buildings for providing necessary space, in other words late arrival of the main public transport infrastructure.
- One of the reasons for an inefficient spatial planning of public transport integration stations can be because of this lack of land or density of buildings, because mass rapid transit or other modes' infrastructure are comparatively new in Istanbul. Interchange stations are being constructed on already built-up areas.
- Waterborne modes' schedules and headways are not well aligned with other modes as already mentioned. For this reason, schedule/headway integration is a crucial point in order to capture passengers from cars and buses. This situation will also reduce traffic load on strait bridges.
- Paratransit systems, pedestrians and cyclists are not well integrated into the body of public transport system.
- There has been a huge progress in terms of tariff/ticketing integration in Istanbul since 2009.
- Every new public transport line has an effect on transacted line or mode. This situation is seen by the ridership of different modes or operators. The ridership of BRT, IETT and Metro Istanbul A.Ş was evaluated within the time period of 2004 and 2017 in this study (see Figure 6.29. and Figure 6.30.). It has many connotations on how new lines allure travelers or change the ridership of other modes in a positive or negative way. At this point it should be stated that there can be both a rivalry of lines and a feeding of lines. If convenient transfers are

built when a new line is planned, it fosters the already existing line. A well line/route integration feeds other integration aspects. In the same way, all of the integration components have effects on the others. That is why the integration aspects should not be thought as unconnected or separate components.

- There might be some inferences about public transport integration in Turkey from the case of Istanbul. Many cities are trying to build their railway systems as the backbone of the city's public transportation. It is also designated as the main public transport mode for the whole system. Even though the integration issue within national documents are limited with some of the integration components, cities in Turkey should try to achieve integration with all of its components, as studied in this research.

7.3. Future Research

This study was an attempt to conceptualize a framework of an integrated public transport system, which emerged as an outcome of the necessities for sustainable and efficient transportation systems as well as to meet huge mobility demand of millions of people in metropolitan cities.

As explained in detail above, the study focused on Istanbul case in Turkey, making use of the literature review, best practice cases in the world and some data collection methods like interviews in Istanbul.

It is necessary to highlight one constraint. The checklist was produced by making a literature review and analyzing best practice cases from the world. Nevertheless, there is a significant difference of Istanbul from other cities. Even though Singapore, London and Toronto seemed to have already built-up railway and other modes' systems that necessitates infrastructure, Istanbul is still working on to complete its main MRT backbone. That is why some of the transfer stations, which are investigated as example transfer stations within this study, were having constructional activities during the field work. These activities block some of the space at stations. This may have affected some evaluations in the study regarding pedestrian circulation, safety

and other spatial contexts. From this aspect, when the MRT backbone of Istanbul is nearly completed, it could be helpful to carry out a similar analysis at the stations again.

To further develop this research, data collection methods can be widened. Although interviews with experts were conducted within the context of this study, questionnaire method together with interviews can be a more comprehensive way to conduct a research and conclude in a rich seam of information. Interviews have been conducted with decision makers from different public transport service provider institutions/associations. However, perception and opinions of users in Istanbul can also help to collect a wider set of data. Therefore, an extensive questionnaire survey with users can be also conducted in Istanbul. The questionnaire may involve some questions with regard to waiting times during the transfers, approximate transfer numbers on one day, the most frequently preferred public transport mode and preferred transfer stations, shortcomings of information systems about public transport, reasons to favor automobiles, opinions about tariffs, spatial barriers at transfer stations and the ways for users to communicate with responsible service providers and the functionality of those systems. Hence, user perspective may lead to a more satisfactory policy and strategies.

Furthermore, this study can be expanded to include other cities or geographies. Istanbul case has its own local characteristics, decision making processes, space specific features and experiences. To further enrich the existing body of literature in public transport planning experiences in different cities, this research can be utilized as a starting point or a basis for a wider research that involves higher number of case studies.

From that point of view, this study's framework can be used for a comparative analysis that comprises several cities from Turkey. The findings of this study, such as the checklist, can be used and tested by implementing it in other cities. In other words, other cities in Turkey can be analyzed by using the same method of this study. Findings from different cities and experiences can also help refine and further develop this framework for planning and operating an integrated public transport system.

REFERENCES

- Acar, İ. H. (2010). *Yolcu Taşıma Sistemlerinde Bütünleşme: Transist 2010 Ulusal Toplu Ulaşım Sempozyumu ve Sergisi Bildiriler Kitabı.* Istanbul, Turkey. Retrieved from https://www.iett.istanbul/webimage/file/sempozyumlar/Transist2010Bildiri.pdf
- Agarwal, O.P., & Kumar, A. (2015). Institutional Labyrinth: Beyond Establishing Lead Urban Transport Institutions. *Sage Transportation Research Record: Journal of the Transportation Research Board, 2500*(1), 142-148. https://doi.org/10.3141/2500-17
- Akı, M. (2012). *Kentsel Toplu Taşıma Kapsamında Metrobüs Sisteminin Yaya Erişilebilirliğinin Değerlendirilmesi: İstanbul Örneği* (Master's thesis, Istanbul Technical University, Istanbul, Turkey). Available at Turkish Higher Education Institution's theses database. (Thesis No.323685)
- Akinyemi, E. & Zuidgeest, M.H.P. (2000). Sustainable Development & Transportation: Past Experiences and Future Challenges, *World Transport Policy & Practice*, *6*(1), pp. 31-39.
- Arthur D. Little Corporate. (2018). *Report on mobility index: The Future of Mobility 3.0 Reinventing mobility in the era of disruption and creativity* , Boston, Massachusetts, United States of America: Corporate author as publisher.
- Babalık-Sutcliffe, E. (2002). Urban Rail Systems: Analysis of the Factors Behind Success, *Taylor&Francis Transport Reviews*, *22*(4), 415-447.
- Babalık-Sutcliffe, E. (2012). Toplu Taşıma Sistemleri. In T. Kılınçaslan (Ed.), *Kentsel Ulaşım: Ulaşım Sistemi - Toplu Taşım-Planlama-Politikalar*. (pp.127-178), Istanbul, Turkey: Ninova Press.

- Babalık-Sutcliffe, E. (2016). Urban Rail Operators in Turkey: Organisational Reform in Transit Service Provision and the Impact on Planning, Operation and System Performance, *Journal of Transport Geography, 54*, 464-475.
- Babalık-Sutcliffe, E. (2017). Turkey. In D. Pojani&D. Stead (Eds.), *The Urban Transport Crisis in Emerging Economies* (pp.247-267). https://doi.org/10.1007/978-3-319-43851-1
- Beyazıt, E. (2007). *Kent Yaşanabilirliğini Arttıran Yaya Mekanlarının Türlerarası Ulaşım Sistemi İçinde İrdelenmesi: Kabataş Örneği* (Master's thesis, Istanbul Technical University, Istanbul, Turkey). Available at Turkish Higher Education Institution's theses database. (Thesis No.223122)
- Bike Share Toronto. (2019). *Pricing*. Retrieved April 1, 2019, 20.55, from https://bikesharetoronto.com/pricing/
- Can Yüce, E. (2013). *An Assessment of the Planning and Operational Performance of the Bus Rapid Transit in Istanbul* (Master's thesis, Middle East Technical University, Ankara, Turkey). Available at Turkish Higher Education Institution's theses database. (Thesis No. 338283)
- Cervero, R. (1998). *The Transit Metropolis: A Global Inquiry.* Washington, D.C, United States of America: Island Press.
- Cervero, R. (2013). Bus Rapid Transit (BRT): an Efficient and Competitive Mode of Public Transport, *UC Berkeley: Institute of Urban and Regional Development*. Retrieved from https://escholarship.org/uc/item/4sn2f5wc.
- Costa, L. da F., Travençolo, B.A.N., Viana, M.P., & Strano, E. (2010). On the efficiency of transportation systems in large cities. *Europhysics Letters, 91*(1), 1-5. https://doi.org/10.1209/0295-5075/91/18003
- Croci, E. (2016). Urban Road Pricing: A Comparative Study on the Experiences of London, Stockholm and Milan, *Transportation Research Procedia, 14*, pp.253-262.
- de Roo, G., Miller, D. (2000). Introduction - Compact cities and sustainable development. In G. de Roo, & D. Miller (Eds.), *Compact cities and sustainable*

urban development; a critical assessment of policies and plans from an international perspective (pp. 1 - 13). Ashgate: Ashgate Publishing.

- Dişli, Y.E. (2006). *Toplu Taşıma Sistemleri Entegrasyonu ve Şişli Mecidiyeköy Uygulaması* (Master's thesis, Istanbul Technical University, Istanbul, Turkey). Available at Turkish Higher Education Institution's theses database. (Thesis No. 175764)
- Edwards, B. (2011). *Sustainability and the Design of Transport Interchanges*. New York, United States of America: Routledge.
- Eggenberger, M., & Partidario, MR. (2000). Development of a Framework to Assist the Integration of Environmental, Social and Economic Issues in Spatial Planning. *Journal of Impact Assessment and Project Appraisal, 18*(3), 201-207. https://doi.org/10.3152/147154600781767448
- Embarq Türkiye. (2014). *BusLab Istanbul Kadıköy-Kartal Hattı:Kadıköy-Kartal Hattı Boyunca İETT Hatlarının İyileştirilmesi, Etkin Erişilebilirlik ve Türler Arası Etkileşim.* Retrieved March 17, 2019, from https://wrisehirler.org/sites/default/files/BusLab_İstanbul%20Kadıköy-Kartal%20Hattı.pdf
- Erçetin, C. (2014). *Planning and Management of Bike Sharing Systems for Sustainable Urban Transport: Konya, Kayseri and Istanbul Cases* (Master's thesis, Middle East Technical University, Ankara, Turkey). Available at Turkish Higher Education Institution's theses database. (Thesis No.379967)
- file:///C:/Users/User/Desktop/London%20Transportation%20Master%20Plan.pdf. Retrieved March 10, 2019, 14.16
- FitzRoy, F., Smith, I. (1998). Public Transport Demand in Freiburg: Why did Patronage Double in a Decade?, *Transport Policy, 5*(3), pp.163-173. https://doi.org/10.1016/S0967-070X(98)00024-9
- Givoni, M., & Banister, D. (2010). *Integrated Transport: From Policy to Practice.* London, England: Routledge.

- GO Transit: Regional Public Transport Service for the Greater Toronto and Hamilton Area. (2019). *Stations, Stops & Parking*. Retrieved April 1, 2019, from https://www.gotransit.com/en/stations-stops-parking
- GO Transit: Regional Public Transport Service for the Greater Toronto and Hamilton Area. (2018). Your Fare. Retrieved November 10, 2018, from https://www.gotransit.com/en/trip-planning/calculate-fare/your-fare#
- Goldman, T., & Gorham, R. (2006). Sustainable Urban Transport: Four Innovative Directions, *Technology in Society, 28*, 261-273. https://doi.org/10.1016/j.techsoc.2005.10.007
- Goodwin, P. (1999). Transformation of Transport Policy in Great Britain. *Transportation Research Part A: Policy and Practice, 33*, 655-669. https://doi.org/10.1016/S0965-8564(99)00011-7
- Goodwin, P. B., Hallett, S., Kenny, F. and Stokes, G. (1991). Transport: The New Realism. Report to Rees Jeffreys Road Fund. Oxford, Transport Studies Unit. Retrieved from https://www.tsu.ox.ac.uk/
- Gordon, J.B., Koutsopoulos, H.N., Wilson, N.H.M., & Attanucci, J.P. (2013). Automated Inference of Linked Transit Journeys in London Using Fare-Transaction and Vehicle Location Data. *Sage Transportation Research Record: Journal of the Transportation Research Board, 2343*(1), 17-24. https://doi.org/10.3141/2343-03
- Grava, S. (2003). *Urban Transportation Systems: Choices for Communities.* McGraw-Hill, New York.
- Grise, E., Boisjoly, G., Maguire, M. & Ek-Geneidy, A. (in press). Elevating access: Comparing accessibility to jobs by public transport for individuals with and without a physical disability. *Elsevier ScienceDirect Transportation Research.* https://doi.org/10.1016/j.tra.2018.02.017
- Guibourg, C. (2015, October 9). Longest Tube Interchange: 10 Tube Stations Where Changing Lines Takes Longest. *City A.M*. Retrieved August 2, 2018,

from http://www.cityam.com/226215/longest-tube-interchange-10-tube-stations-where-changing-lines-takes-longest

- Guihaire, V. & Hao, J.K. (2008). Transit Network Design and Scheduling: A Global Review. *Elsevier Science Direct Transportation Research, 42,* 1251-1273. https://doi.org/10.1016/j.tra.2008.03.011
- Güngör, A., Öztürk, E. (2017). Otopark Sistemlerinde İstanbul Kart Uygulaması İspark Örneği. *Istanbul Commerce University Journal of Science, 16*(31). 73-84. Retrieved from http://acikerisim.ticaret.edu.tr/
- Haque, M.M., Chin, H.C., Debnath, A.K. (2013). Sustainable, Safe, Smart-Three Key Elements of Singapore's Evolving Transport Policies. *International Journal of Transport Policy, 27.* 20-31. https://doi.org/10.1016/j.tranpol.2012.11.017
- Hrelja, R., Monios, J., Rye, T., Isaksson, K. & Scholten, C. (2017). The Interplay of Formal and Informal Institutions Between Local and Regional Authorities when Creating Well-functioning Public Transport Systems. *International Journal of Sustainable Transportation, 11*(8). https://doi.org/10.1080/15568318.2017.1292374
    - http://webdosya.csb.gov.tr/db/sehirciliksurasi/icerikler/kom-syonraporlar-son-20180226140426.pdf
- HVV: Hamburg Transport Association. (2018). *Line and Route Network Plans*. Retrieved July 13, 2018, 18.45, from http://www.hvv.de/en/timetables/line-route-networks-plans/overview/
- International Energy Agency. (2017). *Tracking Progress: Transport*. Retrieved November 12, 2018, 16.42, from https://www.iea.org/etp/tracking2017/transport/
- Istanbul Electric Tramway and Tunnel Establishments. (2018). *IETT Stratejik Planı 2018-2022*. 55-128. Retrieved February 17, 2019, from https://www.iett.istanbul/tr/main/pages/iett-2018-2022-yil-stratejik-plani/12

- Istanbul Electric Tramway and Tunnel Establishments. (2018). *İstanbul'da Toplu Ulaşım*. Retrieved December 24, 2018, 13.04, from https://www.iett.istanbul/tr/main/pages/istanbulda-toplu-ulasim/95
- Istanbul Electric Tramway and Tunnel Establishments. (2019). *IETT Toplu Ulaşım Ücret Tarifesi*. Retrieved September 10, 2019, from https://www.iett.istanbul/tr/main/pages/iett-toplu-ulasim-ucret-tarifesi/42
- Istanbul Metropolitan Municipality (2009). *1/100000 Ölçekli İstanbul Çevre Düzeni Planı Özet*. İstanbul. 1-12. Retrieved November 21, 2018, 18.04, from http://www.ibb.gov.tr/tr-TR/Documents/ISTANBUL_CDP_GENEL_BILGI.pdf
- Istanbul Metropolitan Municipality Department of Public Transport Services. (2018). *Hakkımızda*. Retrieved December 4, 2018, from https://tuhim.ibb.gov.tr/hakk%C4%B1m%C4%B1zda
- Istanbul Metropolitan Municipality Department of Transport. (2011). İstanbul. *İstanbul Metropoliten Alanı Entegre Kentsel Ulaşım Ana Planı*. 1-377. Retrieved January 14, 2019, from http://www.ibb.gov.tr/tr-TR/kurumsal/Birimler/ulasimPlanlama/Documents/%C4%B0UAP_Ana_Raporu.pdf
- Istanbul Metropolitan Municipality. (2015). *İBB Stratejik Planı 2015-2019*. İstanbul. Retrieved March, 16, 2019, from http://www.ibb.gov.tr/tr-TR/kurumsal/Birimler/StratejikPlanlamaMd/Documents/2010_2014/stratejikplan15_19.pdf, https://www.ibb.istanbul/News/Detail/35052
- Istanbul Metropolitan Municipality. (2017). *İBB Ulaşım Raporu*. İstanbul. 1-116. Retrieved December 31, 2018, 12.55, from https://www.ibb.istanbul/SitePage/Index/176
- Istanbul Metropolitan Municipality. (2018). *İBB'den Otobüs-Metro Arası Ücretsiz Aktarma Hizmeti*. Retrieved March 14, 2019, 22.16, from https://www.ibb.istanbul/News/Detail/35052

- Istanbul Metropolitan Municipality. (2019). *Şehir Haritası*. Retrieved September 5, 2019, from https://sehirharitasi.ibb.gov.tr/
- Istanbul Metropolitan Municipality. (2019). *Yönetim Şeması*. Retrieved August 27, 2019, from https://www.ibb.istanbul/CorporateUnit/Chart
- Istanbul Metropolitan Municipality. *İBB Faaliyet Raporları 2011-2018*. İstanbul. Retrieved December 30, 2018, from https://www.ibb.istanbul/SitePage/Index/176
- İSPARK İstanbul Parking Facilities Trading Inc. (2019). *İspark'tan İsbike Akıllı Bisiklet Projesi*. Retrieved June 28, 2019, from http://ispark.istanbul/projeler/isbike-akilli-bisiklet/
- İstanbul Büyükşehir Belediye Başkanlığı. (2017). Yıllık faaliyet raporu. Retrieved from https://www.ibb.istanbul/Uploads/2018/4/2017-iBB-Faaliyet-Raporu.pdf
- İstanbul Elektrik Tramvay ve Tünel İşletmeleri (İETT). 2008-2017 Yıllık Faaliyet Raporları. Retrieved from https://www.iett.istanbul/tr/main/pages/faaliyet-raporlari/17
- Jeon, C.M., & Amekudzi, A. (2005). Addressing Sustainability in Transportation Systems: Definitions, Indicators, and Metrics, *Journal of Infrastructure Systems 11*(1), 31-50. https://doi.org/10.1061/(ASCE)1076-0342(2005)11:1(31)
- Kaplan, H. (1967). The Toronto Transit Commission: A Case Study of the Structural-Functional Approach to Administrative Organizations. *The Canadian Journal of Economics and Political Science, 33*(2), 171-189. https://doi.org/10.2307/139770
- Kennedy, C.A. (2002). A comparison of the sustainability of public and private transportation systems: Study of the Greater Toronto Area, Kluwer Academic Publishers, *29*, 459-493. Retrieved from https://link.springer.com/
- Lennard, S.H.C., Lennard, H.L. **(**1995). *Livable Cities Observed: A Source Book of Ideas and Images.* Gondolier Press, California.

- London City Hall. (2014). *London Infrastructure Plan 2050*. London. Retrieved August 3, 2018, from https://www.london.gov.uk/what-we-do/business-and-economy/better-infrastructure/london-infrastructure-plan-2050
- Master Plan Report for Istanbul Metropolitan Area Integrated Urban Transportation, Istanbul Metropolitan Municipality, 2011. Retrieved December 3, 2018, from https://www.ibb.istanbul/Uploads/2017/3/iUAP-ozet-Rapor.pdf
- May, A.D., Kelly, C. and Shepherd, S.P. (2006). The Principles of Integration in Urban Transport Strategies. *Transport Policy, 13*(4), 319-327. https://doi.org/10.1016/j.tranpol.2005.12.005
- Metro Istanbul A.Ş. (2019). *Tarihçe*. Retrieved July 30, 2019, from http://www.metro.istanbul/Home/Tarihce
- Metro İstanbul A.Ş. 2012-2017 yıllık faaliyet raporları. Retrieved from https://www.metro.istanbul/icerik/faaliyet_raporlari
- Ministry (former) of Public Works and Settlements. (2009). Kentleşme Şurası 2009: Kentsel Teknik Altyapı ve Ulaşım Komisyonu Raporu. Retrieved from http://webdosya.csb.gov.tr/db/kentges/editordosya/kitap2.pdf
- Ministry of Environment and Urbanization. (2017). Şehircilik Şurası Komisyon Raporları. Retrieved from: https://sehirciliksurasi.csb.gov.tr/komisyon-raporlari-i-6286
- My Transport Sg. (2018). *Available Bus Arrival Time*. Retrieved July 26, 2018, 16.05, fromhttps://www.mytransport.sg/content/mytransport/home/myconcierge/busarrivaltime.html
- My Transport Sg. (2018). *Trunk Buses*. Retrieved July 25, 2018, 15.00, from *https://www.mytransport.sg/content/mytransport/home/commuting/busservices.html#*

- Nal, S. (2008). *Sustainable Transport in City-Regions: The Case of Izmir City Region* (Master's thesis, Middle East Technical University, Ankara, Turkey). Available at Turkish Higher Education Institution's theses database. (Thesis No.176718)
- Ontario Ministry of Finance. (2017). *The Greater Toronto Area in the Map of Ontario Census Divisions, Ontario Population Projections Update 2017–2041, Ontario and Its 49 Census Divisions*. Toronto. 2-4. Retrieved October 23, 2018, 11.32, from https://www.fin.gov.on.ca/en/economy/demographics/projections/projections 2017-2041.pdf
- Organisation for Economic Co-operation and Development (OECD), **(**1997). *Towards Sustainable Transportation.* Proceedings of the OECD, Conference Report of Conference Organized by the OECD and hosted by the Government of Canada, March 24-27, 1996 in Vancouver, Canada. Retrieved from http://www.oecd.org/mwg-internal/de5fs23hu73ds/progress?id=_WbDsYdmYtUs2Gny8fhB86jtdlbWX9YsaO7Pufrg9k4,
- Out-of-station interchanges in London. (2018). Retrieved August 2, 2018, 18.12, from https://tfl.gov.uk/corporate/publications-and-reports/out-of-station-interchanges
- Öncü, M.A. (2007). *Public Transport Improvement Policies: Assessment of the Role of Route and Fare Integration, Modal Reorganization with Special Emphasis to Izmir Case* (Master's thesis, Middle East Technical University, Ankara, Turkey). Available at Turkish Higher Education Institution's theses database. (Thesis No. 217142)
- Park and Ride London. (2018). *All London Underground Stations with Parking*. Retrieved November 13, 2018, 18.30, from http://parkandridelondon.com/London-Underground-Car-Parks/Map-all-parking

- Park and Ride London. (2018). London Underground Oyster Fare Finder. Retrieved November 13, 2018, 18.40, from http://parkandridelondon.com/oyster-fares-calculator
- Parry, I.W.H., & Small, K.A. (2009). Should Urban Transit Subsidies be Reduced? *American Economic Review, 99*(3), 700-724. Retrieved from https://www.aeaweb.org/
- Presidency of Turkish Republic. (1963-2019). *Beş Yıllık Kalkınma Planları*. Ankara. Retrieved December 8, 2018, from http://www.sbb.gov.tr/kalkinma-planlari/
- Richardson, N.H. (1989). Land Use Planning and Sustainable Development in Canada. Ottawa: Canadian Environmental Advisory Council.
- Sampaio, B.R., Neto, O.L., & Sampaio, Y. (2008). Efficiency analysis of public transport systems: Lessons for institutional planning. *Elsevier Transportation Research Part A, 42*, 445-454. https://doi.org/10.1016/j.tra.2008.01.006
- Saraçoğlu, B. (2012). *Toplu Taşıma Sistemlerinin Entegrasyonunda Aktarma Merkezleri: İstanbul Tarihi Kıyı Bölgeleri Örneği* (Master's thesis, Bahçeşehir University, Istanbul, Turkey), Available at Turkish Higher Education Institution's theses database. (Thesis No.341235)
- Sharaby, N., & Shiftan, Y. (2012). The Impact of Fare Integration on Travel Behavior and Transit Ridership, *Transport Policy, 21*, 63-70. https://doi.org/10.1016/j.tranpol.2012.01.015
- Singapore Department of Statistics. (2018). *Singapore in Figures*. Singapore. 4. Retrieved July 24, 2018, 16.13, from https://www.singstat.gov.sg/-/media/files/publications/reference/sif2018.pdf
- Singapore Government Publicly Available Dataset. (2018). *Annual Effective Transfer of Car Ownership by Make.* Singapore. Retrieved November 13, 2018, 19.41, from https://data.gov.sg/dataset/annual-effective-transfer-of-car-

ownership-by-make?view_id=082b602c-6e56-494c-8521-9c6ffe97aa6b&resource_id=289badcc-d458-4348-953e-7324b7f859e1

- Singapore Government Publicly Available Dataset. (2018). Public Transport Utilization: Average Daily Public Transport Ridership. Retrieved November 13, 2018, 18.59, from https://data.gov.sg/dataset/public-transport-utilisation-average-public-transport-ridership?view_id=29dd184a-55e2-4d85-8702-affc46ce7324&resource_id=552b8662-3cbc-48c0-9fbb-abdc07fb377a
- Singapore Government Publicly Available Dataset. (2018). *Transport at a Glance*. Singapore. Retrieved November 15, 2018, 08.20, from https://data.gov.sg/group/transport
- Singapore Land Transport Authority. (2013). *Land Transport Master Plan.* Retrieved July 24, 2018, 16.28, from https://www.lta.gov.sg/content/dam/ltaweb/corp/PublicationsResearch/files/ReportNewsletter/LTMP2013Report.pdf
- Singapore Land Transport Authority. (2018). *Circle Line: CCL-6 Becoming a Full Circle*. Retrieved July 26, 2019, 12.45, from https://www.lta.gov.sg/content/ltaweb/en/public-transport/projects/circle-line.html
- Singapore Land Transport Authority. (2018). Commuting. Retrieved June 21, 2019, 21.12, fromhttps://www.mytransport.sg/content/mytransport/home/commuting.html#Fares_&_Ticketing
- Singapore Land Transport Authority. (2018). *Integrated Transport Hubs*. Retrieved July 26, 2018, 20.22, from https://www.lta.gov.sg/content/ltaweb/en/public-transport/system-design/integrated-transport-hubs.html
- Singapore Land Transport Authority. (2018). *Private Buses*. Retrieved July 25, 2018, 19.00, from https://www.lta.gov.sg/content/ltaweb/en/public-transport/buses/private-bus.html

- Singapore Land Transport Authority. (2019). *Enhancing Physical Accessibility for All*. Retrieved March 31, 2019, 21.37, from https://www.lta.gov.sg/content/ltaweb/en/public-transport/system-design/enhancing-physical-accessibility-for-all.html
- Singapore Land Transport Authority. (2019). *Mandatory Give Way to Buses Scheme in Singapore: How Does the Scheme Work?*. Retrieved March 11, 2019, 20.55, from https://www.lta.gov.sg/content/dam/ltaweb/corp/PublicTransport/img/mandatorybus.png
- Singapore Public Transport Council. (2018). *About PTC*. Retrieved July 25, 2018, 21.20, from https://www.ptc.gov.sg/about/overview
- Singapore Public Transport Council. (2018). *Fare Structure*. Retrieved July 25, 2018, 18.45, from https://www.ptc.gov.sg/regulation/bus-rail/fare-structure
- Singapore Urban Redevelopment Authority (2014). *Master Plan*. Retrieved November 13, 2018, 15.00, from https://www.ura.gov.sg/Corporate/Planning/Master-Plan/Key-Focuses/Transport
- Sinha, K. C. (2003). Sustainability and Urban Public Transportation, *Journal of Transportation Engineering, 129*(4), 331-341. DOI: 10.1061/(ASCE)0733-947X(2003)129:4(331)
- SNC Lavalin. (2015). *Urban Transit Projects Are Shaping the Growth of Canadian Cities, White Paper*. Retrieved November 8, 2018, 15.00, from http://www.snclavalin.com/mwg-internal/de5fs23hu73ds/progress?id=po2XF4As66U4A615ttaMhry2NLwVhf_iZzsIflEFdA4
- Statistics Canada. (2017). *Population size and growth in Canada: Key Results From the 2016 Census*. Toronto. Retrieved October 8, 2018, 11.31, from

https://www12.statcan.gc.ca/census-recensement/2016/as-sa/98-200-x/2016001/98-200-x2016001-eng.cfm

- Susniene, D. & Jurkauskas, A. (2010). Stakeholder approach in the management of public transport companies. *Transport, 23*(3), 214-220. https://doi.org/10.3846/1648- 4142.2008.23.214-220
- Şahin, E. (2016). İETT, İlk 'Akıllı Durak' Projesini Yıldız Teknik Üniversitesi Durağıyla Başlattı. *Web Tekno*. Retrieved May 7, 2019, 21.27, from https://www.webtekno.com/internet/iett-akilli-durak-h16834.html
- Şimşek, S. (2016). *2019 Yılı Hedef Alınarak İstanbul Ulaşım Planında Raylı Sistemlerin Diğer Ulaşım Modlarıyla Entegrasyonu* (Master's thesis, Bahçeşehir University, Istanbul, Turkey), Available at Turkish Higher Education Institution's theses database. (Thesis No.436031)
- Tan, C. (2016, March 10). Bus and Train Ridership Hits New High. *Asia One*. Retrieved November 15, 2018, 22.09, from http://www.asiaone.com/bus-and-train-ridership-hits-new-high
- Tekeli, İ. (2009). *İstanbul ve Ankara için Kent İçi Ulaşım Tarihi Yazıları*. (1st ed.). İstanbul, Türkiye: Tarih Vakfı Yurt Yayınları.
- The Greater Toronto Area in the Map of Ontario Census Divisions (Ontario Ministry of Finance, Ontario Population Projections Update, 2017–2041, Ontario and Its 49 Census Divisions. Retrieved October 23, 2018, from https://www.fin.gov.on.ca/en/economy/demographics/projections/projections 2017-2041.pdf
- The Ontario Metrolinx Agency. (2013). *The Big Move Baseline Monitoring Report*. Toronto. Retrieved November 3, 2018, from http://www.metrolinx.com/thebigmove/en/strategies/strategy5.aspx
- The Ontario Metrolinx Agency. (2014). *2015-2020 Metrolinx Five Year Strategy: Building Tomorrow's Transportation Network Today*. Toronto. Retrieved November 7, 2018, from http://www.metrolinx.com/mwg-

internal/de5fs23hu73ds/progress?id=M6yMknxaMm8-cI7JAYCjzL3h7_yTN4SOiwUeQC-vo2A

- The Ontario Metrolinx Agency. (2014). *2017-2022 Metrolinx Five Year Strategy: Creating Connections*. Toronto. Retrieved November 7, 2018, from http://www.metrolinx.com/mwg-internal/de5fs23hu73ds/progress?id=Vq4leAvClhzQvIyJJpdbQyVwqv-nym9qybiu3Osj8Qo
- The Ontario Metrolinx Agency. (2015). *Transit Fares in the GTHA Today - an Overview*. Retrieved November 6, 2018, 14.25, from http://www.metrolinx.com/en/regionalplanning/fareintegration/Transit_Fares_in_the_GTHA_Today-An_Overview_EN.pdf
- The Ontario Metrolinx Agency. (2017). *GTHA Fare Integration Draft Preliminary Business Case: Draft Report for Discussion*. Toronto. 1-156. Retrieved November 5, 2018, 18.03, from http://www.metrolinx.com/mwg-internal/de5fs23hu73ds/progress?id=4NyF0NhDJxhX4LVoNpC0w8k18UDzSSsHHVjUsjT94D4
- The Ontario Metrolinx Agency. (2017). *GTHA Fare Integration Draft Preliminary Business Case*. Retrieved November 5, 2018, 18.07, from http://www.metrolinx.com/mwg-internal/de5fs23hu73ds/progress?id=4NyF0NhDJxhX4LVoNpC0w8k18UDzSSsHHVjUsjT94D4
- The Ontario Metrolinx Agency. (2018). Metrolinx Overview. Retrieved October 30, 2018, from http://www.metrolinx.com/en/aboutus/metrolinxoverview/metrolinx_overview.aspx
- The Ontario Metrolinx Agency. (2018). *Regional Transit*. Retrieved November 6, 2018, 13.25, from http://www.metrolinx.com/en/regionaltransit/regional_transit_index.aspx

- The Ontario Ministry of Transportation. (2017). *Greater Golden Horseshoe Transportation Plan*. Ontario. 1-69. Retrieved November 16, 2018, 17.00, from https://www.gghtransport2051.ca/wp-content/uploads/sites/18/2016/10/11.29.2017.TransportationProfile_AODA-1.pdf
- The Singapore Ministry of Transport. (2018). *How Your Bus Rides are Better Under the BSEP (Bus Service Enhancement Programme)*. Retrieved November 16, 2018, 22.45, from https://www.mot.gov.sg/transport-matters/public-transport/Detail/how-your-bus-rides-are-better-under-the-bsep/
- Toronto City Council. (2009). *Toronto Walking Strategy*. Toronto. 9. Retrieved November 9, 2018, 14.32, from https://www.toronto.ca/services-payments/streets-parking-transportation/walking-in-toronto/toronto-walking-strategy/
- Toronto City Council. (2017). *Advancing Fare Integration Report for Action*. 1-10. Retrieved November 5, 2018, 12.53 from https://www.toronto.ca/legdocs/mmis/2017/ex/bgrd/backgroundfile-107766.pdf
- Toronto Pearson Airport. (2018). Retrieved October 30, 2018, 12.20, from https://www.torontopearson.com/en/toandfrom/public/##
- Toronto Transit Commission. (2015). *Service Level Review*. Toronto. 1-99. Retrieved November 9, 2018, from https://www.toronto.ca/legdocs/mmis/2015/ex/bgrd/backgroundfile-81914.pdf
- Toronto Transit Commission. (2017). *Operating Statistics*. Toronto. Rterieved November 14, 2018, 19.36, from https://www.ttc.ca/About_the_TTC/Operating_Statistics/2017/section_two.jsp

- Toronto Transit Commission. (2017). *Toronto Transit Commission Annual Report*. Toronto. Retrieved November 15, 2018, 08.15, from https://www.ttc.ca/PDF/About_the_TTC/Annual_Reports/TTC_2017Annual Report.pdf
- Toronto Transit Commission. (2018). *Service Details*. Retrieved November 9, 2018, 16.35, from https://ttc.ca/Routes/General_Information/Service_Details.jspi
- Toronto Transit Commission. (2018). System Map, Interactive Subway Map, Subway and Sreetcar Map. Retrieved November 8, 2018, 08.47, from https://www.ttc.ca/Routes/General_Information/Maps/index.jsp
- Toronto Transit Commission. (2018). *Trip Planner*. Retrieved April 1, 2019, 20.52, from http://www.ttc.ca/Trip_planner/index.jsp
- Toronto Transit Commission. (2019). *Bike Access and Amenities*. Retrieved April 1, 2019, 20.48, from https://www.ttc.ca/Riding_the_TTC/Bikes/Bike_access_and_amenities.jsp, https://bikesharetoronto.com/about/
- Toronto Transit Commission. (2019). Bike-and-Ride. Retrieved November 9, 2018, from https://www.ttc.ca/Riding_the_TTC/Bikes/index.jsp
- Toronto Transit Commission. (2019). *Commuter Parking*. Retrieved April 1, 2019, 21.01, from https://www.ttc.ca/Riding_the_TTC/Parking/index.jsp
- Transit Fares in the GTHA Today: an Overview, 2015, Metrolinx Regional Transportation Agency. Retrieved November 5, 2018, 14.25, from http://www.metrolinx.com/en/regionalplanning/fareintegration/Transit_Fares_in_the_GTHA_Today-An_Overview_EN.pdf
- Transit Link Pte. Ltd. (2018). *How 2 Go*. Retrieved July 26, 2018, 11.38, from https://www.transitlink.com.sg/eservice/how2go/h2g.php
- Transport for London. (2012). *Guidelines for Planning Bus Services. London*. Retrieved August 2, 2018, from http://content.tfl.gov.uk/mwg-

internal/de5fs23hu73ds/progress?id=quHXfbqgObp-z_mWQzPHxhjK7cnh1VESmD9X7faFvHU,

- Transport for London. (2016). *Travel in London Report 10*. London. Retrieved November 15, 2018, 12.45, from https://tfl.gov.uk/corporate/publications-and-reports/travel-in-london-reports#on-this-page-4
- Transport for London. (2018). *Drivers of Demand for Travel in London: A Review of Trends in Travel Demand and Their Causes*. London. 17. Retrieved November 15, 2018, 18.35, from http://content.tfl.gov.uk/mwg-internal/de5fs23hu73ds/progress?id=YsCUgXwwQgLMGx_qE0io_j6pq0ZbM_haRaG421Fwm3U
- Transport for London. (2018). *How We Are Governed*. Retrieved July 30, 2018, 12.55, from https://tfl.gov.uk/corporate/about-tfl/how-we-work/how-we-are-governed?intcmp=2724
- Transport for London. (2018). *Plan a Journey*. Retrieved July 31, 2018, from https://tfl.gov.uk/plan-a-journey/
- Transport for London. (2018). *Standard Tube Map*. Retrieved August 2, 2018, 13.14, from http://content.tfl.gov.uk/mwg-internal/de5fs23hu73ds/progress?id=Xy1ewDeUe_fWBa7esZAAT44e9f0DC4-b3wCj61G8u5M
- Transport for London. (2018). *The Key Bus Routes in Central London*. Retrieved August 2, 2018, 13.22, from http://content.tfl.gov.uk/mwg-internal/de5fs23hu73ds/progress?id=GqxPkSjeUZitgEQKbfbYDMPiyUWloGCIlPTMvsK674
- Transport for London. (2018). *Timetables*. Retrieved July 31, 2018, from https://tfl.gov.uk/travel-information/timetables/
- Triplinx: The Official Trip Planner and One-Stop Transportation Information Resource for the GTHA. (2018). *Trip Planner*. Retrieved November 6, 2018, 13.14, from https://www.triplinx.ca/

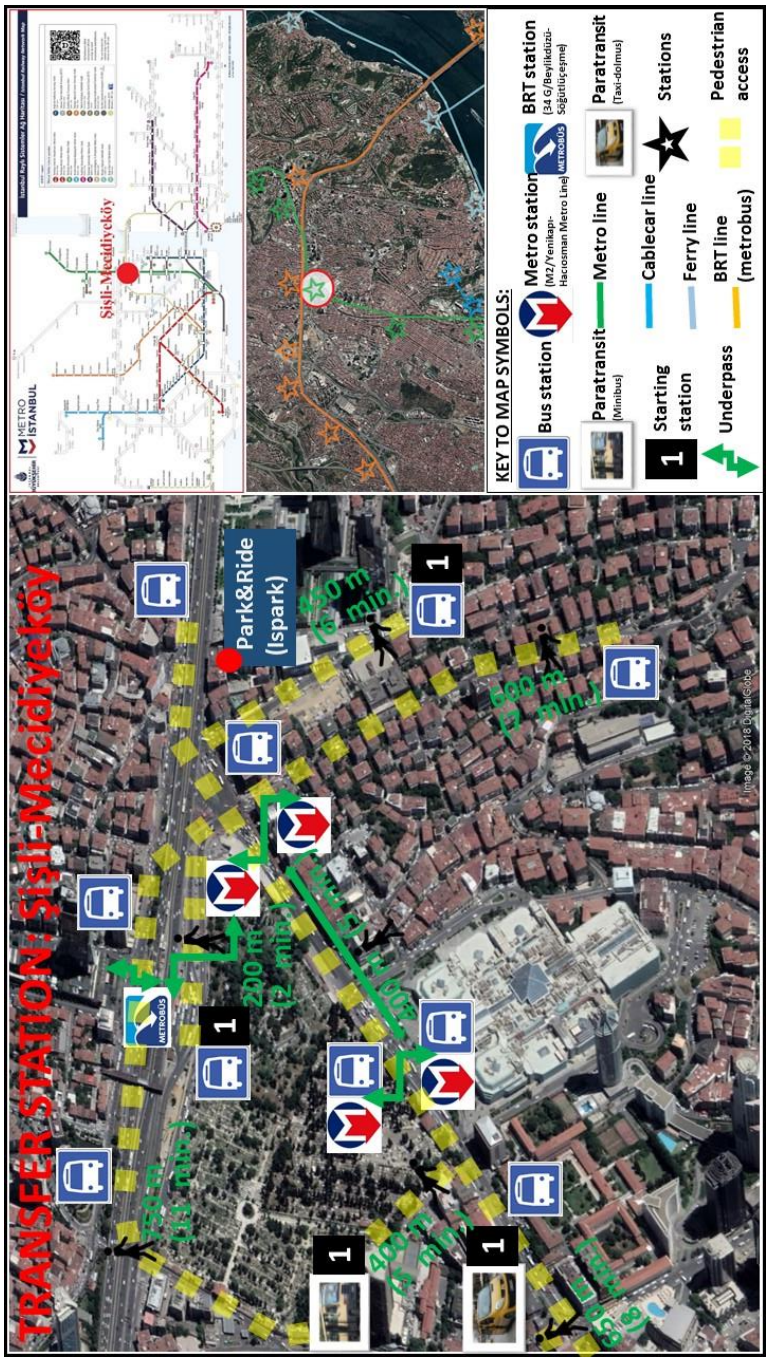
- Trust for London Foundation. (2018). *Demography: London's Population and Geography*. Retrieved July 27, 2018, 19.30, from https://www.trustforlondon.org.uk/data/topics/population-geography/
- Turkish Republic Ministry of Environment and Urbanization. (2009). *Kentleşme Şurası 2009 Kentsel Teknik Altyapı ve Ulaşım Komisyon Kitabı*. Ankara. Retrieved December 25, 2018, from https://kentges.csb.gov.tr/kentlesme-surasi-2009-i-284
- Turkish Republic Ministry of Environment and Urbanization. (2017). *Şehircilik Şurası 2017 Şehirlerimizde Kimlik, Planlama ve Tasarım Komisyonu.* Ankara. Retrieved December 25, 2018, from https://kentges.csb.gov.tr/sehircilik-surasi-2017-i-285
- Turkish Republic Ministry of Transport and Infrastructure. (2005). *Ulusal Ulaştırma Ana Planı Stratejisi 2005-2015*. Ankara. 1-519. Retrieved December 12, 2018, from https://www.bebka.org.tr/admin/datas/sayfas/files/Ulasrma_Ana_Plani_Stratejisi.pdf
- Turkish Republic Ministry of Transport and Infrastructure. (2013). *Ulaştırma, Denizcilik ve Haberleşme Şurası 2013 Sonuç Bildirgesi*. Ankara. 1-40. Retrieved December 14, 2018, from http://www.ubak.gov.tr/BLSM_WIYS/SGB/tr/Pdf/20141013_125213_5643_1_88338.pdf
- Turkish State Railways. (2019). *TCDD Taşımacılık A.Ş. Marmaray Ücret Tarifesi*. Retrieved April 11, 2019, from http://www.marmaray.gov.tr/icerik/sefer/Ücretlendirme/16
- Turkish Statistical Institute. (2018). Temel İstatistikler. Retrieved November 21, 2018, from http://www.tuik.gov.tr/UstMenu.do?metod=temelist
- Ulaştırma Bakanlığı. (2005). Ulaştırma Ana Planı Stratejisi Sonuç Raporu, 2005-2015. Retrieved from

https://www.bebka.org.tr/admin/datas/sayfas/files/Ulasrma_Ana_Plani_Stratejisi.pdf

- Ungemah, D., Rivers, M. & Anderson, S. (2006). The World can be Flat: Case Study of Flat-rate Pricing for Vanpool Operations. *Journal of the Transportation Research Board, 1956*(1), 30-33. https://doi.org/10.1177/0361198106195600104
- Vuchic, V.R. (2005). *Urban Transit: Operations, Planning, and Economics*. New Jersey, United States of America: John Wiley&Sons, Inc.
- Vuchic, V.R. (2007). *Urban Transit Systems and Technology*. John Wiley&Sons, Inc., New Jersey.
- Wheeler, S. (2000). *The Transit Metropolis: A Global Inquiry by Robert Cervero, Berkeley Planning Journal, 14*(1), 133-135. Retrieved from: https://escholarship.org/uc/item/1wh7z9zr
- *Wordpress*. (2013). Singapore Bus Information at a Glance. Retrieved March 11, 2019, 21.40, from https://publictransportsg.wordpress.com/2013/10/01/bus-stops/
- Yaman, Y.C. (2015). *Integration and Coordination Between Regional/Urban Plans and Transportation Plans: The Case of the Rail Transit Investments in Gaziantep* (Master's thesis, Middle East Technical University, Ankara, Turkey). Available at Turkish Higher Education Institution's theses database. (Thesis No.415526)
- Yılmaz, D.Ç., Gerçek, H. (2014). Analitik Hiyerarşi Yöntemi ile İstanbul'da Bütünleşik Bisiklet Ağı Kümelerinin Önceliklendirilmesi. *Pamukkale Üniversitesi Mühendislik Bilim Dergisi, 20*(6), 215-224. Retrieved from http://pajes.pau.edu.tr/jvi.asp?pdir=pajes&plng=tur&un=PAJES-29292

APPENDICES

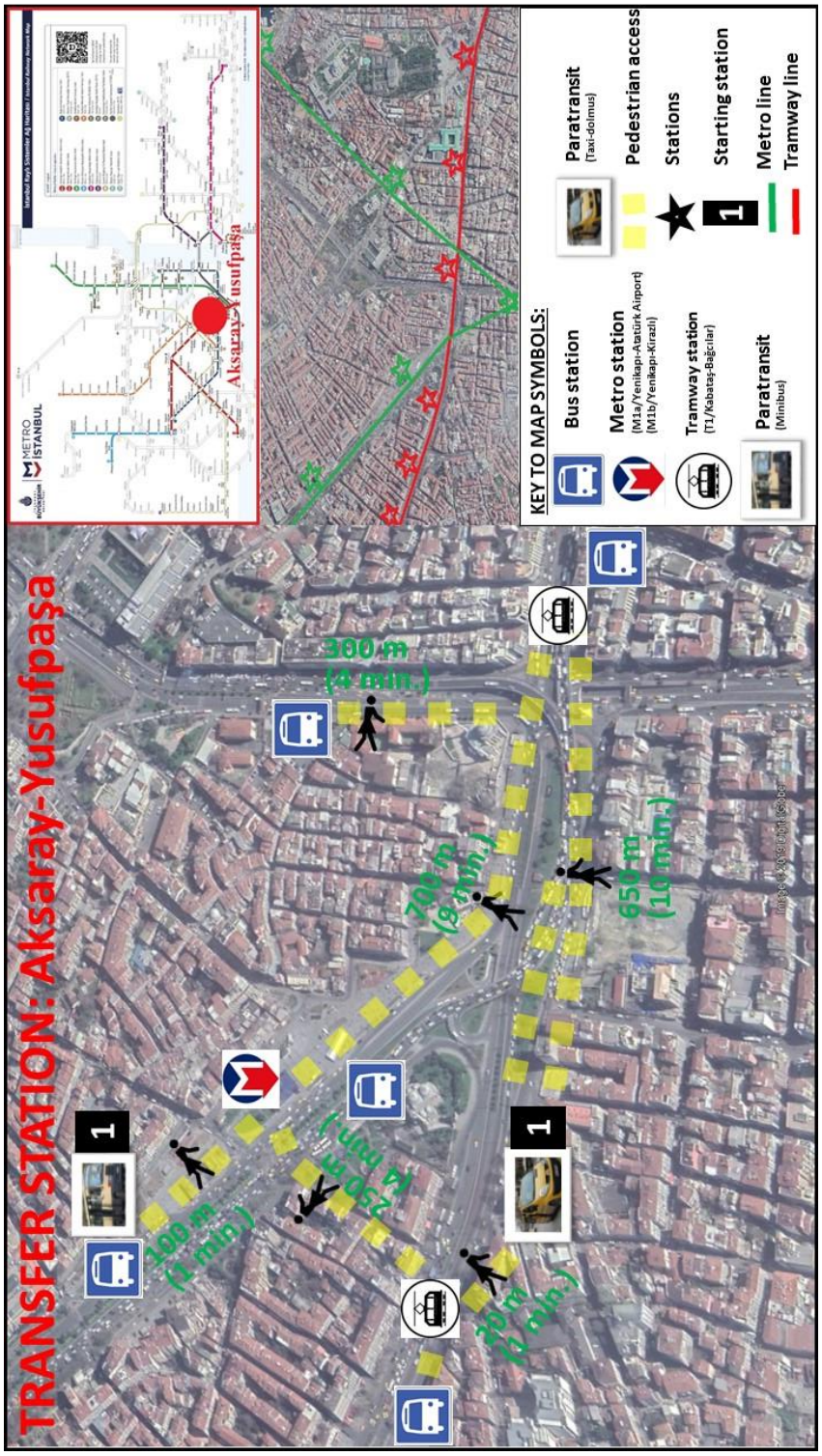
A. The Illustrative Map of Line/Route Integration at Şişli-Mecidiyeköy Transfer Station in Istanbul



B. The Illustrative Map of Line/Route Integration at Zeytinburnu Transfer Station in Istanbul

C. The Illustrative Map of Line/Route Integration at Yenikapı Transfer Station in Istanbul

D. The Illustrative Map of Line/Route Integration at Aksaray-Yusufpaşa Transfer Station in Istanbul



E. The Illustrative Map of Line/Route Integration at Kadıköy Transfer Station in Istanbul