INTEGRATION OF DOLMUŞ AS A PARATRANSIT MODE TO THE EXISTING PUBLIC TRANSPORT NETWORK: ANKARA EXAMPLE

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ABSTRACT

INTEGRATION OF DOLMUŞ AS A PARATRANSIT MODE TO THE EXISTING PUBLIC TRANSPORT NETWORK: ANKARA EXAMPLE

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In recent years, as one of the most important examples of the emerging economies, in Turkey, there has been a significant development in public transport in terms of technology and capacity parallel to economic development. Development of various public transport systems brought along the need for integrated transport systems, i.e. the planning and operation of different transportation modes together to increase the efficiency. Integrated public transport is also a necessity to create an attractive transit alternative, which is competitive to the exponentially increasing private car usage. Any project for an integrated transport system in metropolitan cities of Turkey must recognize the challenges of dolmuş, a paratransit system, without which the creation of a fully integrated system is not possible since it is one of the most important transportation modes, carrying significant shares of passengers in most of the metropolitan cities. However, it is important to provide a better understanding of the role of paratransit mode dolmuş in public transport and accessibility particularly from user's perspective and to analyze whether the presence of paratransit modes create challenges for public transport service quality by hindering integration in routes, services and fares; and to find out how these affect the accessibility of users.

For the evaluation of the paratransit operations, a case specific approach is needed because; each locality has its own tendencies and social dynamics. In order to understand the user perception and to evaluate the user satisfaction about the paratransit mode dolmuş, a survey study, including questions on mode choice and dolmuş, was conducted in METU Campus in November 2014 and May 2015, named as "METU Campus and Transportation Survey". Within the context of the survey study, 623 users were interviewed and depending on the results, survey data was analyzed with a view to understand the usage of dolmuş, its role in campus accessibility, its relation with other modes, and to formulate proposals for integrating dolmuş into the rest of public transport operation by considering both route and fare integration. The aim of this study was to investigate the perception of users about dolmuş, which embodies a high share of the total public transport services in the case of Ankara and to propose possible scenarios for the future of dolmuş in the transportation network.

Keywords: Paratransit, Dolmuş, Transport System Integration, User Perspective

ÖZ

BİR ARA TOPLU TAŞIMA TÜRÜ OLARAK DOLMUŞUN MEVCUT TOPLU TAŞIMA AĞINA ENTEGRASYONU: ANKARA ÖRNEĞİ

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Son yıllarda, büyümekte olan ekonomilerin en önemlilerinden biri olan Türkiye'de ekonomik gelişime paralel olarak toplu taşıma teknolojisinde ve kapasitesinde dikkate değer bir gelişme olmuştur. Çeşitli toplu taşıma sistemlerinin gelişimi, bu çeşitli ulaşım türlerinin verimliliğini arttırmak için birlikte planlanması ve işletilmesi anlamına gelen entegre ulaşım sistemleri ihtiyacını beraberinde getirmiştir. Entegre toplu taşıma, katlanarak artan özel araç kullanımı ile yarışabilir, cazip bir toplu taşıma alternatifi kurmak için de gerekli hale gelmiştir. Türkiye'deki büyükşehirlerde entegre ulaşım ile ilgili her projede bir ara toplu taşıma türü olan dolmuşun yaratacağı sorunların farkında olunmalıdır çünkü birçok büyükşehirde kayda değer oranlarda yolcu taşımasından dolayı en önemli ulaşım türlerinden biri olan dolmuş olmadan tamamıyla entegre bir sistem kurulması mümkün değildir. Ancak, bir ara toplu taşıma türü olarak dolmuşun toplu taşımada ve özellikle kullanıcılar açısından erişimde rolüne dair daha iyi bir kavrayış geliştirmek, ayrıca ara toplu taşıma türlerinin varlığının -entegrasyonu rotalarda, servislerde ve ücretlerde zorlaştırdığından- toplu taşıma hizmet kalitesinde çıkardığı sorunları değerlendirmek ve bu sorunların kullanıcıların erişimini nasıl etkilediğini öğrenmek oldukça önemlidir. Ara toplu taşıma işletmelerinin değerlendirilebilmesi için, örnek saha özelinde bir yaklaşım gereklidir; çünkü her bölge kendine özel eğilimlere ve sosyal dinamiklere sahiptir. Bir ara toplu taşıma türü olan dolmuş ile ilgili kullanıcı algısını ve memnuniyetini değerlendirmek için Kasım 2014 ve Mayıs 2015 aylarında ODTÜ kampüsünde "ODTÜ Yerleşke ve Ulaşım Anketi" adıyla, tür seçimi ve dolmuş ile ilgili sorular da içeren bir dizi anket çalışması yapılmıştır. Anketler kapsamında, 623 kullanıcı ile görüşülmüş ve bu anket verileri dolmuşun kullanımı, kampüse erişimde rolü, diğer toplu taşıma türleriyle ilişkisini anlamak ve mevcut toplu taşıma ağına –hem rota hem de bilet entegrasyonunu dikkate alarak- olası bütünleştirme önerileri geliştirmek üzere analiz edilmiştir. Bu çalışmada amaçlanan, Ankara örneğinde tüm ulaşım hizmetlerinin önemli bir kısmını bünyesinde toplayan dolmuş ile ilgili kullanıcıların algısını araştırmak ve ulaştırma ağı içerisinde dolmuşun geleceğine dair olası senaryolar önermektir.

Anahtar Sözcükler: Ara toplu taşıma, Dolmuş, Ulaşım Sistem Entegrasyonu, Kullanıcı Bakışı

Dedicated to my mother and father…

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LIST OF ABBREVIATIONS

AGT	Automatic Guideway Transit
AMANPB	Ankara Metropolitan Area Planning Bureau
BRT	Bus Rapid Transit
CBD	Central Business District
CNG	Compressed Natural Gas
EGO	Ankara Electricity, Gas and Bus Operations Organizations
ITS	Intelligent Transportation Systems
LRT	Light Rail Transit
METU	Middle East Technical University
OECD	Organisation for Economic Co-operation and Development
SPSS	Statistical Package for the Social Sciences
TL	Turkish Lira
UKOME	Municipality Transportation Coordination Centers
UN	United Nations
US	United States

CHAPTER 1

1. INTRODUCTION

1.1. Context and Problem Definition

In the 21st Century's metropolitan city, public transport is the vital element to attain a sustainable urban environment. Against increasing private car ownership rates and related to that, sprawling urban macroforms, the most influential tool that can be used by transportation planners is the encouragement and improvement of public transport. For the developing country cases paratransit, which represents all types of travel that falls between privately operated cars and conventional transit (Vuchic, 2007), should also be emphasized. Paratransit modes in developing countries (and in some cases developed countries for short periods) have been in use to meet public transport demand since the beginning of the early 1900s. In the developing country context, paratransit modes often emerged to meet the mobility need of rural migrants in urban areas, who generally settled in neighborhoods that were not well served with existing public transport systems. In time, paratransit systems increased their role in urban transport and became one of the main transport modes in the cities, used by most citizens. It has often been argued that with the development of high-quality public transport systems, the role that paratransit systems play would diminish as the need for them would decrease, and that they would eventually disappear. This has not been the case in many developing countries however: paratransit systems continue existing in most developing countries, including Turkey, despite the development and expansion of new public transport systems, including urban rail and bus-based solutions. Although paratransit continues to exist together with newly developed public transport systems, there emerge problems of fragmentation since these privately operated services often compete with other public transport systems rather than complement and integrate with them. Considering both these fragmentation problems and the technological advances that make smart and integrated ticketing possible, there is clearly a need for the restructuring of paratransit operations. One of the options for the restructuring of paratransit operations are the cancellation of paratransit systems from the network entirely. Nevertheless, most authors argue against this option emphasizing the innovative and attractive attributes of paratransit systems from both users point of view and from the point of view of offering a diversity of travel options. Indeed certain characteristics of paratransit as a significantly flexible transportation mode against conventional substitutes, provide many advantages to the users in the network. Especially in the developing world cases emergence and continuity of these systems can only be explained with these advantages they offer to their users. Besides, the policy to cancel all paratransit systems and to replace them with conventional transportation modes may not be an ideal or realistic approach, as urban transport policy and planning challenges in the developing world differ significantly from those found in urban areas of the developed world, as do the resources to address the movement needs of such cities (Dimitriou & Gakenheimer, 2011, xvii). Rather than eliminating paratransit operations altogether, to understand the needs and the perceptions of the locality is required. For developing that kind of understanding for transportation, to emphasize the mobility needs, accessibility opportunities, concerns and expectations of the users, as one of the most important stakeholders, is a necessity. As public transport is a public service, which is bought by the passengers compulsorily everyday, the user (passenger) perspective at the very first hand should be evaluated in detail for further policy proposals.

1.2. Aim/Research Questions

The aim of this research is to provide a better understanding of the role of paratransit in public transport and accessibility particularly from user's perspective and to analyze whether the presence of paratransit modes create challenges for public transport service quality by hindering integration in routes, services and fares; and to find out how these affect the accessibility of users. The approach that is based on user perspective can provide insights on which service characteristics of paratransit are valued by transit users and the reasons behind mode choice decisions of those users who prefer paratransit systems. Based on these findings it is possible to discuss how users may be affected by the complete removal of paratransit services from public transport systems. Through the results of this analysis, possible policy options in restructuring paratransit can be defined and formulated. The hypothesis is that, even though many of the experts in the field defend the cancellation of dolmuş operations, because of the dominance of dolmuş services in transportation network in many metropolitan cities, it is a necessity to conduct a study on the future of dolmuş. Besides, as it will be shown throughout the study, development of transportation networks are quite parallel with the development of urban form. This relationship is directly connected with the social breakpoints like migrations, wars and global crises, which are the major effects on development of the society throughout the history. That is why, to create an approach based on the relationship of transportation and societal impacts would result in an in-depth and context-specific understanding of the transportation issues and problems and would enable a better understanding of the contemporary situation with an in-depth perspective. Dimitriou (1990, 70) indicates the importance to develop an approach on transportation with a social science perspective with the following statement:

> *Social science disciplines by their very nature, tend to view problems of urban transport from a much wider standpoint than either the economist or engineer. They are, for example, more likely to be concerned with social and community impacts of transport on the poor and other underprivileged groups, the use of transport in serving basic needs, and the impact of transport as an agent of urban development (Dimitriou, 1990, 70).*

In brief, it would not be wrong to state that, this study does not evaluate the efficiency of public transport and the relation of paratransit systems issue from a technical perspective. Instead, the approach that is adopted covers the economic, statistical, social and spatial aspects of the paratransit systems and public transport network.

1.3. Methodology

For the evaluation of the paratransit operations, a case specific approach is needed. As stated previously, each locality has its own tendencies and social dynamics. That is why developing a comprehensive, worldwide-accepted approach is not possible for the re-structuring of a transportation service specific to certain geographies and economies. As Turkish public transport network is going through a metamorphosis in the last 20 years in terms of technology and data gathering processes, and additionally, mostly the metropolitan cities are suffering from increase in private car usage, lack of system integration and relatively high public transport fares; the capital city Ankara is chosen for the case study.

The analysis comprise a detailed historical overview of the emergence and presence of the paratransit mode in Turkey, which is known as “dolmuş”. In addition to this country-wide analysis, transport history of Ankara, with particular emphasis on developments in public transport and in paratransit systems, is analyzed. Preliminary findings, namely characteristics of paratransit in developing countries in general, the transportation history of Ankara and changes in users’ modal split, showed that there is a need for a research on the reasons regarding the increasing share and role of paratransit dolmuş in Turkish cities, and in Ankara in particular, since paratransit operations appear to have gained strength in the last years despite major public transportation investments in the city, including metro lines. In spite of the current shares of dolmuş in urban transport, it should be noted that many experts in Turkey are addressing paratransit operations as archaic and outdated transportation options. To investigate the reflection of that thought about paratransit on users was quite important before a policy proposal. Consequently, the study focused on a travel survey implemented on students of a major university campus, Middle East Technical University (METU) campus in Ankara. At that point it is important to indicate that, the reason for the decision on a sample consisting of only students was to understand the perceptions of a more transit dependent user group on high public transport costs of private operators. The survey, which included a number of questions on mode choice and dolmuş in accessing the campus, was carried out as a part of a more comprehensive study on developing sustainable mobility options for the METU Campus.

The results of the survey is evaluated in two parts. In the first part, descriptive statistics regarding user characteristics, mode choices, expectations on possible future investments are presented. Additionally, users' travel time and ticket cost values are deducted for their commuting trips. In the second part of the survey evaluation, depending on that last part of the descriptive statistics, an in-depth analysis is made on time savings and additional ticket costs. This part of the analysis aimed at understanding the reasoning behind the high modal share of paratransit operations even on main metro corridors in Ankara. Apart from this, an in-depth-interview is conducted with a paratransit operator about the operator costs in Ankara. The findings of this in-depth interview on operator costs and the previous findings on time savings and ticket costs are merged to formulate a scenario for the integration of paratransit mode to public transport systems.

1.4. Structure of the Thesis

The thesis is organized in seven chapters. Following this chapter of introduction, the Second Chapter introduces definitions of public transport and the role of paratransit modes in urban mobility. This is followed by Chapter 3, which presents a detailed literature on paratransit in the world, together with advantageous characteristics of this mode and the challenges it creates for urban transport. Policies adopted worldwide in dealing with paratransit operations are also discussed in this chapter. Following this universal context, Chapter 4 focuses on the case of Turkey. Firstly, a brief history of dolmuş operations in Turkish context in general is presented. Secondly, this chapter focuses on an in-depth analysis of the historical development of Ankara transportation network. Another discussion in this chapter is the contemporary discussions on the future of dolmuş. Chapter 5 focuses on the accessibility to METU Campus in Ankara and presents the findings of the survey conducted on students. Descriptive statistics covering the responses of the users in campus about modal split, perceptions on existing transportation network and expectations on possible future investments are presented. Furthermore, based on the answers travel time-ticket cost and distance relationship is investigated. The following is Chapter 6, which represents the joint evaluation of travel time and ticket cost in aggregate totals. Besides, the results of an in-depth interview with a dolmuş operator are presented. A new ticket pricing approach is also emphasized in this chapter. Finally, Chapter 7 presents the main findings of the study together with recommendations for possible policies in addressing the dolmuş phenomenon in Turkey. Last chapter is concluded with a suggestion section on future research about the possible challenges on transport system integration and paratransit modes.

CHAPTER 2

2. PUBLIC TRANSPORT AND THE ROLE OF PARATRANSIT

2.1. Introduction

Globally, there is an increasing trend of urbanization and urban population rates. The share of the urban population is higher than rural population as of today. 54 percent of the world's population reside in urban areas and the annual increase in urban population growth is about 2.1% annually on average in the world (UN, 2014; World Bank, 2015). More importantly, the world's cities with more than 500,000 inhabitants grew at an average annual rate of 2.4%, which is higher than the average growth rate. While urban population is increasing dramatically, one of the most important needs in urban areas is the mobility need of urban population. Two main elements meeting this mobility need are private vehicles and public transport. For those two elements, it is important to indicate that motor vehicle ownership increase rates are higher than world's population growth rate (Dargay et. al., 2007). That lays a great burden on urban areas in terms of environmental impacts and fossil fuel constraints. In the present time, ever-increasing car ownership -especially in metropolitan areas- have many negative externalities in terms of economic sustainability (fossil fuel dependency), social sustainability (unequal accessibility for different groups in the society) and environmental sustainability (increasing carbon emissions and consequently climate change). These externalities show that it is inevitable to change the current trends towards private car usage in order to reach a sustainable transportation network; and to do this it is necessary to promote public transport rather than private car usage. As the basic element and backbone of urban transportation, public transport has continued its existence since the 19th century. There are various policies to support and encourage public transport, some of which are to construct new systems with high capacity, quality and reliability, to increase service quality (frequency, reliability, safety, speed etc.) of the existing transportation services, to regulate ticket prices of public transport in affordable and attractive levels for all users. Another important policy is the integration of transportation operations in the city. Both OECD conference in 1996 and the Charter of Stockholm by Council for European Urbanism indicated that integration of all transportation systems in terms of mode, travel time, integration points and smart ticketing is a requirement for sustainable transportation (Kaplan, 2009). As private vehicles provide a transportation service that is door to door, convenient and comfortable, quite fast because of the low out-of-vehicle distance compared with other modes; to create a public transport network which has the capability to compete with private car usage is difficult. Actually, integration of all urban transportation modes can provide cheap, convenient and comfortable travel opportunity on the one hand and enables the accessibility of a great data, which would help the solution of probable future problems on the other hand. Besides, by 2050, 66 per cent of the world's population will be living in urban areas (UN, 2014). That is why; it is a necessity to develop a new perspective for a sustainable transportation network. As stated by Rodrigue et al. (2006), with the developing technology, transportation systems are not durable and are quite open to the changes because of social, economic, environmental changes. This diverse structure of urban transportation services is better to be emphasized in that manner.

Within this framework in this chapter, firstly, the definition of public transport will be made and a conceptualization will be developed. After that, the need for transport system integration will be emphasized in detail. In the last part of the chapter, paratransit modes, as one of the components of public transport, will be reviewed by explaining the role of these systems in urban transport together with their advantages and challenges.

2.2. Definition of Public Transport

Public transport is an urban transportation service, which serves the urban population. There are six main features to define an urban transportation system as "public transport". According to Babalık-Sutcliffe (2012, 127) for a transportation mode to be considered as public transport, the following conditions should be met:

- It should be accessible to everyone (with a payment for the journey)
- It should enable journeys made by different passengers at the same time
- It should operate on a pre-determined route
- It should have a certain price
- It should have pre-determined stations which are basically access points to the system
- It should have a pre-determined schedule, which includes service frequency and times (sometimes flexible)

In the light of these six features; public transport (sometimes referred to as transit) could briefly be defined as a transportation service which is run by the public authority with a pre-planned time-schedule and service frequency, on a pre-planned route with certain station points, with a certain price sometimes depending on the distance enabling more than one journey at the same time (Grava, 2003; Vuchic, 2007; Babalık-Sutcliffe, 2012).

Public transport consists of various transportation modes namely; the commuter rail systems, light rail systems, heavy rail or metro systems, buses, minibuses, ferries etc. As there are many modes in urban areas, it is quite important for these modes to operate together. No transportation mode is capable to reach every location in the city. Especially rail systems that need high-density urban areas for the efficient operations are not suitable to serve fringe areas with low density. Therefore, integration of modes is crucial. To give an example, metro systems on the main corridors should be operated together with feeder bus and minibus services on the secondary roads; ferry systems in the sea transportation is better to be integrated with land transportation systems like rail, bus or minibus for the cities around rivers or sea. That is why in the upcoming section of this chapter, integration of modes will be explained in detail.

2.3. The Need for Transport System Integration for Efficient Public Transport

Public transport services have different schedules, different routes, different capacities and different payment methods. Transport system integration means the involvement of all entities of transport (rail, road, water etc.) within a single operation for the efficiency of the entire network and for the benefit of the users.

Full integration of transit systems emerged under the title of Transit Federation during the mid-1960s in Hamburg firstly. As it is explained by Vuchic (2007, 439), the motivation of the experts was to create a transit system which provides a direct travel opportunity with a single payment for a rich coordination among different lines and with these improvements to annihilate the disadvantages of the transit against the private car usage. In order to solve the problems that cause a disadvantageous position for transit modes over car usage, a single information system, a single payment system and reasonable or free transfer fees were planned for an integrated, multimodal travel. Furthermore, Givoni and Banister (2010, 5) mentions that integration within the transport network often relates to the terms "multimodal" and "intermodal", which are used interchangeably, but in general reflect the use of more than one mode of transport within one journey (of passengers or good) and/or the consideration of more than one mode of transport (e.g. in transport policy). In the literature, there are many researches, which are showing that a single mode is unable to create an optimal system (Cervero, 1998; Grava, 2003; Vuchic, 2007; Givoni and Banister, 2010). Since, every transportation option meets different types of travel demand, it is necessary to have them all in transportation network to create an efficient system (See Figure 1).

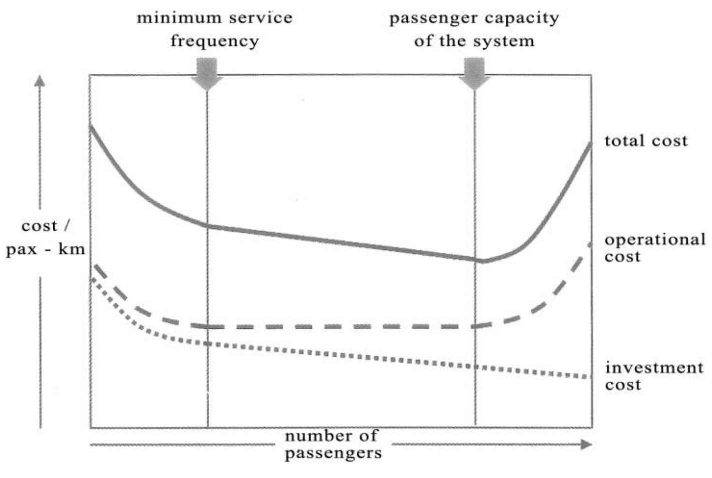

Figure 1. Number of Passengers-Cost Relation in Transportation Systems (Elker, 2012, 247)

The needs for the mobility vary so much that an optimal transportation system can be created only by responding to all these different requirements.

> *…The wider the range of transport modes offered and the greater the spectrum of income brackets accommodated, the more effective the transport system; and that diversity reflects the response to changing transport demands of different urban areas and groups. Many Third World city officials, however, do not consider diversity an asset (Dimitriou, 2011, 142).*

In practice, integrated transport systems are difficult to establish and manage. Nevertheless, local decision makers have to be aware that supporting integration projects finally results with better accessibility, cheaper fares and consequently with increased public utility in terms of public transport. Some of the roles of the local government during this process could be giving subsidies to the local transport operators for integration or introducing smart card integration for ticketing. In the 21st Century, transport system integration is already on the agenda of both developed and developing countries. Surely, the process of system integration is quite difficult for the decision makers especially in the developing world examples. In the developing world cities, there is mostly a lack of responsibility sharing between the local service providers and the local governments. As stated by Cervero, (1998), normlessness of the transportation network -especially in the metropolitan cities namely New Delhi, Cairo or Istanbul- mostly results in the deficiency in equilibrium of transportation network depending on the local needs. For example, in Bangkok, Thailand, there are large numbers of groups who are operating the transport services. Until the recession hit in early 1997, three different rail transit projects, each sponsored by a different federal ministry, were proceeding along toward implementation in hopes of relieving Bangkok of its worsening traffic nightmares (Cervero, 1998, 38-39). However, it is possible to see many implementation projects in terms of system integration. As again stated by Cervero (1998, 277/292), in the beginning of the 1970s the officials of Curitiba realized that fragmented public transport services in Curitiba was one of the pioneer reasons of vehicle ownership increases. By the lead of mayor Jaime Lenner, city officials introduced an integrated public transport project in 1974. Between the years 1974-1994 this project has been so successful that a survey in 1991 showed that Integrated Transport Network reduced automobile usage by some 27 million trip per year. In Istanbul too, there is a fragmented structure in terms of public transport provision, and the physical integration of different public transport systems is often referred to as a major problem (Gerçek & Demir, 2008; Hennig, 2011; Babalık-Sutcliffe, 2016). There is a comprehensive smart card system however, bringing together various different operators, including privately operated individual bus operators. Nevertheless, operation of dolmuş, the paratransit mode in Turkey, is not included in this smartcard system, significantly hindering the effectiveness of the fare integration implementation. This issue in Turkey is to be explored in more detail in the upcoming parts of this study.

Especially, in countries, which have a transportation network dominated by private and small scale operators, it is much more difficult to manage the expectations of different stakeholders. This fragmented structure mostly results with an inefficient and expensive transportation network. In the beginning of the 21st Century, most of the developed world cities have created their own transit federations to optimize their own systems. London, Paris, Hamburg were some of these cities (Vuchic, 2007, 439). Some developing country cities have also created transit authorities to oversee the operation of public transport; however, institutional fragmentation still exists in many cities, hindering the coordination of services (Cervero, 2013; Dimitriou, 2011, 8-39) and this applies to the transport services too. Public transport services in developing country cities are often characterized by private and small-scale operators, which present severe challenges for transit authorities in their projects for integrated transport. In particular "jitneys and minibuses are the mainstays of the transit network" in many developing countries (Cervero, 1998, 15) and these services that are privately operated by individuals on a profit-making motive can create fragmentation in overall transport policy and operations. To provide a better understanding of the nature of this challenge in developing country cities, the following section provides a review of paratransit services both from a universal perspective and in the case of developing world cities.

2.4. Paratransit as a Public Transport System

It has been described above that public transport consists of various different modes, and the most commonly referred ones are commuter rail systems, heavy rail or metro systems, light rail and tram systems, buses, trolleybuses and ferries. However, in many cities in the world, there are “other” modes in addition to these main categories, and these should not be overlooked as in many cases they carry significant proportion of public transport passengers. Transportation experts categorize these “other” modes under the title of paratransit (which means through transit). In the literature, there are different words that have the same meaning with the paratransit. Informal transit, demand responsive transit, low cost transport, third-world transport, light vehicle transport, intermediate public transport, unconventional forms of public transport, the unincorporated sector of public transport etc. (Cervero, 2000; Wright, 1986; Adam Smith Institute, 1980; Vuchic, 2007; Iles, 2005 cited in Toker-Özkurt, 2014).

Cervero (2000, 3), defines specifically the developing country examples which are different from the private and public transport and explains them with the following statement:

> *…these privately operated, small-scale services are varyingly referred to as “paratransit”, “low-cost transport”, “intermediate technologies”, and “third-world transport”. The term adopted in this study is “informal transport”, for this term best reflects the context in which this sector operates –informally and illicitly, somewhat in the background, and outside the officially sanctioned public transport sector.*

Cervero indicates that informal transport term mostly refers to the informally emerged, mostly unregulated, developing country transportation types. From a different perspective, according to Wright (1986, 9);

> *Paratransit, the term applied to small passenger transport vehicles operating informally on a fare-paying basis, often is a valuable supplement and in some places an alternative – to regular bus transit services. Paratransit systems are characterized by the variety of services they offer. These may include: (a) personalized door-to-door service; (b) shared service with routes determined by individual passengers; (c) regular service along fairly well-defined routes (similar to bus transit).*

In addition to the above explanations, Vuchic (2007, 501) also offers a comprehensive definition, which is as follows:

> *The broadest but rather imprecise definition is that paratransit represents all types of urban passenger travel "between" the privately owned and operated automobile on the one hand, and conventional transit with fixed routes and schedules on the other. By that definition paratransit covers taxis, jitneys, dial-a-ride, and subscription commuting services but also car rentals and car pools.*

The differentiation of the modes varies by countries. Nevertheless, it should be noted that paratransit in general, is not a transportation mode which only emerges in the relatively less developed countries. There are variations of paratransit modes in the developed countries too.

An important point about the paratransit is its relations with the public transport modes, which may be operating on the same or parallel routes in many cases, hence creating a competition between systems rather than offering services that complement each other. Especially in the developing world, private entrepreneurs are the operators of paratransit systems and, as explained in detail in the upcoming chapters, that characteristic creates significant challenges for public transport services. Cervero (1998, 387-388) points out the real problem about this disintegration with the following statement for the case of Mexico City:

> *Where the intermediate carriers falter, especially when compared to privately operated paratransit feeders, is with respect to service and fare coordination. There are no obvious efforts to synchronize timetables, though, since Metro services tend to be so frequent, this is not a serious concern. However, the lack of fare integration is. Though tariffs are relatively cheap, multiple fare payments can be quite burdensome to Mexico City's millions of daily transit-dependent customers.*

To understand and to analyze the paratransit modes, a detailed analysis about the existence, development and current characteristics, which create this disintegration problem with the current network, is necessary. Especially in developing countries like Turkey, paratransit covers a significant share of the passenger transport. That is why developing countries' officials need to address paratransit to create a totally integrated public transport network in their metropolitan cities. The incorporation (and thereby recognition) of the roles of the informal and traditional sectors of transport is necessary -in a manner whereby both contribute positively to an integrated and financially more viable urban transport system (Dimitriou, 1990, 26-28).

The limited adaptability of the conventional public transport modes, particularly that of regular bus services, results in the unsatisfaction of the users in the urban transportation network. Especially in the developing world cities, the lack of comprehensive transportation policy making results in inadequate service frequency, poor accessibility and more importantly expensive conventional transport options. On the other hand, in the existing situation private and public transit options create an equally challenging operational environment, damaging each other's performance. For a successful analysis, comparison studies are necessary between the conventional and non-conventional public transport options on the one hand and between the public transport and private transport on the other hand. Uncontrolled urban form and related to that car-dependent cities in developing countries especially in the last 30 years are two big challenges about sustainable urban development (Cervero, 2013). Different public transport services operating parallel to each other diminishes the efficiency of the total transport network and creates urban traffic especially in the peak hours that results in a derived demand for the private cars. Paratransit operators, which emerge because of the shortcomings in public transport network, after securing their position, mostly claim main public transport corridors of high-demand and damaging the operations of the conventional public transport modes. That is why the transit system is never fully integrated without addressing the paratransit services and finding mechanisms to integrate them into the public transport network and services. Dimitriou (1990, 113) underlines the importance of that coordination stating that:

> *The concept of co-ordinating complementary modes is most applicable to the Third World in respect of the formal and informal systems as advocated by Soegijoko (1986) on the basis of research findings in Indonesia. Informal systems, especially when using very small vehicles, are best suited to serving*

those areas which larger vehicles cannot reach, providing a facility for short-distance trips, and for those in which some special facility is required (for example, luggage space).

With this awareness, it is obvious that paratransit vehicles should be coordinated with the conventional buses and metro services for the efficiency of the system. Furthermore, public transport from a sustainable urban development framework is the essential part of transportation network and including paratransit vehicles into the existing network would diversify the public transport options –especially in the developing countries- substantially. It is important to keep in mind that the integration process is quite important to create a successful operation. With the help of land use analyses, Intelligent Transportation Systems (ITS) applications and case specific negotiations, decision makers have to introduce integration projects. Paratransit systems as they exist in developing and in developed world should be analysed and with the help of up-to-date integration methods of the 21st Century technological improvements. In transit system integration, three different stakeholders exist: users, i.e. passenger, operators and decision makers. The advantages and challenges of paratransit should be considered from these three stakeholders' point of view. The strict analysis methods of transport planning and engineering are unable to elaborate the true analysis of the paratransit modes on their own. That is why historical and sociological assessment should support the technical analyses about paratransit systems in developing countries. That means an investigation of the inefficiencies of the existing conventional public transport network and the emergence and existence of paratransit in different geographies in the world. Only after that analysis, it would be possible to understand whether paratransit modes are the expired residuals of the existing network or whether they are still meeting the demand of the public especially in specific locations.

CHAPTER 3

3. PARATRANSIT SYSTEMS IN THE WORLD

3.1. Introduction

In the literature, most authors and sources state that the origins of paratransit systems go back to the beginning of the last century in which motorized vehicles production became widespread. Iles (2005) emphasizes that, disproportionate development of the urban population compared with the conventional public transport service capacity inevitably resulted with the public transport service deficiency in terms of flexibility, convenience and comfort. Private operators could meet this lack of sufficient public transport service and that gave birth to paratransit operators in countries experiencing urbanization intensely (Tekeli, 2010; Iles, 2005; Cervero, 2000). In the last six-seven decades, paratransit operators adapted themselves in surprising ways and even if conventional public transport service became sufficient, they continued their operations and evolved in many forms.

This chapter provides a general overview of paratransit, which is one of the most dominant modes in the transportation networks of cities especially in developing world. Paratransit modes are self-generated and self-sufficient, having emerged as services that are not dependent on operating subsidies. It would not be wrong to say that as in the nature, the transportation networks create their own survival of the fittest mechanism and the paratransit has proved to be a survivor of the system. The term paratransit will be used in this study to explain these particular transportation modes, which aligns between public transport and private cars (Grava, 2003, 255).

The “para” prefix means “through” linguistically. Therefore, it would not be wrong to say that the term paratransit best contains the transportation modes, which fall outside the public transport and private transport titles. In the first section of this chapter, characteristics of paratransit and general issues regarding its operation will be examined in detail. Throughout the chapter, comparisons are provided with the conventional modes of transport. This comparison is important to understand the emergence and existence of the paratransit modes in the transportation network. A systematic evaluation of paratransit modes is quite difficult as stated by Grava (2003, 234) who describes studies on paratransit as trying to hit a moving target, which is extremely fuzzy around the edges. In the next section of this chapter, firstly the most common paratransit operations in the world of paratransit will be defined and explained. Then, advantageous and challenging characteristics of those common operations will be emphasized in detail. This will be followed by a section on urban transport policies for dealing with paratransit modes in general. In the conclusion part, there will be an introduction of Turkish Paratransit examples and the chapter will conclude with a brief introduction to the problem of integration of paratransit modes to the existing transportation network.

Before presenting the characteristics of paratransit systems, some main points about paratransit should be clarified to conceive a better understanding of the concept. Paratransit, as a transportation mode represents the creativeness of the vulnerable groups in reality. From Africa to Asia, America to Europe there are different forms of paratransit services. The difference between developed and developing economies resulted because of the economic policies performed in the last decade. For developed countries, a system was created in which legality and legitimacy is the basis. Emergency exits were left outside of this safe system. That rasped the creativity and the ability to design the future especially of the vulnerable groups (Işık & Pınarcıoğlu, 2013, 74). For the very reason, paratransit system developed according to the frontiers composed by their governments. Nevertheless, for the developing country cases like other informal sectors in the city namely street vending and squatter settlements, paratransit vehicles constituted their own reality in different forms. This kind of innovation occurred from grassroots, created a different structure in terms of housing, service sector and transportation. The following section aims at providing a general overview of the characteristics of paratransit systems in the world; however, as will be seen in the next part, the more researchers get inside the paratransit subject the more complicated it gets. For that reason, starting from the main characteristics of paratransit that are common in most parts of the world is necessary and the next section will focus on that issue.

3.2. Main Characteristics, Advantages and Challenges of Paratransit Systems

As explained in the previous chapter, there are different definitions of the term paratransit by many experts in the world. It is not a coincidence that there is a wide spectrum to explain the operational and organizational characteristics of paratransit in different localities. For example, as a basic definition, Lave and Mathias (2000) defines paratransit with the words "alongside transit" while Bakker (1999) defines it as an option for far away countries and for market-niches like elderly and disabled people in the Western countries. On the other hand, Cervero (1992 and 2000) indicates that paratransit represents a type of transportation service that functions in a "laissez –faire" context in which the authorities allow for a very flexible regulatory environment, that enables vehicles to cruise the streets for customers, providing either door-to-door or mainline service. From another perspective, Mastrogiannidou et al. (2006) coins the term "demand responsive" as they fill the lack of comfortable travel demand with low cost. Tüydeş and Özen (2008), similar to Bakker, define paratransit as any type of public transportation that is distinct from conventional transit, which provides door-to-door or curb-to-curb service combining the cost advantage of transit with flexibility of more private modes, such as taxi or car. In brief, it would not be wrong to say that, in developed world paratransit provides a service similar to shuttle services of airports, which are in service for people with disabilities and mobility challenges, although demand responsive or demand driven are also being used for that type of paratransit in the literature. For the developing world cases, the term paratransit represents partially or completely informal public transport operations of private entrepreneurs. A wide-scope definition is summarized by Cervero (1998, 15) covering the main characteristics of paratransit as follows;

> *The smallest carriers often go by the name of paratransit, representing the spectrum of vans, jitneys, shuttles, microbuses, and minibuses that fall between the private automobile and conventional bus in terms of capacities*

and service features. Often owned and operated by private companies and individuals, paratransit services tend to be flexible and highly market-responsive, connecting multiple passengers to multiple destinations within a region, sometimes door-to-door and, because of multiple occupants, at a price below taxi (but enough to more than cover full operating costs).

In this part, to understand the paratransit concept a brief explanation is necessary. As it can be seen further below, paratransit covers many different vehicles in the traffic. Depending on the geography and the economy of the country the needs and hence service characteristics differentiate. While jitneys or shared-taxis are mostly developing world paratransit types, taxis or dial-a-ride services of companies are examples of the developed world paratransit types. Principally, same vehicles are articulated to the existing network in different contexts depending on the needs of the locality and within the local legal framework. For example minibuses serve as dial-a-ride services in suburban areas, as shuttle services between airports and central areas, feeder services for the conventional transit option in developed world cities (See Figure 2). In the developed world because of the low capacity, minibuses are rarely used on mass transit corridors. On the other hand, in the developing world minibuses in the form of paratransit serve as the main public transport option especially in the metropolitan cities where the conventional modes are inefficient to meet the demand.

Figure 2. Jitney vans in Atlantic City, US (Grava, 2003, 238)

There are plenty of names for the paratransit vehicles in the world. Jitney Buses in the USA, Dial-a-Ride services in the UK, Dolmuş in Turkey, Peseros in Mexico, Auto rickshaws and tricycle rickshaws in Pakistan, Trishaws in Hong Kong (Cervero, 2000; Grava, 2003; Tekeli & Okyay, 1981). As a result of the wide spectrum, paratransit covers both the formal, company based, comparably expensive minibus services of the developed countries and even the informal bicycle or motorcycle services, in the developing world (See Figure 3 and Figure 4).

Figure 3. Bicycle Rickshaws in a Rural Town in Thailand (Grava, 2003, 258)

Figure 4. Jeepneys in Manila, Philippines (HU University of Applied Sciences Utrecht Website)

As it will be analyzed in detail in the next chapters, the issue about the paratransit especially in the less developed countries is that the position of this mode between private and public transport, in other words the betweenness of paratransit, makes it both a beneficial alternative solution to the metropolitan cities' mobility demand and a threat to the efficiency of existing public transportation services. Beneficial because, paratransit services emerge when the existing public transportation services are unable to or having difficulty in meeting the existing demand level, and therefore they play a major role in serving mobility needs with a wide variety of smaller vehicles (Dimitriou, 1990, 85). In addition to that, paratransit, by assembling at least several travelers in the same vehicle, improves the total performance of transportation systems that would be otherwise completely overwhelmed by single occupancy automobiles (Grava, 2003, 248). However, from a different point of view, it could be a threat because as paratransit vehicles are privately operated in case of disintegrated transport network, they become competitors of public, conventional services. It may be claimed that some competition is beneficial to increase the average quality of any service; however, profit maximization mostly takes place at the expense of safety, comfort and sustainability measures of transportation. This would be the case especially, if the control and regulation capabilities of the government authorities are limited.

In Figure 5, a comprehensive classicification is given showing the different characteristics of the flow between private autos and regular (conventional) transit in the world. It contains the carpools, vanpools, subscription buses, car-sharing systems, taxis, jitneys, dial-a-ride and hybrid services which are different types of paratransit operations in the world.

According to the examples of paratransit, it can be deducted from the literature that the paratransit concept has some common qualifications, namely flexibility and adaptability, cost advantage and convenience. Furthermore, as explained by Nantulya and Muli-Musiime (2001, 219), "the paratransit has a dual mode of transport that falls between private transport and conventional bus transport. It often has a fixed or semi-fixed route, but with the added convenience of stopping anywhere to pick up or drop off passengers and not having fixed time schedules." It is necessary to add safety issues, regulation issues and high rents of paratransit services as some negative qualifications of paratransit operations in the sector following the first four qualifications listed in Nantulya and Muli-Musiime explanation above.

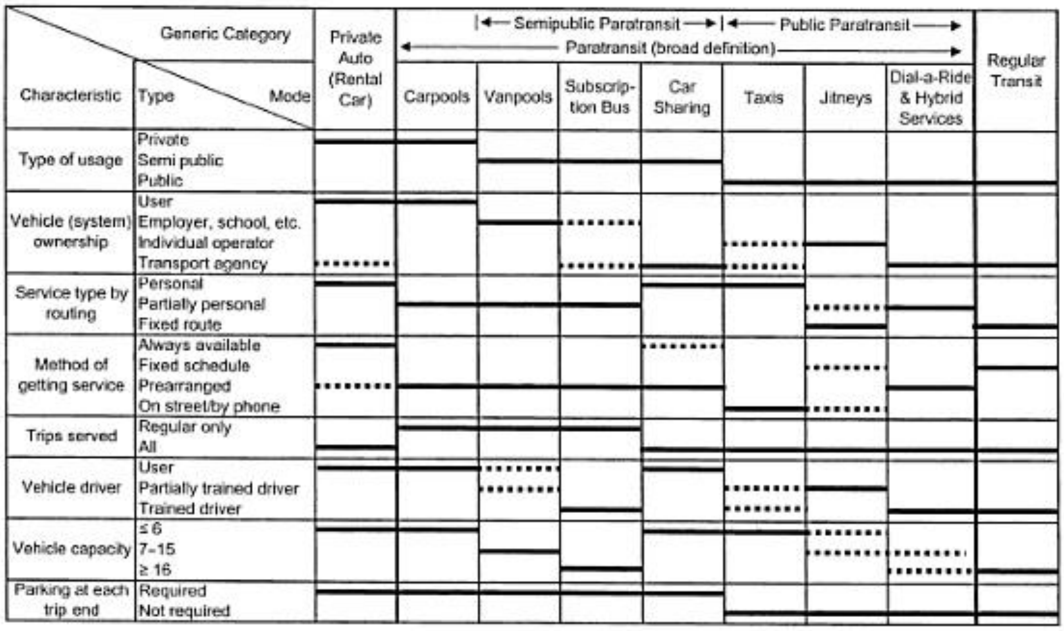

Figure 5. Basic Characteristics of Paratransit Modes (Vuchic, 2007, 501)

As seen in Figure 5 above, paratransit modes can be analyzed and classified according to type of usage, ownership of the vehicles, service type by routing, method of getting service, trips served, vehicle driver, vehicle capacity and parking at each trip end. These eight features of transportation modes cover all paratransit vehicle types and consitutes a comprehensive framework for the evaluation of paratransit vehicles. However, the main aim of this section of the study is to understand the paratransit concept and service characteristics in detail, based on Vuchic’s conceptualization, a new approach which emphasizes paratransit concept in detail should be made. Even though Vuchic’s conceptualization is a comprehensive one covering all paratransit operations, it has deficiencies especially about paratransit vehicles of different localities. As developing country urbanization process and mobility needs differentiate from the developed world cases in significant manners, new conceptualization is required for developing a better understanding. From that perspective, characteristics which is covering both developed and developing country cases could be divided into two as advantageous and challenging characteristics. Advantageous characteristics could be listed as flexibility-adaptability, affordability, convenience and comfort. The disadvantageous ones could be listed as ownership pattern, traffic safety issues, issues of transit integration, unreliability and congestion effect of low capacity vehicles.

3.2.1. Advantageous Characteristics

3.2.1.1. Flexibility-Adaptability

One of the major advantages of paratransit is its ability to adapt to the existing transportation network. In the report of Adam Smith Institute (1989) which was prepared for London Transport Office, this characteristic is emphasized in detail:

> *The typical (paratransit) light vehicle service is a flexible one, serving a planned route without fixed stops. Passengers will generally board them at well-known points, or will hail them at convenient stopping points. Passengers similarly tell the driver when they wish to alight. This gives a much more personal service, more tailored to individual needs.*

As a transportation mode, which is competing with the door-to-door transportation opportunity of the private cars, that is a major characteristic for the emergence and the survival of the paratransit vehicles. Grava (2003) coins flexible characteristics of paratransit as the most influential strengths of paratransit services. Cervero (1998) also points out that much of the success of these systems lies in their flexibility and adaptability. Depending on the daily needs of the users, service patterns can easily adjust. While the operation characteristics are quite flexible, vehicles are also easily adaptable to changes. Mostly, relatively mid-size or small-size vehicles are preferred on suburban area operations. Physical advantages also increase the comfort of the paratransit vehicles especially in the off-peak hours:

> *Combis normally carry two to three times as many riders as sedans and concentrate mainly on intermediate-volume markets in the suburbs. Some combi operators guarantee seats. Minibuses seat up to twenty-five passengers with room for an equal number to stand (Cervero, 1998, 389).*

Adaptability both physically and operationally is important. It is important to specify that vehicle size advantages of the paratransit create an advantage for operators over municipal public transport buses or metros. As the vehicles carry few passengers and make stops only on demand, any comparable trip duration will be less than regularly scheduled transit (Grava, 2003). Compared with the conventional modes, especially for getting on-off according to the demand of the passengers create a major advantage which other public transport modes are unable to supply. If there were a single reason that can explain the existence of paratransit systems as a dominant mode in transportation network, flexibility-adaptability would be the crucial one.

3.2.1.2. Affordability

Paratransit services mostly offer a cheap service because of the competitive working environment. As in the Adam Smith Institute's report (1989), there are many advantages when compared to conventional modes like bus or metro in terms of price policies:

> *The light vehicle overturns conventional ideas on the economies of scale. Although smaller, it is more cost-effective to run. There are several reasons for this. The large vehicle might carry more passengers for fuel or driver costs on a theoretical journey, but the small vehicle scores in practice. Its capital costs per seat are very much less…It maintains lower garage costs, and lower network costs. It normally operates with a lower loan proportion than public sector operation, and therefore does not carry the same burden of debt repayment. It uses its staff more efficiently and more flexibly, making use of part time work where demand patterns make this an obvious economy.*

All of these can consequently result in an ability to offer lower fares. Nevertheless, paratransit provides a service extremely flexible to meet travel demand; and it is also possible that passengers tend to pay more for a more flexible and adaptable service to their trip end. In addition, because of the private operation, paratransit vehicles are adaptable not only to the physical needs but also to the financial needs of the passengers. That economic advantage has consequential results in four main areas. Firstly, operational structure provides very low labor cost in paratransit. Driver/Owner structure creates a straightforward employee/employer situation in terms of wage distribution. Conventional transit has a bottom level price due to wages of the drivers, strict legal borders for the working hours. In addition, regulation requirements namely service, comfort, safety etc. are not high especially in inadequate regulatory environments. Lastly, paratransit provides a flexible and convenient service, which is closer to taxi service and from this point of view, it is cheap (Vuchic, 2007). The last one is the answer of the question why paratransit vehicles are able to work with costs, which are higher than public transit but lower than private transit. When a passenger pays for paratransit service, in reality he/she thinks the service is better than the conventional public transport service. A trip with the paratransit may be much comfortable, faster and cheaper from passengers' point of view. That is why; even if the prices are higher from public transport, regarding the advantageous qualifications of the service of paratransit, it is considered by users to have an appropriate price.

3.2.1.3. Convenience

Another advantage of the paratransit vehicle is its convenience especially for the trips in the peak hours. There is usually a scheduled, fixed service frequency of other public transport vehicles in the system. Public transport vehicles are mostly big, non-flexible, and vulnerable to the changes. Due to its scale (i.e. large numbers but small vehicles), they provide an advantage for drop-off and pick up time, provide a service with a high frequency, stop only depending on the requests of the passengers, can easily maneuver during the peak hour in main arterials (Grava, 2003). Even the assumption of relatively fixed routes can be challenged by paratransit, and replaced by general predictability about where they operate and where one stands a good chance of catching one (Adam Smith Institute, 1989). There are no fixed stops, which would have decreased the speed of the travel, quite an important aspect especially for work trips. These all increases travel speed of the vehicle. In addition, there are several researches about the psychological positive contributions of vehicle size on the passengers, who "tend to feel more secure since each one is closer to the driver" (Cervero, 1998, 15). In other words, the shorter the distance between the passengers and the driver, the safer the passengers feel in public transport vehicles.

Wright (1986, 9) explains the convenience of the system depending on the size of the vehicles with the following statement:

> *Paratransit operators are responsive to the needs of the public and adapt quickly to changing patterns of demand. Because of their small size, paratransit vehicles are able to provide frequent and viable service at low levels of demand. Often, small paratransit vehicles are the only form of transport able to penetrate the labyrinth of narrow streets sometimes found in the old parts of cities and in squatter areas.*

Within that context, it would not be wrong to say that, minibus is an effective substitute to the regular bus since it can provide a relatively faster transportation service due to the above characteristics regarding its vehicles and service flexibility. Even it would not be wrong to state that, paratransit, by assembling at least several travelers in the same vehicle, improves the total performance of transportation systems that would be otherwise completely overwhelmed by single occupancy automobiles especially from the low-density fringe areas (Grava, 2003, 248). Passengers tend to travel with frequent and fast services, however paratransit vehicles offer that kind of advantageous services only by violating the rules about departures and driving. That is why, the provision of an advantageous service is mostly indirect result of the negative characteristics of paratransit and further in the study they will be two focus points in terms of safety and the difficulty of integration.

3.2.1.4. Comfort

There is not a consensus between the technical experts about whether paratransit provides a comfortable service or not (Cervero, 2000; Grava, 2003; Kılınçaslan, 2012; Tekeli, 2010; Vuchic, 2007). For the developed world examples, paratransit creates a service, which is premium at premium fares. Dial-a-ride services or shuttle services especially in the premium context could be seen everywhere today (airports, ports, hotels etc.). For captive riders, i.e. those who do not have access to private transport and hence use public transport in their trips, paratransit services can provide a comfortable travel option. The comfort and semi privacy that commuter vans can provide are powerful inducements toward at least some form of communal transport (Grava, 2003, 271). For the developing world examples, if comfort were considered as the physical formation or air conditioning of the vehicles, the prejudice about the uncomfortable travel characteristic of paratransit would be partially true. However, this statement is partially true because, conventional buses and metro systems are often unable to provide a high quality service in these developing countries. Besides, for paratransit there are two qualifications what makes paratransit vehicles preferable against its conventional competitors. The first one of them is the probability of having a seat. As paratransit services operate with small vehicles and frequent stops on their route, this results with a higher probability of having a seat. Especially, while there is very low public transport supply by municipality, middle class in the society choose paratransit related with this availability of seats (Tekeli & Okyay, 1981). The second one is number of transfers. The less the number of transfers is, the more comfortable the travel is. With their flexible routing and private operating structure, paratransit vehicles are much more sensitive to these needs of the passengers. According to Cervero (1998, 15), different relationship between the passenger and the operator could even result in a taxi-like route change:

> *Driven by the profit motive, paratransit entrepreneurs aggressively seek out new and expanding markets, innovating when and where necessary… Unencumbered by strict operating rules, jitney drivers will sometimes make a slight detour to deliver someone hauling groceries to his or her front door in return for an extra charge.*

Consequently, paratransit can provide a comfortable service around the world, depending on the needs of the users. This comfort measure is quite important to understand that, both in the countries with a successful public transport service and in the countries with common insufficiencies in their transportation network paratransit owes its own existence to different comfortable service opportunities depending on the local necessities.

3.2.2. Challenging Characteristics

3.2.2.1. Ownership Pattern

Ownership patterns of paratransit services can in fact be both advantageous and problematic. In both developed and developing countries, paratransit systems mostly have private ownership pattern. In developed world examples, the services mostly serve to the areas, which conventional modes are unable to reach or areas in which it is very expensive for public authorities to supply service. Private companies in the developed country examples mostly operate these services. Dial-a-ride services or jitney services in the US are some examples to that. Mostly one big firm in London or New York controls all the operations. In the developed world, paratransit services are generally introduced to the system by public authorities through contracts that allow these services to serve the fringe areas or the elderly or handicapped users with a reasonable pricing. It would not be wrong to say that, with that characteristic paratransit fulfils the efficiency of the total transportation network especially for the captive riders who are dependent on public transport.

On the other hand, in the developing world examples individuals operate these services. Different from the developed countries, the emergence of the paratransit in developing countries is generally in consequence of the insufficient supply of the public transport by central or local authorities. That is why they have a natural freedom, which is provided by the decision makers of the cities in which they operate. Cervero (2000, 3) draws attention to that with the following statement;

> *…in many cases, the informal sector is tolerated by public authorities, allowed to exist as long as it remains more or less "invisible" to most motorists, confined to low-income neighborhoods. Often, however, patrol officers and local "bosses" must be paid off for the right to operate in their "turf". Informal transport is just one of many sectors of the underground economy that thrives in many third world countries.*

Various private operators can create a challenge since the public authorities have to deal with numerous individuals in planning the operational issues, such as routes, pricing, integration etc. Therefore, while the contracting out of services to a private company to provide services to low-demand areas or special user groups may be an effective solution in the cities of the developed world, the fragmented ownership structure and the presence of numerous individual operators is a challenge characterized by most paratransit services in the developing world. Having said that, there is also a debate that, this particular ownership pattern contributes to the operations of paratransit (Cervero, 1998; Dimitriou, 1990). In a multitude of operators individually working, this patterns actually provides the flexibility of the vehicles. On the other hand, even though as the major public transport system it has disadvantages against conventional rail systems, as a feeder system it operates better than conventional bus service. This is because, paratransit vehicles –different when compared to buses- are more flexible, aim profit maximization and more efficient operation, hence providing vehicle capacity depending on the needs of the area that the service is provided.

3.2.2.2. Traffic Safety Issues

As explained in detail in the previous part, there are some features, which make paratransit a beneficial substitute to public transport. On the other hand, some characteristics make paratransit problematic and challenging for public transport and urban traffic in the city. These negative characteristics are the natural result of the advantageous dimensions. Cervero (2000, 4), represents his own observations during the UN Habitat Project for developing country informal transport research:

> *Aggressive and unruly driving among drivers whose very livelihoods depend on filling empty seats all too often causes serious accidents…Often times, the sector is chaotic and disorganized.*

Especially for the developing country context Kılınçaslan (2012, 127) emphasizes the problems created by paratransit in terms of safety. She lists the basic qualifications of a successful public transport system with punctuality, service frequency, reliability, safety, comfort, accessibility, affordable ticketing and ease in understanding the service, and adds that paratransit systems are unable to meet the conditions about the safety and ease in understanding the service, i.e. routes, stops, etc. The statement about transportation, which claims that the natural result of the free-market economy and competitiveness will increase the quality of the transportation, is not entirely true in this context. That is because; the tendency to maximize profits creates an equally challenging system and decreases the quality of the service for the maximization of profits. Safety issues are relatively less important for the operator. The operator focuses on the headway counts, speed of the service in peak traffic and the users of the paratransit system are negatively affected by the self-ordained drivers of paratransit vehicles (Cervero, 2000; Wright, 1986). Not surprisingly, even in the developed countries profit maximization can create some problems. For example, in New York, as in London at the same time, rivalry between omnibus proprietors was fierce, and recklessly driven omnibuses were a notorious hazard to pedestrians (Vuchic, 2007, 9). On the other hand, lack of education and limited control of the public authorities on the individual operators especially in the developing world cities create issues about the drivers. Long working hours of the salaried drivers also increases the psychological tension of the drivers and that mostly results with a low attention in traffic, while over-eagerness during the peak hours also reduces the control and increases the probability of traffic accidents.

3.2.2.3. Issues of Transit Integration

As it is privately operated and partially independent from the conventional modes, it could be very difficult for the policy makers to regulate the paratransit systems with a view to integrate it into the rest of public transport operations. Especially, if there is a lack of monitoring mechanism during the planning and operation processes of paratransit vehicles, this can cause problems. It would not be wrong to state that incoordination of paratransit vehicles is mainly a developing world transportation problem. In the developed world examples, public authorities control privately operated public transport services on a regular basis. In this sense, public authorities' officials determine the range, price and quality of the service, length of routes and zoning measures of paratransit services. These regular arrangements make paratransit vehicles in developed countries much more compatible for integration operations. On the other hand, for the developing world, integration of the system into the existing public transport network is vital because, -as explained in the second chapter- the main aim of paratransit organization is to maximize the profit and that creates challenges for integrating this mode with metro or bus systems. Additionally, the lack of regulation accelerates this unequal structure between transportation modes.

The evaluation of issues of paratransit integration to the existing network can be made historically. This historical perspective would help to understand the difference between developed and developing country cases. In the very beginning of the private car era both in developed and developing world cities, there were systems, which were quite close to the paratransit systems of today. Actually, these systems emerged because of the lack of supply in the metropolitan areas. In developed country examples, the local governments allowed them for the diversity of the transportation network. As paratransit operations just began, they were not a major necessity for all users and they were very easy to cancel in this respect.

Consequently, the local authorities of these developed countries have cancelled most of the operations (Dimitriou, 1990; Grava, 2003; Tekeli & Okyay, 1981). However, different from developed country experience, in developing countries, they have been the vital parts of the system in the last fifty-sixty years and it is very difficult to cancel this system entirely. In addition to this, there are some political concerns, which are hog-tying for the decision makers. As Tekeli (1977, 83) expresses, paratransit vehicles' ownership organization structure and the management organization in developing world cities has an impact on the decision makers directly because of the political concerns of the local governments. Decision makers have very little to say about the organization of the paratransit vehicle drivers. The question is why this problematic structure continues its existence during the formalization process of transportation network. There should be some management and regulation to minimize the negative outcomes of the irregularity problem starting from the redistribution of surplus. In some developed world countries like Turkey or Mexico, the camaraderie between paratransit operators creates a pareto-optimum point between the operators (Cervero, 1998, 390; Tekeli et al., 1976). This structure firstly solves the redistribution problems and then the operational problems. That is why; these unregulation problems are solved automatically by the self-management system and users are not directly affected from them.

In terms of lack of negotiation, Tekeli and Okyay (1981) define the problem between the Turkish paratransit drivers and municipalities with the propositional phrase "power relations problem". As the case studies showed, this statement is valid for other developing country cases too (Cervero, 1998; Dimitriou, 2011; Grava, 2003). The organization of the vehicle-owners is mostly horizontal for paratransit vehicles. In most of the countries, there is a limitation on the vehicle numbers, which enables every vehicle owner to benefit from the rent. However as explained by Wright (1986, 9), while the owners are benefitting from the opportunities, contribution is very little to the city finance. In addition, being a horizontally organized group it is very difficult for the decision makers to deal with them. There is generally no single managing authority for these systems. Besides, their dominant impact on the other modes is another increasing factor of the license plate rents. It is thought that, this problem is specific to the developing world; however, the enormous cost of creating different public transport services provided an advantage to the paratransit vehicles if it is not controlled in the developed country cases. For example, jitney vehicles, which are quite common in developing world cities, emerged in the beginning of the 20th century in the US. Around 1915, several states enabled the jitney operators to work in the central areas. However, these operations were cut off suddenly by the early 1920s. The reason behind limiting the operations was the lobbying of the streetcar companies. Jitneys were working parallel to the streetcar routes and the success of the jitneys directly influenced the ridership of streetcars (Grava, 2003; Tekeli & Okyay, 1981). According to Vuchic (2007, 511) regular transit vehicles (streetcars) were obliged to operate on exactly specified routes, including heavily as well as lightly traveled ones, with announced headways throughout the day. Thus, they operated services with various financial results, including a number of non-remunerative ones. They had to provide public service under specified conditions. That created a gap for flexible operating vehicles in the network. However, when the flexible operating vehicles in the form of jitneys exist, this creates a competition in which flexible vehicles and services can have several advantages as described in the section about advantageous characteristics of paratransit. Concerns and conflicts arising from such competition seem to have had an effect on the elimination of jitney services in the US case.

In developing world cities, a major problem is that most of the drivers in the sector and the vehicles are unable to meet the requirements for traffic such as minimum vehicle size, maximum age of fitness standards, etc. (Cervero, 2000; Vuchic, 2007). Mostly, the price of the licenses to operate the vehicle is quite high, which makes it a significant sector in terms of urban economy. In addition, the ticketing of the system is mostly with cash. Independent from the electronic ticketing, mostly it is not possible for the authorities to follow the number of passengers carried by the paratransit vehicles. That creates a gray economy for paratransit services. Additionaly, it is difficult to create an integrated ticketing formula for transport system integration because mostly, paratransit operators benefit from that lack of ground for legal action. Introduction of any new regulations, laws and requirements for paratransit necessitates the agreement of a multitude of vehicle owners and drivers, and this makes the regulation issue extremely difficult as it challenges any cooperation between public authorities and these individual private operators. That is why integration of paratransit modes is on one hand a necessity, even vital for the efficiency of the system and on the other hand a challenge for the decision makers.

3.2.2.4. Unreliability

Another negative characteristic of paratransit vehicles is unreliability. In fact, unreliability of paratransit vehicles depends on the service they provide. In the beginning of this chapter, it has been emphasized that the term paratransit covers vanpools, taxis, car sharing, dial-a-ride, jitneys etc. Unreliability measure is not valid for dial-a-ride services or taxis. However, jitneys, as the dominant type of paratransit in developing countries, are generally criticized for offering unreliable services in off-peak hours. Vuchic (2007, 67) indicates the following about the reliability issues of jitneys;

> *Because of their low capacity and much lower labor cost (they are often driven by their owners, who work long hours), jitneys operate with higher frequency, making them convenient for potential users. Their reliability and safety are lower than those of transit buses in cities where regular transit is well organized. Jitneys are used extensively in developing countries, particularly where labor costs are very low and regular buses do not offer sufficient capacity or quality of service.*

Putting emphasis on the "off-peak" is vital for the unreliability measure. Researches show that during peak hours jitneys provide a convenient and reliable service because of the quick passenger loading as a result of small vehicle sizes (Adam Smith Institute, 1989; Grava, 2003; Tekeli & Okyay, 1981). During off-peak hours loading times of the vehicles increase and mostly owner/operator decreases the average travel time of the vehicles to increase the occupancy rate of the vehicles. That result with the decrease in convenience and reliability.

Another problem about the reliability can be related to the route flexibility of vehicles. It was described above as a positive attribute that paratransit vehicles sometimes change their routes and skip many stops if their passengers are not requiring them to follow those routes and to get off at certain stops. Sometimes this can result in express services to a major trip attraction point, and this may be appreciated by those on board since this can reduce their travel time. However, change of routes would result in unreliability of services for those passengers who may be waiting for a vehicle on the routes that the drivers decide not to take. Service frequency may reduce for such passengers waiting at stops.

3.2.2.5. Congestion Effect of Low Capacity Vehicles

The last but not the least aspect of negative characteristics of the paratransit operation is its impact on traffic congestion. As emphasized in the previous characteristics, flexibility and reliability measures of paratransit is directly related with by request oriented routing and stopping characteristics of paratransit vehicles. However, while these operational characteristics appeal to passengers on board, that they also cause traffic congestion for the other transportation modes. Tekeli et al. (1976) express that, as in other informal sectors in the informal transport sector too, operators (or owners) aim profit maximization for no matter what it costs. That creates a burden that should be paid by system itself. In formally working systems, that burden is collectively compensated by all elements in the system. However, when informal operations exist, as there is no control on them, the burden created by their own profit maximization efforts are paid by the other users of the system (Işık & Pınarcıoğlu, 2013; Tekeli, 1977). Congestion problem created by paratransit vehicles is inevitable because of lack of regulation and control especially in the developing world. Their frequent (and unexpected) stops in anywhere in traffic without considering other vehicles' operations creates the congestion and sometimes traffic accidents.

In addition, paratransit vehicles are often small and low-capacity vehicles; and their low capacity on main routes compared with the bus and urban rail systems (in terms of vehicle size) results with the congestion problem too. Cervero (1998) states that as passenger volumes rise, the advantages of paratransit start to diminish, since smaller vehicles cannot cope with carrying large-line haul loads.

Vuchic (2007, 214) also emphasizes the importance of the vehicle size and unregulation with the following statement:

> *Due to their small capacity, minibuses operate in great numbers, offering frequent services and few stops along the line. Thus passengers enjoy frequent and fast service, but the comfort, safety and reliability of these*

vehicles are often below the standards required from transit services. Operating with group taxis, vans, midibuses and buses, they cause congestion and very chaotic traffic conditions.

In brief, it is seen that paratransit systems offer many advantages but also cause some severe transport and traffic problems. It can be claimed that, while some characteristics are positive from paratransit users' point of view, the same attributes also cause transport and traffic problems.

3.3. Urban Transport Policies for Paratransit

In the previous two sections of this chapter, the definition of paratransit vehicles has been given and a review of main characteristics -both advantageous and challenging ones- of paratransit has been provided. In the third part of the chapter, a review will be made on urban transport policies implemented worldwide in dealing with paratransit system. It is important to make an emphasis on the perception of paratransit operations from different perspectives to develop an understanding for the future decisions on it.

There is a conflict about the transport policy making on paratransit. Two major thoughts exist: either to abolish the operations and paratransit (especially in developing world cities) or to introduce paratransit vehicles where needed (especially in developed world cities) (Cervero, 2000; Dimitriou, 1990; Kılınçaslan, 2012).

Those who support the elimination of the operations are advocating fully formalized public transport network. As cities reach higher states of development, authorities "to upgrade the civic image of the city", introduces projects, which discourage paratransit operations. However, this process for "modernizing" the city may actually abolish sophisticated transportation options (Grava, 2003, 256). The belief is that they create a challenging system, which damages municipality operations and safety parameters, rather than a system increasing the efforts of the operators for the overall system efficiency (Kılınçaslan, 2012, 175-176). However, it should not be forgotten that, existence of the paratransit is a result of the insufficiency of public transport supply in comparison to the demand. Mostly, paratransit vehicles already emerge or continue their existence because of the needs of mobility. As mentioned before, in the morning and evening peak hours in congested traffic, paratransit could be a good option even for private car users. From that point of view, the existence of paratransit is quite important especially in countries with high –or increasing- private car ownership in terms of controlling private car usage in urban traffic.

Those who support the operations of paratransit claim that, paratransit systems can help to increase the efficiency of transportation systems. Surely, jitney services like dolmuş are not being promoted everywhere, but other forms of paratransit is demanded especially in the cities that are suffering from urban sprawl as a result of high car ownership rates. For example, a new generation paratransit system was developed in the municipality of Philippi in Northern Greece. This new paratransit system was designed so as to be assisted with intelligent transportation systems, where not only booking is done in a computerized manner, but also the vehicle routing would be supported by algorithms using recently developed methods and technologies, such as dynamic traffic assignment, real-time guidance with GPS and navigation systems, and communications systems (Mastrogiannidou, et al., 2006 cited in Toker-Özkurt, 2012, 121). This example shows that a completely new paratransit system can be developed in certain contexts as a solution to certain mobility needs.

Nevertheless, as Cervero (1998, 16) argues, “In both the developing and developed worlds, paratransit best operates in a supporting and supplemental role”. He also points out the role of points out the role of paratransit systems as feeder lines with the following sentences (386-387),;

> *In a press interview following the release of Metro's master plan, Miguel Valencia Mulkai, president of the Regional Ecology Forum for the Valley of Mexico, cautioned, "Expanding the Metro is the surest way to urban sprawl. The further out the lines run, the broader the secondary transport web." By "secondary transport web" is meant the system of paratransit feeders and bus transit distributors that tie into Metro's terminal stations, effectively extending the travel shed for Metro services by several orders of magnitude. A consequence of spread-out development has been high rates of intermodal transferring -35 percent of regional trips in 1994 involved a change from one mode to another...It has required the natural workings of the marketplace in a loosely regulated paratransit sector to close the coordination gap.*

From that perspective, competition between the public operators and private operators could be beneficial for either public or private owners. Private operators who compete with public sector and aim profit maximization could increase the service quality. That is why it is quite important to constitute an urban transportation planning approach, which includes all different transportation modes. In other words, transportation system should be re-planned in a comprehensive way of thinking. Introduction of route and ticket integration and management of strict safety measurements, and high quality feedback mechanisms are required. Car ownership and more importantly private car usage in urban traffic is significantly increasing but it could be controlled with the opportunities that is created by a combination of private and public transport options. Paratransit actually offers a perfect tool to fill the gaps in transportation operations. Dimitriou (1990, 79) emphasizes this qualification of paratransit in his study on paratransit vehicles:

> *The often observed mismatch between adopted urban transport planning goals and Third World city grass-root needs is most notably reflected in the pre-occupation of many urban transport studies with meeting private motorised transport needs and tackling related problems of traffic congestion, rather than addressing wider issues affecting a larger proportion of society. As a result, there has been an under-emphasis on the importance of pedestrian, cycle and animal movement; on matters of social justice; and on the productive role of the informal transport sector.*

To overcome this under-emphasis of paratransit opportunities, ways to benefit from the opportunities it created should be emphasized. This emphasis could be made in three main titles. Relation of dolmuş with other modes is the first one. This relation with conventional modes should be evaluated from user perspective and decision makers’ perspective in detail. New policy suggestions on future of dolmuş would be nourished from the needs of these stakeholders. Second one is about the lobbying activities of dolmuş. Operators as an element of decision making process should be considered in integration policy proposals. The last one is about the land use and paratransit relationship. One of the inflexible measurements in urban areas, the development of built environment and paratransit relationship should be considered and the ways of minimizing the uncontrolled urban growth should take its place on the agenda of local decision makers.

3.3.1. Relation with Conventional Modes (Urban Rail and Buses)

In many developing world cities main arteries are supported by the local government with metro, LRT or BRT services and private entrepreneurs operate on connections that link the main arteries with sprawled urban settlements. Besides, especially in the sub-zones, it is obvious that there are some advantages that paratransit has against conventional modes. For example; bus vehicles are considered much more comfortable; however, as indicated previously, small vehicles have their advantage for users. While single body buses are much more comfortable than articulated or double-decker buses; the selection of bus size is usually a complex task because the relative importance of these factors varies with local conditions (Vuchic, 2007, 212). Minibus vehicle size is advantageous in terms of service frequency, operating speed and maneuverability than any other bus vehicles. Besides, its demand responsive characteristics enables its operations accessible according to the needs of the users. For example, in İstanbul example, dolmuş service is considered as one of the most reliable forms of rapid transit, for being an affordable service running almost 24 hours a day (Toker-Özkurt, 2010, 76). The demand-responsive qualifications of dolmuş, has definitely affecting that perception of the users.

In transit management examples in the world, there are different approaches. Upon Metro's 1969 opening, the CGT began issuing paratransit licenses only for routes that fed into Metro stations (Cervero, 1998, 393). Also Kılınçaslan (2012, 157) emphasizes that, in cities with metro or BRT lines most of the low capacity public transport option are used as feeder lines.

Making use of paratransit as a feeder service can create a network with a good geographical coverage, resulting in many advantages for the urban environment:

> *Mexico City's congestion and pollution would be much worse were it not for the dynamic and wide-ranging transportation system that has evolved over the years in response to explosive growth. Notably, a hierarchy of transportation services-both public and private- has emerged, providing a rich mix of travel options in terms of geographic coverage, vehicle carrying*

capacities, and levels of integration. At the top of the hierarchy and forming the backbone of the system is Metro, a predominantly rubber-tire, high-speed subway network that crisscrosses the Federal District. With metro forming the main arteries of the region's transit network, equally vital to the lifeblood of the metropolis have been the network's capillaries: the extensive system of paratransit feeder services known locally as peseros and colectivos (Cervero, 1998, 380).

Mexico City’s feeder paratransit operators namely peseros and colectivos are real-time examples showing positive attributes of paratransit service as feeder systems (Cervero, 1998). Furthermore, researches about Southeast Asia metropolitan city Delhi shows that, providing rickshaw services as feeders to the metro would probably help to reduce high carbon emissions and increasing private vehicle usage in Delhi (Doll & Balaban, 2013).

Consequently, it can be stated that where regulated, paratransit operations can support conventional public transport operations. Nevertheless, as stated before, due to the nature of paratransit, unregulated operations generally result in a competition with conventional modes.

3.3.2. Relation with the Decision Makers (Lobbying)

Assessment of the lobbying activity of paratransit drivers is required. Especially, in developed country cases there is a misunderstanding that paratransit operators are unable to create a lobby, which has an impact on decision making process. The idea of paratransit operators not having the ability to create a lobbying could be tested with the United States example. As mentioned before, jitneys in the US served between the years 1914-1916 and they wounded up by the powerful tram companies after a while. Actually, powerful, privately owned structure of “other” transportation modes disabled the strengthening of jitneys in the US example (Grava, 2003, 235-236; Tekeli & Okyay, 1981, 29). However, the difference between developed countries like the US and the developing countries distinguishes itself in the operation period. While the US example experienced the jitneys only in a short time, most of the developing country transportation networks have been nourished dominantly by paratransit. As they are the main public transport providers in many of the developing country cities, any competition introduced by the municipality with the paratransit is generally opposed and prevented by their organizations. In the Turkish example, the plate ownership given to the operators without time limitation created an irrevocable privilege for these people (Kılınçaslan, 2012, 313). In Mexico City, as the governments are unable to regulate paratransit sectors, the members of the sector created a self-operating mechanism:

> *In light of the difficulties in enforcing paratransit regulations and given the enormity of Mexico City's paratransit sector; the emergence of pro-active route associations was inevitable. Each of the more than 100 peseros and minibus routes in the Federal District is today represented by a route association. Additionally, there are fifteen umbrella organizations that actively lobby for the interests of the paratransit industry in general and their constituent route associations specifically. Overall, then a hierarchical organization structure has evolved to administer, self-police, and promote the city's hierarchy of paratransit services (Cervero, 1998, 394).*

Besides, an important point is about their organizational structure. In the previous section it was mentioned that there is a horizontal organization rather than a vertical organization between owner/operators of paratransit. In many examples, the license plates are quite expensive and as there is a horizontal organization, it is not possible to compensate any low-profit operation with the surplus from the other operations and that makes it very difficult to negotiate with the operators as well. For example, in Mexico City district authorities do not have the resources to enforce rules among some 100,000 licensed paratransit operators in the city, much less the tens of thousands of unlicensed ones (Cervero, 1998, 393). That is why; the central government managed the process at first.

Yet, there is an inevitable evolution of informal sector from the informal foundation to a formal, modern foundation. Two ways can be followed during this process: to leave it to the historical process or to speed up this evolution. In either of the cases, the fact that should not be forgotten is that informal sector is a societal issue, which is revealed by the unbalanced societal structure (Işık & Pınarcıoğlu, 2013, 51). For the first choice, it could be said that car producers are quite influential on society and maybe with rapidly increasing car ownership rates they will meet the mobility needs of the middle-income groups, which will lead to the removal of paratransit. However, Southern American examples Por Puestos (jitneys) still continue their existence (Alpöge, 1975 cited in Tekeli & Okyay, 1981) . The author of this study prefers to focus on the second option. Considering the lobbying connections of paratransit operators, it is clear that paratransit or taxi artisans could antagonize the policies, affect them in a significant manner, and hence hinder their effective implementation. As Kılınçaslan states for the case of Turkey, the power of this group, which is organized and mostly represented at the municipality level, and the fact that a certain section of the society has been living off from this sector for 70 years should be considered well by transportation planners.

In most countries, government authorities have cited problems with unsafe vehicles and drivers in justifying their efforts to regulate and "formalize" paratransit operations. However, most of the time, these efforts have been limited by ignorance on the part of regulatory authorities and mistrust between authorities and operators (Schalekamp, Mfinanga, Wilkinson, and Behrens, 2009 cited in Toker-Özkurt, 2012, 79). As a successful example, in Mexico;

> *Regional transportation planning authority has jurisdiction over the seven municipalities and incorporated areas in the outlying suburbs. These organizations control market entry by issuing permits and licenses. They also negotiate permitted routes of operation, set tariffs, and maintain performance standard (e.g., driver and vehicle fitness). Within these limitations, however, private operators are free to operate as they choose, including the hours they work and schedules they maintain. Because of purported oversupply of minibuses, the Federal District has not issued new paratransit permits for many years (Cervero, 1998, 393).*

Definitely, there are still conflicts between experts even in the best cases in terms of integration. For example, in the Mexico example –which is one of the most successful examples in terms of integration of variety of transportation systems- there was an attempt to replace colectivos and minibuses with buses in the late 1990s. At the end, as in other country examples, under the modernization title, removal of the inferior and obsolete paratransit mode is necessary. However, the lobbying activity of the paratransit operators should be managed by the authorities to eliminate the negative externalities during the modernization process.

3.3.3. Relation with Land Use (Urban Form)

The relation between land use development and any transportation mode requires an analysis in detail, because urban form is one of the slowly developing input of transportation affecting measures. According to Vuchic (2007, 86), starting from the decentralization of central activities, following the increase in private car ownership, there should be precautions to control the urban development. Rapid increase in private vehicle ownership (including cars etc.) results with significant changes in modal split however, simultaneous interventions to land use and transit operations can prevent a drastic decrease in transit ridership. With urban rail investments and enlarging bus fleets, micro-scale development control is expected. However, in reality uncontrolled urban development takes place, even around the metro stations scattered residential development take place. The most effective tools on the shares of public and private transport are the set of policies toward land use and transportation (Curtis et al., 2009; Cervero, 2013).

Society benefits from different transportation options depending on their residential locations. Paratransit systems serve especially to the unserved suburban areas, outlying neighborhoods in which the metro cannot operate. That is why; land use is a variable effecting the usage of paratransit as important as car ownership patterns. As indicated by Tekeli (2010, 239) Southern American developing country experiences show the fact that the demand for paratransit services in the households with car ownership and households without car ownership remains similar to each other. That is why number of trips for travelling with paratransit vehicles remains constant. Another important point about paratransit is related with the urban environment that it serves. Paratransit efficiently operates in urban environment, which is developed with respect to private cars both in developed and in developing countries. To make it more clear, the need for paratransit vehicle differentiates in developed and developing countries. While in developed countries, paratransit vehicle mostly operates as dial-a-ride services in suburban areas as a result of urban sprawl, in developing countries paratransit operations take place in either main arteries and subzones of those arteries because of insufficient public transport services. In other words, even though their impact is relatively limited compared with huge investments like metro, their adaptability to private car oriented, sprawled urban environment is higher than any other conventional mode (Cervero, 1998; Tekeli & Okyay, 1981). At that point, an assessment on urban form-transportation relation is vital. Because, the more sprawled the cities are the more people's travel demand is affected by this sprawl, since it gets much more difficult to travel with a single mode. Paratransit modes, different from the conventional modes, operate according to the change in demand. That is why; reliability measure of the paratransit operations has a direct relationship with the urban development.

From that perspective, the relationship between land use and paratransit usage should be considered as well. Paratransit do not directly affects the development of urban form but its performance and its share are directly affected by the changes in urban form. Therefore, land use impacts of dolmuş are another dimension to take into account. If there is a policy for the elimination of paratransit mode, an efficient transportation service on the fringe areas is necessary. In that manner, as mentioned before, paratransit –if exists- has the capability to be the best service type for particular urban areas on the fringe. The challenge is to find the proper mechanism for the efficient operation of paratransit in urban development in the each locality.

3.4. Summary and Discussion

As explained throughout this chapter, paratransit refers to different types of modes in the world. Paratransit emerges intentionally or unintentionally wherever a need exist. Street jitney systems in Houston or New York in the US; Dial-a-Ride Services in London in the UK are not much different from the Jeepneys of Philippines; Matatus of Nairobi or Kombi shared taxis of South Africa or Dolmuş of Turkey (Cervero, 1998; Grava, 2003; Enoch, 2005). Even though there are various names in different localities, the positive and negative characteristics of paratransit vehicles are quite similar.

From passengers' point of view, the quality of the service depends on cost, travel time, comfort and safety measures. Paratransit systems provide a service, which is generally more expensive than the conventional modes, however the quality of the service may be considered by its users to be higher than public transport, even very close to private transport. For this reason, paratransit services kept working in the last century in a variety of forms in developed and developing world. On the other hand, the negative characteristics namely unsafe driving characteristics of the drivers and the challenges for regulation and control by public authorities sometimes create high tensions between drivers and passengers as well as between drivers/owners and local authorities. While traveling quite fast in the peak traffic, users mostly sacrifice from a safe travel option. Mostly, other users are affected negatively because of the traffic jam created by paratransit vehicles.

From the local government’s point of view, paratransit systems have both benefits and challenges for urban transport. They help in meeting mobility needs of citizens, and in many cases, they fill in the gap between demand and supply that arises due to the insufficiencies of the conventional public transport service in a city. However, what is challenging for local government is the basic characteristics of paratransit operations. As explained in detail previously, paratransit vehicles are difficult to regulate and consequently they remain below conventional standards in many aspects. Besides, horizontal organization scheme of the owner/operators complicates the ways to negotiate. Additionally, the last negative aspect of paratransit, which is the congestion effect of the vehicles, should be eliminated however, that means the removal of flexibility, the most crucial characteristic, of the system. In other words, formalizing paratransit operation could mean to eliminate the advantages of the system, resulting eventually in the elimination of paratransit operations.

It should also be remembered that, especially in the developing world examples, paratransit services are self-sustaining systems, which can contribute to the urban economy in terms of employment. Cervero (1998, 390), in his case study in Mexico City, underlines the employment opportunities of paratransit by stating that; Mexico City's paratransit sector has become an important source of urban employment. Informal transport sector does not only cover operational manners but also cottage industries in vehicle adaptation and maintenance of the vehicles are included. All these considerations in job creation are particularly significant in developing countries (Grava, 2003, 250).

In terms of the economy of the city, it should also be pointed out that these services do not operate with expectations of subsidy from the local authorities. In other words, local authorities do not make investments or expenditures to support the operations of the paratransit vehicles:

> *Almost without exception, paratransit is operated by individual private owners or small enterprises, is highly competitive, and is run at a profit. As a result, paratransit places very little burden on city finances (Wright, 1986).*

Nevertheless, this lack of dependence on public authorities and public funds makes paratransit services operate with extreme freedom, resulting in not only in a rivalry between municipal public transport services and these private operators, but also difficulties of route control, fare control, fare integration etc. Besides, they are quite influential in the decision making process as they dominate the transportation service on the main arteries and their horizontal structure makes it difficult to negotiate with them.

In the light of all this information, undoubtedly there is a need for integration for the future existence of paratransit services without losing their positive characteristics but diminishing their negative qualifications for decision makers and for users. The need for transport system integration is quite important for an efficient and fulfilled public transport network.

Considering the challenges and problems associated with paratransit, there is often a tendency of transportation experts (planners, engineers or policy makers) about abolishing the operations of paratransit vehicles. Dimitriou argues that many Third World city officials do not consider the advantages of paratransit, such as the diversity it creates in public transport supply, but instead “given the city's limited capacity to accommodate growing motorised traffic volumes, traditional and informal transport modes are often considered “obstacles” to the modernisation (read 'motorization') of the transport system” (Dimitriou, 1990, 21). What is suggested here by Dimitriou is that, traditional paratransit modes may offer opportunities for a diverse and rich public transport system, and that eliminating them althogether in the name of modernization often results in a system that increasingly depends on motorized transport. In addition, such modernization may be too costly, and maintaining traditional paratransit services may offer low-cost solutions. As explained by Şanlı (1981), for example in İstanbul, the survival of the paratransit services was a result of the decision that investments for the infrastructure enhancements in the foreseeable future would be too costly for the possible new alternative mass transport systems which could fully substitute for the paratransit system in Turkey, i.e. dolmuş and minibus system (Cited in Toker-Özkurt, 2012). This lack of budget is an issue for most developing country cities.

Additionally, transport planners and policy makers should not fail to notice those attributes of paratransit services that are considered as positive and attractive for passengers. While most cities in the world suffer from increased car usage, there is a need to make public transport more attractive and some service characteristics of paratransit are considered as more attractive than those of regular transit by many public transport users. Eliminating paratransit services altogether may have significant impact on travel behavior and transit usage. In other words, the potential of paratransit in providing diverse and flexible services should not be overlooked.

Having said that, problems of paratransit services in terms of the difficulties in regulating routes, stops, fares, vehicle standards, etc., are challenges for creating an effective urban transport system, and they need to be addressed. Regulation on routes is necessary not only to sustain the reliability of services but also to ensure that paratransit does not compete with regular transit modes. Besides, it is necessary to channel these low-capacity vehicles to lower demand routes so that they do not result in congestion in high demand corridors, which should be served with high-capacity transit, such as bus rapid systems or metro systems. These interventions can help create an integrated system, where paratransit can play a role without jeopardizing other public transport modes and the efficiency of urban transport as a whole. For an integrated system, regulation of stops and regulation of fares are also necessary, although flexible stopping and cash payment can often be seen as positive attributes of paratransit from the point of view of users. Nevertheless, in an age when most cities are adopting smart card systems that provide reduced transfer fares or free transfers across the urban transit network, cash payment is a problem that needs to be addressed in paratransit. Similarly, regulation of standards for vehicles and drivers is important so that city authorities can implement coherent policies, in terms of making public transport clean, energy-efficient, safe, and accessible by all.

All of these issues emphasize the need for integration in public transport for the case of paratransit. To underline the importance of system integration, some misconceptions must be corrected. For that correction, it would be helpful to benefit from Vuchic's (2007, 257-258) itemization. The first one is the misunderstanding that transfers are not tolerable. Transfers are desirable between on surface and underground transportation modes if they are fast and convenient. The best transfer systems in the world, namely London, New York, Paris have their integrated systems across all types of transport operations (bicycles, sea transportation, buses, metro, private car etc.). The second misconception is common to the developed world cities and claims that transit hence its integration should include only urban rail services on arteries and public bus services on streets. This planning tendency was strongly supported in developed world cities in the UK, the US, Japan, France etc.; however, it resulted with "bipolarized transit" which created serious damages in the network: a recent upsurge in the development of medium-capacity modes -including BRT, LRT and AGT- has clearly demonstrated the need for a "family of modes" instead of two extremes only. Additionally, there is another misconception, which should be mentioned according to many other experts in the literature: the belief stating paratransit vehicles provide a service, which is identical with the conventional modes and hence can be replaced with the latter rather than being integrated into it. On the contrary, there are many case studies showing that paratransit vehicles are required in meeting the transportation demand, which is not met by the regular public transportation, due to both operational capabilities they offer and service characteristics that appeal to users (Cervero, 1998; Grava, 2003). Cervero (1998, 395) also states that many third world and developed world cities could profit from introducing competitive transportation marketplace, allowing profit-seeking entrepreneurs to seek out new market niches and, in so doing, fill service gaps left by the public sector and in such marketplace paratransit could have a role to play too.

An important point that emerges from the above review of benefits and challenges of paratransit services is that; this issue cannot be tackled from a single point of view, such as that of city authority, or paratransit operators and drivers, or the passengers who may find certain service attributes appealing while suffering from other issues, such as safety and cost of travel. Consequently, any planning and operation policy regarding paratransit should include all stakeholders, such as city authorities that run public transport services, paratransit operators, public transport users, and all other citizens affected from urban transport and traffic.

For the Turkish paratransit case, dolmuş system should be evaluated from that perspective. In a number of cities today, there are projects to better regulate and integrate paratransit services with the rest of public transport. Integration is necessary from the point of view of local authorities that aim at creating an efficient and accessible public transport network and service. Such integrated services would also benefit passengers. There is a need to assess the integration process and the challenges that is possible to emerge. A strategic approach for the reformulation of the dolmuş reality in Turkish cities is needed.

Consequently, the upcoming chapters focus on the Turkish paratransit mode, dolmuş. In the next chapter, the “dolmuş” phenomena will be analyzed firstly in a historical perspective and secondly with a technical perspective. As it is one of the most dominant modes in the cities with the highest population, in the 21st Century an in-depth analysis of this mode in a selected metropolitan area is indispensable. For this purpose the study will focus on Ankara and in particular the role of this mode in accessing a major university campus within Ankara. After a comprehensive analysis and evaluation, there will be a discussion on existing integration policy projects and possible integration proposals that take into account expectations of particularly the users of this system, but also their operators and the local authority that is in charge of providing an efficient and effective public transport service to the city.

CHAPTER 4

4. DOLMUŞ AS A PARATRANSIT MODE IN TURKEY

4.1. Evolution of Dolmuş As an Element of Turkish Urbanization Process

In transportation studies, statistics, spatial representations, legal regulations can explain the reasoning of the operations of conventional modes; however, the tangible reasons of the existence of paratransit mode in any country, requires additional research. As in other social phenomena, which are shaping up the society, to understand paratransit modes' operations in Turkey, urbanization process of Turkish cities and the needs of migrant populations should be evaluated in detail. In order to address the contemporary problems, which are related with Turkish paratransit mode "dolmuş", it is important to have an in-depth understanding of Turkish urbanization with its various dimensions that also include transportation.

Before starting the socio-spatial analysis, a linguistical analysis is essential. The reason for that need is the fact that "dolmuş" not only represents a transportation mode but also a culture, which is characteristic to Turkish cities and Turkish society. As transportation is a derived demand of societal needs, characteristics of the society and society's living environment is vital for the analysis. The term "dolmuş" linguistically states, "being full" or "being filled" and represents the fulfillment of the capacity. In terms of transportation, it represents the transportation vehicle being full with the passengers. It is stated by Tekeli and Okyay (1981) that the term dolmuş was firstly coined for the boats, which were operating in İstanbul in the late 1870s. In the contemporary situation, the term dolmuş constitutes all types of informally emerged transit vehicles in Turkey. It has a variety of different names; taxi-dolmuş, minibüs-dolmuş, minibüs etc (See Figure 6 and Figure 7).

Figure 6. Minibüs-Dolmuş Vehicles in Ankara, Turkey (Wikipedia, 2016)

Figure 7. Taxi-Dolmuş Vehicles in İstanbul, Turkey (Birgün Gazetesi, 2015)

There are quite a few number of scientific studies about the dolmuş. Like the other informally emerged phenomena, dolmuş was quite difficult to be worked on and that fuzzy-side of urban transportation was not easy to study. The study of Tekeli and Okyay; "Dolmuşun Öyküsü" (The Story of Dolmuş) could be called as the main reference guide about the evolution of dolmuş until the year 1981. A brief summary is needed to understand the existing characteristics of dolmuş today as a paratransit mode. The characteristics of Turkish paratransit mode dolmuş in general can be summarized with 13 aspects (Tekeli & Okyay, 1981, 8-9):

- Passengers get on the vehicle one by one (there are no proposed stations)
- Vehicle departs when it is on capacity, i.e. when it is full

- Departures are not scheduled
- There are no fix fares
- Service provision is easily adaptable to the travel needs of users
- It provides a service, which is easily adapting itself for the needs of the users, who have similar travel requirements but do not have an organization among them
- Operators are mostly individual entrepreneurs
- It is a kind of marginal sector in transportation service
- Vehicles are mostly designed for another type of conventional service and after the purchase they are modified depending on the needs
- It mostly operates higher than the regular load capacity in the peak hours
- Vehicles are mostly small-size or mid-size vehicles (taxis or minibuses)
- It competes with the conventional public transport systems
- It is not a service that is special to a specific transportation type (automobile, motorboat, plane, bus etc.)

In the light of that emphasis, an evaluation of dolmuş operations is possible with regard to the common characteristics of public transport operations, which were given in detail in the beginning of the Chapter 2. In the table below, it can be seen that dolmuş operations cover only three of the public transport qualifications completely. Nevertheless, dolmuş operations do not perfectly satisfy the other three qualifications of public transport. These missing or partially covered qualifications make dolmuş operations a true example of paratransit in Turkey.

Table 1. Common Public Transport Qualifications of Dolmuş Operations

Common Qualifications of Public Transport Services	Providing Accessibility to everyone (with a payment for journey)	Enabling journeys made by different passengers at the same time	Having a certain price	Operating on a pre-determined route	Having pre-determined schedule, which includes service frequency and times	Stops in pre-determined stations which are basically access points to the system
Dolmuş Operations	Provides completely	Enables completely	Have completely	Operate partially	Has partially	Do not have the feature

As in other developing country examples dolmuş as a Turkish paratransit mode is quite dominant in transportation network where it exists. The capacity of dolmuş vehicles vary from 5 to 15 people. Routes are pre-determined for dolmuş today, however the qualifications that still make it a "para" transit mode are its flexibility in terms of getting on-off and time adaptability during daytime (frequent in peak hours, infrequent in off peak hours). Minibüs-dolmuş –in the context of this study referred to as dolmuş- (a type of jitney service) is one of the most widespread operations of Turkish paratransit services. With its 15 people capacity, this jitney like minibus vehicle is quite dominant in metropolitan areas. Actually, the domination of this jitney service is not a coincidence. As the capacity of this vehicle is relatively low, service frequency is higher especially in the morning and evening peak hours when compared to the conventional bus systems (Kılınçaslan, 2012, 134). About the service vehicle size of dolmuş, Tekeli and Okyay (1981, 14) indicated the following:

> *From a different perspective, if dolmuş vehicle was operating with buses, loading times in the beginning of the trip would increase and (as dolmuş is a vehicle, which departs, when it is on capacity) off-peak hours departure frequency would be lower. That would inevitably decrease the efficiency in the off-peak hours.*

That operational characteristic, which makes dolmuş advantageous compared with conventional modes, have actually evolved in years. The evolution of the needs of "dolmuş passengers" directly bred the evolution of dolmuş operations in terms of vehicle type, operation systematic and fare regulations. To explain this evolution a brief analysis of the development of a dolmuş route in any city would be beneficial. Tekeli and Okyay (1981) have represented the regulation and steps of a new paratransit route as follows:

- The first step is to define the starting and finishing point of the trip and hence the first and the last station of the route. It is needed to regulate the trip demand. Thus, the passenger can know where to find the dolmuş.
- The second step is to ensure that the dolmuş waiting at the first station will be full enough. Since the vehicle, departs when sufficient passengers have boarded, the first station is important. Passengers expect to get on and off anywhere they want; on the other hand, drivers usually want to use the

defined points to let passengers get off and undefined points to take passengers. Thus, there usually occurs a contradiction between aims of controllers and features of dolmuş vehicles.

- Another step is to define the vehicles that will operate in that route. This is commonly done by placing a signboard of the route to somewhere on the vehicle. Actually, standardization of vehicle types according to their brand name or model is also preferred to operate at the same route.
- Another step is to determine the fares that will be collected from the passengers. This is generally determined by the municipality (Toker-Özkurt, 2012, 71).

With that key information about understanding the dolmuş phenomena, a chronological emphasis would help to understand the reasons, which makes dolmuş preferable –even one of the most dominant transportation choices- in the 21st Century in Turkey. There are questions that should be answered respectively: What were the reasons, needs, social facts that resulted with the emergence, rising and stagnation of dolmuş? And what are the reasons that help the survival and current presence of dolmuş? In the upcoming parts of this section, answers to these questions will be explored.

4.1.1. Early Period of Dolmuş (Emergence-Development)

Historically, with the establishment of the Republic of Turkey in 1923, a substantial urbanization process started to take place. Establishment of the Republic was the beginning of belated industrialization process of Turkish nation. However, firstly budget inadequacies after the 1929 Great Depression, then pre-war developments and finally Second World War slowed down the urbanization process (Tekeli & İlkin, 1977; Tekeli, 1987, 65). Dolmuş firstly emerged during that period. Following the 1929 Economic Crisis, Turkish citizens were looking for recovery methods for their monetary losses. According to an old newspaper, a restaurant owner in Cağaloğlu, İstanbul, introduced “dolmuş”. After the 1929 Economic Crisis aforementioned man closed his restaurant and started to operate a taxi at first. However, as consequence of this economic impasse, the taxi operator who has a much more regular customer than other drivers transformed his service to one that enabled his regular customers to travel with their friends (Tekeli & Okyay, 1981, 3). That service type, which was quite similar to shared-taxi services, is referred to as the start point of the dolmuş service in Turkey. This service was named as "taxi-dolmuş" in the beginning. Vehicles were mostly old modelled automobiles and the capacity was mostly up to 5 people. While for the Istanbul case the emergence happened unintentionally, for the Ankara case the emergence happened in a different way. As explained in the historical development of Ankara in the upcoming sectons, in the early 1920s most of the transportation demand was met by walking because of city size. With the declaration Ankara as the capital, the increasing transportation demand was met by private entrepreneur vehicles named "kaptı-kaçtı". Starting from 1935 municipality gathered all public transport operations under its own structure. In 1944, budgetary insufficiencies hindered effective public transport services and this enabled private entrepreneurs to introduce a new transportation mode and the first dolmuş type; taxi-dolmuş was born. After many discussions, an agreement was signed between the drivers and the public authority. With this agreement taxi-dolmuş vehicle started to operate on the routes which were between the old and new centers and between the old center and residential areas of the capital (Tekeli, 1987, 67).

For the Turkish paratransit case, five major breaking points can be identified historically, and these will be highlighted throughout the text including the upcoming sections. The first breaking point[1] was the introduction of dolmuş system into the transportation network. This introduction was not problematic for municipal operations because private and public operations were not challenging each other; on the contrary, they were operating on different routes. However, in both Ankara and İstanbul, the longer the dolmuş operations period, the more they become an important element of the transportation system. As in other country examples, their own organizational associations gained ground in cities and between the 1940s and 1960s, dolmuş operations became widespread and legal in the metropolitan areas. This legalization brought along the entrance of dolmuş vehicles into the routes, which were formerly served by public transport services. As most of these areas were central or close to the center, they had high accessibility and related to that, they included high profit for public transport operators. That was the second breaking point[2] in the history of dolmuş itself. With the introduction of the vehicles to central lines, never again it had been possible to stop their operations on the central, profitable lines. With this second breaking point, dolmuş completed its birth and emergence period and started to be the dominant mode in urban transportation. Until the mid-1950s taxi-dolmuş services operated with taxis and mostly at a relatively higher price than municipality buses. Even though dolmuş vehicles were operating on the central lines, they were providing a service different from the conventional public transport.

4.1.2. Rising-Period of Dolmuş (Evolution-Lobbying)

The US was the main exporting country of the post-war period and Turkish urbanization got its share from that political power conversion. In post-war period Turkey, there was a great foreign currency stock during the late 1950s and Turkish citizens were able to buy a lot of US made automobiles during that period. In the mid-1950s, taxi-dolmuş service started to diversify and evolve. As the rapid urbanization continued in major Turkish cities, migration from rural to urban areas started to increase incrementally. That resulted with a new form of paratransit in metropolitan cities, which was named as minibus-dolmuş. Surely, the emergence of minibuses was not only a result of the rapid urbanization but also an outcome of the emergence of a new class, named as newcomers (migrants). In the post-war period, Turkey dealt with the consequences of rapid urbanization with the ever-increasing urban population arriving in cities from rural areas with the expectation that cities would provide wider opportunities of employment. Rapid urbanization, fueled by the migration from the rural areas to the major metropolitan cities, affected the urban form directly. Housing supply in cities were not sufficient for the influx of newcomers, and hence the newly arriving migrants met their housing need by building their own houses, known as "gecekondu", another form of informal sector since they were unauthorized housing without permits. Gecekondu development took place on the urban fringes; however, as they were not legal and authorized developments, public transport services were not planned and operated to serve these areas (Şentürk, 2015). Neither the water and sewage services were provided to these unauthorized areas, nor publicly operated transportation services like bus operations. Only after these neighborhoods reached a particular size and population, municipalities started to provide both road infrastructure and bus services, often with motives of political gains. Karpat (1976, 144-145) explains the importance of having a public transport service to the squatters at that period with the following statement:

The squatters derived a feeling of equality from the fact that they travelled in common with other city residents. "Before the bus came," explained a squatter, "We were a village near İstanbul. Now we have become a semt, a district on the outskirts of the city". Others said that travelling on the bus forced them to learn polite manners and helped them to save the time lost walking to work places.

In general, this phase of being left without urban transport services lasted for 15-20 years in most of the gecekondu areas and that significant period was surpassed by the dolmuş services in cities like Ankara and İstanbul, which are the biggest urban areas in Turkey. With the power of meeting travel needs of particular groups of the society, dolmuş operators not only consolidated their ground in transportation network but also started to enjoy the license rents with the limitations of vehicle numbers. During the 1960s, dolmuş created its variations to strengthen its position in total transportation network on the one hand, and with the increased rents it became a lobby that started to interfere into the decision-making processes on the other hand. Additionally, in 1961 there had been a vital change in the development of Turkish motor vehicle sector. Starting from that year the production of the minibuses started to take place in Turkey (Tekeli, 1987, 68). That industrial enterprise was the third breaking point[3] in the history of dolmuş. It brought along the ease of repayment, the change of central authority policies and the consolidation of motor vehicle producer lobbying.

On the other hand, during that period, while industrial facilities were developing, their need for qualified labor force was increasing, too. The impact of dolmuş on qualified and unqualified workers appeared in different ways. Qualified workers were mostly early coming migrants in the city. They were mostly dwelling in the older gecekondu areas. They chose their district independent from the factory locations. That is why; qualified workers needed their own transportation options for commuting (home to work) trips. Private sector industrial corporations were unable to provide special services for employers. That is why; informal dolmuş services met that mobility demand of labor force. Even some dolmuş routes were especially designed to connect these fringe settlements and industrial areas (Tekeli et. al., 1976, 338). For instance, minibus services operating between gecekondu areas and industrial areas emerged spontaneously in metropolitan cities. While gecekondu was a kind of mechanism that minimizes distances between home and work, dolmuş or minibus services were the services, which ease the transportation between home and work for workers. Both of them emerged independent from industrialist's supports. Both of them are balanced by the system itself. Nevertheless, both of them promote decentralization of industry and location decision of the industrial facilities on the urban fringe (Tekeli et. al., 1976, 339). On the other hand, from the non-qualified workers perspective, existence of dolmuş operations became the job itself. To make it more clear, the employment need of newcomers (a new group migrated from rural to urban areas) emerged as an outcome of huge migrations. As industrialization started to develop recently and most of the newcomers were low skilled workers, there were not enough job opportunities. This inefficiency in employment supply resulted in the emergence of informal transit services. Related to that, sub-sectors related with the dolmuş operations emerged. In other words, in a period of affordable private car purchase, newcomers created their own job opportunities with dolmuş operations and with subsectors feeding dolmuş operations (Kılınçaslan, 2012, 26). Not surprisingly, the last stations of the minibus dolmuş operations were around the squatter settlement zones (which are also another type of marginal sector). As a paratransit mode, dolmuş vehicles were operating according to the needs of their customers. Interestingly, population who are residing in squatter settlements were not getting off in the closest central business district but in the business zone which fits best to their own work function. That is why; the trip generation and attraction points of dolmuş vehicles were in the old center, where a huge demand for low quality labor force existed (Tekeli et. al., 1976, 20).

Expectations of the public authorities and experts were the disappearance of dolmuş services the introduction of the conventional public transport services. For example, in their book Tekeli et al. (1976, 158) stated that with the improvement of conventional modes, namely convenient public buses, fast streetcar services and maybe a metro system, maybe these conventional modes would take the place of the dolmuş vehicles. However, contrary to expectations, which assume that conventional public transport services will end the operations of paratransit, dolmuş operations continued after the city authorities started to operate buses to serve these areas. Bus was unable to be a competitor of dolmuş because of advantageous characteristics of paratransit mode dolmuş, which have been explained in detail in the previous chapter. Besides, because of the limited budget of the local authorities during the 1970s, the existing bus network was unable to provide a service that could match dolmuş in terms of comfort and frequency.

Empowerment and lack of regulation to dolmuş vehicles were making it difficult to solve that kind of operational problems. The engines-off strike of the Confederation of the Turkish Drivers and Automobile Association was another breaking point[4] in terms of dolmuş operations. Municipality officials noticed the importance of public transport management and integration after this strike. This paradigm shift took place in different manners. Many of the projects following the 1980s were a result of breaking the monopolistic situation of private entrepreneurs on urban transportation networks of metropolitan cities.

4.1.3. Recent Period of Dolmuş (Stagnation-Obsoloteness)

Dolmuş was one of the innovative ideas of the migrants to survive, not only to serve the needs of transport but also to become a "real" citizen and to gain a position in the society. In their book Tekeli and Okyay (1981) emphasize this by stating that dolmuş was both the solution and the problem itself. The solution of the huge migration and population booms would not be possible without creating that kind of innovative ideas for the migrants. Additionally, Sencer (1979) emphasizes that, it is a necessity for newcomers to develop traditional mechanisms (or sectors operating with traditional mechanisms), which would enable their integration to the urban society and the city. However, as an innovative migrant idea, starting from the mid-1980s dolmuş secured its own status quo in transportation network. One of this status quo design emerged in Ankara network, as consequence of the cancellation of station-dolmuş vehicles, which were one of the variations of dolmuş. In 1983, the municipality canceled the operations of station-dolmuş vehicles. That was the final breaking point[5] in the history of dolmuş. There were two main reasons for the importance of that kind of decision. The first one was that; dolmuş used to be a mode operating in different forms. That was enabling dolmuş to provide different types of services for different social groups. Furthermore, minibus-dolmuş vehicles eliminated one of the transportation modes, which were actually a member of dolmuş (paratransit) family. In other words, dolmuş was diminishing the first legal form (as mentioned in early period of dolmuş) of itself. The second important change affected the transportation choice of different groups. Until that year, dolmuş was a service between private transport and public transport. Especially taxi-dolmuş operations were helping to prevent the middle-class to gravitate towards purchasing cars. That decision created a public transport network provided by buses and minibuses. Low comfort, relatively late take-off times and most importantly operational similarity of dolmuş services as a whole directed the attractions of middle classes from public transport to private cars. Surely, cancellation of station-dolmuş services was not the only reason of the increase in car purchases. Actually, car ownership levels were increasing in Turkey for many years. However, dolmuş operations was a kind of threshold which were preventing some groups from purchasing cars and that decision demolished that structure of dolmuş. Dolmuş was successful as a prevention mechanism because, as stated before it was providing a service between public transport and private car (Grava, 2003; Adam Smith Institute, 1989; Tekeli & Okyay, 1981). The evolution of the dolmuş –including five breaking points in the last 90 years- could be followed from the figure below (See Figure 3).

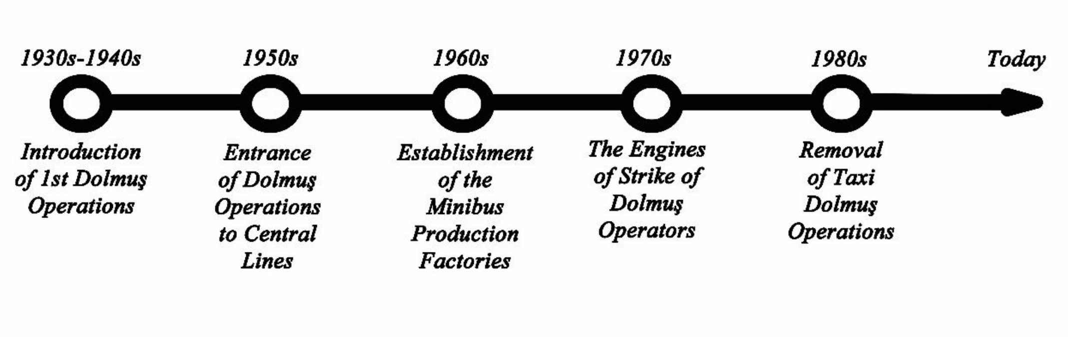

Figure 8. Historical Breaking Points of the Dolmuş Operations in Turkey

The 1990s were the years of urban rail system investments in metropolitan cities in Turkey. From 1996 onwards in Ankara and from 1989 onwards in İstanbul municipalities, the municipalities introduced light rail and metro operations. The opening of these first metro lines could be another breaking point in the history of dolmuş; however, a disintegration problem emerged with the transition to electronic ticketing and routing. Cash payment opportunity and tendency of operators on the main arteries was not supporting the metro operations. While in the 1970s dolmuş vehicles were supporting the transportation supply by complementing the inadequate public services, in the 2000s dolmuş vehicles were actually diminishing the efficiency of the publicly operated public transport operations by competing them. As presented in the upcoming chapters, even on the main arterial metro corridors, dolmuş vehicles were restraining the efficient operations of public transport. Uncontrolled public transport operations of the municipality, namely; the introduction or suspension of public transport operations instantaneously, not developing a ticket or route integration policy between public and private transport, introduction of huge public transport investments without supporting land use decisions and developing a transportation network based on private cars resulted in a loss of passengers in publicly operated public transport.

4.1.4. Dolmuş as of Today

As stated previously dolmuş is both the solution and the problem itself in Turkey. In the beginning of the 20th Century, dolmuş system emerged as a public transport substitute as a result of the inadequacies in the conventional transit system in Turkish cities. By providing both transportation service and job opportunity it became a substantial solution for the migrants. Nevertheless, after the 1980s, its operations were unable to evolve according to the contemporary needs in terms of cost, reliability and comfort and it evolved into a problem in the network. Especially with the increase in the income of middle-class groups, it became the only and the greatest problem focus in the metropolitan cities. However, it should be mentioned that even if it creates a problem in today's modern urban environment, it still exists because of a total inadequacy in the network (Şanlı, 1981). Dolmuş evolved into different forms in the last 60 years as a response to the change in travel needs and the regulation in transportation services. Its adaptability to the existing needs made it survive until today. Besides, urban development –as indicated before- eased the adaptability of dolmuş operations. From the basis of Ankara network as the capital city with a transportation network dominated by dolmuş, it is important to emphasize that the CBD oriented development increased the impact of land use on dolmuş use. To make it more clear, a strong CBD mostly results with high ridership levels coming through the center. Cervero (1998, 84), points out that influence on Toronto, Canada (with a

CBD that is among the highest levels of employment and retail primacy in North America) with the following statement:

> *About 65 percent of all trips entering the CBD and historically well over 200 transit trips per capita, per year; higher than in any U.S. metropolitan area, including greater New York. These outcomes are due in considerable part to the presence of a regional planning body (Metro) whose chief responsibility has been to orchestrate regional growth, in particular the co-development of railway services and land development.*

It was mentioned in the previous chapters that, paratransit vehicles are mostly a better substitute to private cars compared with the conventional buses. In other words, private car oriented urban development created an environment, which is much more suitable for paratransit operations compared with the conventional modes.

According to the conceptualization of Tekeli and Okyay (1981), it is not possible to explain the continuity of dolmuş system currently with conventional approaches. There are three main misconceptions in writings and discussions regarding the dolmuş. The first one is the belief that, dolmuş provides a service which is identical to the conventional transit services. This common misunderstanding has been explained in detail in the previous chapters. If that was true, especially in the municipalities of Ankara and Istanbul, the share of dolmuş should have decreased dramatically, however that is not the case. Even in the areas with rail rapid transit provision dolmuş still exists. The second misconception is that bus, metro or other conventional modes provide a cheaper service than dolmuş. In practice, it appears that way, however -when in vehicle-out of vehicle travel times and other benefits of dolmuş are considered- in reality, dolmuş can provide a much more convenient, fast and comfortable service that balance the price difference. Third and the last misunderstanding is the belief that as dolmuş operators are horizontally organized, they are unable to create an effective lobby influential on municipalities. Maybe in the early periods of dolmuş operations this statement was true; however, today being one of the most dominant transportation mode, dolmuş operators are quite influential on the decision making process in the locality.

In the next part, the existence of dolmuş will be emphasized in detail in a specific case, according to the historical development of Ankara transportation network. The aim of this historical emphasis is to show the development of paratransit modes and conventional modes and to determine the situation of dolmuş operations in a metropolitan city.

4.2. Historical Development of Ankara Transportation System and the Role of Dolmuş

Ankara was declared as the capital city of Turkey in 1923. Since then the city changed from a 20,000 population city with motorized trips comprising less than 10% of total transportation; to a 4,500,000 population city with more than 80% of all trips made by motorized modes (Demirtaş, 2009; EGO, 2015a; Tunçer, 2001). Surely, that resulted with significant changes on urban macroform. There is a bilateral relationship between urban macroform and the development of urban public transport services. In urban planning literature, it is important to point out that if there is a service provided to an area, this provision supports the development of that particular area. On the other hand, if there is urban development in an area, it forces the development of transportation service improvement (Tekeli, 1987, 65). For the Ankara case, it would not be wrong to say that mostly urban development took place first and then, urban transportation services followed this development. To provide a better understanding of this historical context, in the first section of this chapter, a brief history of Ankara transportation system is presented. In the second section, the evolution of paratransit vehicle dolmuş is described in detail for the Ankara case including incidents, needs and requirements that helped the emergence and the existence of dolmuş. In the last section, current situation of dolmuş and contemporary issues and problems regarding urban transport and dolmuş in Ankara are presented, followed by a discussion that forms the basis of the research methodology for this study.

4.2.1. Early Period (1920-1960)

At the beginning of the 1920s, Ankara was a densely crowded citadel town of 25,000 population and was a city of pedestrians because of both topography and size (Tekeli, 1987, 65). There were two major animal powered transportation options.

Horse carts were operating between the vineyards around the railroad station and periphery. With the establishment of the Republic, the number of automobiles started to increase and with that change transportation options started to diversify. However, starting from 1923, Ankara experienced a planned development. Lörcher Plan in the first hand and then Hermann Jansen's plan was applied by the founder government (Tunçer, 2001; Cengizkan, 2004). The 1930s were the period of expansion of old city center. City was growing towards Yenişehir in the south and Cebeci in the east with a rapidly increasing population. Houses in the vineyards that used to be summerhouses became permanent residents. Parallel to this, motorized transportation demand started to increase. This demand was initially met by small buses, named "kaptı-kaçtı": these "small enterprizes were the first type of privately operated public transport operations" (EGO, 1987, 12). Local authority regulated *kaptı-kaçtı* ticket fares and vehicles were radially operating on 12 lines from Ulus to the new growth areas and to the vineyards (Mamboury, 1934, 24). However, the old city center, which has topographical limits, were not in *kaptı-kaçtı* operation zones. Nevertheless, due to low motorized transportation demand (distances were shorter in old inner city compared with the fringe areas) motorized vehicle transportation need was not high. The first contribution of public enterprise to the urban transport during these years was the opening of a 9 km suburban train line operation between Ankara and Kayaş in 1929 (EGO, 1987, 12). This was an attempt to make use of existing infrastructure for urban needs rather than making a new urban transport infrastructure investment. With the change of accessibility matrix in Ankara, a need for the management of public transport operations emerged. With the Council of Ministers decision on 22 January 1930, all possible future public transport operations namely bus, minibus and electric trams, were turned over to the management of Ankara municipality. However, for five years the municipality did not make use of this franchise. With the introduction of buses, which were bought from the USSR, the municipality officially started to operate urban public transport services with the name of "Bus Department of the Municipality of Ankara" in 1935 (EGO, 2015). In that year, there was an average of 40 buses operating on 15 lines (Tekeli, 1987, 65). With the operations of municipality public transport services, *kaptı-kaçtı* buses began to operate on the peripheral routes, which were not in the operation zone of municipality buses. At that point, it should be mentioned that, during the mid-1930s there was an excess supply of public transport. The Economic Depression was affecting the economic development of the Republic of Turkey. However, the public sector was able to create an excess supply in Ankara. During this period, motorized trips constituted only about 22% of total trips due to urban form (EGO, 1987, 12). Within this period, 60% of the motorized trips were by train and municipal buses; and 35% traveled by private operators namely taxi, horse carts and *kaptı-kaçtı* buses.

The 1940s created budget insufficiencies for the municipality. Bus fleet was unable to meet the demand (Öncü, 2009). In addition, the Second World War was affecting international transactions. That is why, it was not possible to import spare parts for the 215 buses; therefore, they were often out of service (EGO, 1987, 12). To increase the bus services, which were insufficient, public officials decided to modify a number of trucks and convert them into passenger vehicles by changing their dumpers with bus bodies. In 1944, Ankara Bus Operating Unit, which is an annexed budget institution, was established (EGO, 2015). Meanwhile, privately operated *kaptı-kaçtı* buses were also suffering from a lack of spare parts. For the solution of that problem private entrepreneurs introduced shared-taxi (which was called later as taxi-dolmuş) solution for the first time in Ankara (Tekeli, 1987, 67).

The development of new means of transportation resulted in an increase in the shares of public transport in motorized travel. During the mid-1940s, the share of public vehicles in total motorized trips was about 70% (EGO, 1987, 12). However, that high percentage did not continue for a long period. The number of public buses was 140 in 1945, and unfortunately 18 of these buses burned during a fire in the bus garage in 1946. To balance the sharp decrease in the number of public buses, cabinet decided to support Ankara public transport service with the additional buses from İstanbul and Hatay municipalities (Tekeli, 1986, 67). This period was a turning point for the public transportation network, because with an attempt of Ankara General Automobile and Driver Association during this bus scarcity, taxi-dolmuş services began to operate between Ulus-Cebeci, Cebeci-Sıhhiye and Ulus-Bakanlık directions which were the central and profitable lines (Öncü, 2009). The consolidation of paratransit vehicles in total transportation network started with this particular decision because, after this decision dolmuş operations could not be taken out from the city center. In 1947, the first trolleybus network of Turkey was established with

10 trolleybuses in Ankara. The bus-depot fire accelerated the purchase and the 10 km-long Bakanlıklar-Ulus-Dışkapı route was established (EGO, 1987, 13). Nevertheless, between the years 1945-1950 while the share of publicly operated transit in daily-motorized trips was decreasing to 50%, the share of privately operated transit increased up to 45%. In 1950 the majority (13) of 21 municipal bus routes were radially emerging from Ulus however, they were not perfectly meeting the newly emerging transportation demand as a result of the spread of CBD functions to the newly developing areas. To increase the efficiency of public bus lines, start points of municipality buses were taken to new development areas; 3 in Bakanlıklar, 2 in Cebeci and 2 in Samanpazarı (EGO, 1987, 13). That also resulted with the spread of some central functions to the newly developing sub-centers in the city.

On the first day of 1950, Municipality Bus Operations was combined with Electricity and Natural Gas Operations of the municipality and "Ankara Electricity, Gas and Bus Operations (EGO)" was established. In the first half of the 1950s, with the introduction of new buses, new bus garages and trolleybuses on Cebeci-Bahçelievler route, fleet enlargement projects were continuing. Number of trolleybuses increased from 10 to 33 in 1952 (EGO, 2015). EGO modernized and increased the size of its bus fleet through continuous purchases between 1950 and 1954 (EGO, 1987, 13). With all of these developments passengers travelled by municipality public transport vehicles increased by 2.7 times in just five years (Tekeli, 1987, 67). The efforts of EGO resulted with 3.5 times increase in patronage for overall public transport within five years; however, the share of public sector slightly increased from 55% to 60% (EGO, 1987, 13) Because, during that time, private entrepreneurs had the opportunity to enlarge their car fleets with the help of the increasing imports. By that way, private entrepreneurs developed their car parks and increased the number of passengers they carried, too. In a report prepared for Ankara Urban transportation in 1959, Leibrand criticized the 70% Ulus centered radial bus operations of EGO and proposed diagonal routes extending from one end to the other end of the city (Tekeli, 1987, 68). As stated by the Leibrand, public transport operations were losing share in total network. As a result, in the second half of the 1950s private entrepreneurs became the dominant operator in the city center and increased their share in total motorized trips.

During this period, insufficient services of EGO buses resulted in the emergence of minibus-dolmuş (a type of jitney system) –which was a new paratransit mode with a carrying capacity of eleven seated passengers- operating by private entrepreneurs. Rapid increase of the minibuses resulted with 330 minibuses operating between Aydınlık-Çankaya and Bahçeli-Dörtyol directions in 1959 (EGO, 1987, 14). Actually, this trend was partially supported and partially blocked by urban plan of the city at that time, knowns as the Yücel-Uybadin Plan that came into effect in 1957. The plan proposed the development of old center Ulus and new center Kızılay started to take place and this planning decision firstly resulted with the decline of commuter rail for urban transport (Öncü, 2009). That was the partial support of the plan for paratransit by declining the use of urban rail systems. However, new development plan also evaluated the existing road networks in detail and made proposals for the solution of existing transportation related problems. These attributes of the plan could have become instruments to block the rapidly increasing paratransit operations and to increase the inefficient operations of EGO buses. Nevertheless, in the upcoming period until the 1980s local authorities gave their focus on developing urban rail projects or highways. To set an example, in 1957, to increase the road capacity, pedestrian pavements and wide refuge in the middle of Atatürk Boulevard were narrowed and most of the trees were removed along the boulevard. With this change, traffic lanes increased from a total of 4 to a total of 8 (total of two directions). This motorway enlargement project was one of the pioneers of the following years' highway oriented urban transportation approach in the Ankara case.

4.2.2. Mid-Period (1960-1990)

The 1960s were the period of highway-based approaches in urban transportation and for the development of urban macroform both in Turkey and specifically in Ankara. EGO fleet parks, number of operating lines remained almost stable and that resulted with a significant decrease in total passengers travelled during the 1960s and the share of publicly operated public transport decreased to 30% in total motorized trips (EGO, 1987, 14). Although the trolleybus lines were extended with the introduction of new vehicles, that did not help to increase the share of public transport. This period was the period in which public transport was declining and privately operated public transport were progressing and institutionalizing. The main reasons of this kind of change were firstly the establishment of minibus production factories in Turkey at the beginning of the 1960s and partially the increase in the number of minibus lines and numbers (Öncü, 2009). In 1961, 315 minibuses were given licenses to operate on 10 lines and with the annual increases this reached to 759 minibuses on 25 lines in 1968 (EGO, 1987, 14). However, to control the superficial operations of the individual operators in the year 1961, Ankara Municipality prepared a set of legal regulations. The linear service routes of the minibuses became radial routes, which were generating from mostly the old center (Ulus) or in a few numbers from the new center (Kızılay). Also in 1961, the local authority forbid the entry of further minibus-dolmuş vehicles into the market. These central lines, which used to be served by minibuses, started to be served by station-wagon dolmuş vehicles with 8-person capacity. This service was basically station-wagon vehicles operating on the central lines introduced by private entrepreneurs as a result avoiding the violation of rules. While their numbers were only 18 in 1961, it reached to 1750 in 1969 quite similar with minibus services. The important differentiation of dolmuş emerged as a result of this. With the introduction of minibus-dolmuş and station-dolmuş vehicles paratransit vehicle passengers differentiated. While minibuses were operating between the old center (Ulus) and low income residential areas, taxi-dolmuş were operating between the new center (Kızılay) and mid-high income groups' residents (Tekeli, 1987, 68).

Between the years 1969-1977, the number of public transport vehicles and small-scale entrepreneur vehicles were limited. Because of this limit, operators were unable to purchase new buses or minibuses. As a reflection of this, minibus dolmuş and taxi dolmuş vehicles started to operate with more passengers per trip. That resulted with longer morning and evening peak hours. The extension of peak hours was only possible with out of vehicle travel time increases and adaptability in the working hours of the labor (Tekeli & Okyay, 1981, 68). While minibus and station dolmuş vehicles were in competition with EGO lines in the city center, there was no rivalry for about 26 EGO operated lines in the low density areas mainly located in the periphery of the city (EGO, 1987, 14). However, these peripheral lines were mostly less profitable. In other words, there was no competition on these peripheral areas because dolmuş operators were not willing to serve them as they would not get high profits from these fringe areas.

While public transport network became unintentionally private entrepreneur oriented; there was also a sharp increase in taxi services between the years 1960-1965. Number of taxis was restricted in 1966 with 7500 vehicles to stop this sharp increase. The same approach applied for station-dolmuş vehicles also in 1969 (Tekeli, 1987, 68). To control traffic congestion, the numbers of both taxis and dolmuş vehicles were restricted; however, insufficient service of publicly operated public transport services resulted with long queues in public transport stops in the city center and an increase in private car ownership (Öncü, 1979). Indeed, one of the most important developments during this period was the rapid increase in private car ownership due to the domestic manufacture of these vehicles in Turkey: Anadol in 1967 and starting from the early 1970s Renault and Fiat factories produced automobiles locally (EGO, 1987, 15). This resulted with the decentralization of high-income group residents on the peripheral areas; and the urban macroform and consequently the transportation demand distribution on space completely changed within years.

The 1970s witnessed the dominance of private enterpreneurs in the Ankara transportation network. Initially, paratransit operators enlarged their share in the market by increasing their fleet size; afterwards they started enjoying "rents of institutionalization" by limiting new entrants to the market (EGO, 1987, 14). EGO, on the other hand, purchased large number of buses on 1969 and did not purchase a single bus until 1977. By 1975, the share of private car passengers was equal to public transport passengers in total motorized trips (Tekeli, 1987, 69). That created a vicious circle for the Ankara case, which continues currently. As mentioned before, the more the private car usage, the more peripheral residential development of high-income groups took place and it continued like that interactively between private car purchases and residential location decision of high-income groups perpetually. At the same time, it was uttered by some municipality officials that there was a need for parking garages in the city center (Öncü, 1979).

The ever-decreasing share of municipality transportation services enforced the officials to prepare a transportation study. With the cooperation of a French Firm called SOFRETU, the first transportation study of Ankara Metropolitan Area was prepared. For the first time for Turkey, a need for an urban rail system was declared with this study. Unfortunately, the central authority did not approve the project. Only the improvement of commuter rail resulted with an increase in train passengers after 1972. However, this increase was minor when compared to the increase in motorized trips. In 1975, the share of the public sector was less than 20% in public transport (EGO, 1987, 14).

In the 1970s, there was another important development that affected urban growth and transport. Ankara Metropolitan Area Planning Bureau (AMANPB) was established in the 1970s and started preparing a metropolitan plan for the city, which would have strong impact on urban development patterns, transport network and public transport. Until the 1970s the spatial growth of the city was limited due to the dependence on lower-speed transport modes, such as buses, dolmuş and walking. In the absence of relatively higher-speed modes, such as urban rail systems, and due to the still low ownership and usage of private cars, urban development occurred only at the fringes, resulting in a compact and high-density urban form. However, the low quality coal heating and low quality oil usage in the center caused a decline in the environmental quality of the inner city due to this compactness and intensity of development. In the year 1970, the tension around the CBD was quite high, because the population was very high compared to the previous master plans. For the elimination of that problem, AMANPB officials determined a new urban form development on the western side of the city. Decentralization of the current macroform and consequent decrease of population in the center would both ease the air pollution problems by distributing the population along two linear corridors on the western and southwestern sides of the city center (See Figure 9). According to that plan, housing development and industrial development would take place on the western development corridor (called Batıkent-Eryaman corridor later) and southwestern part of the city center would be administrative corridor of the capital city Ankara together with new housing development according to the master plan.

Consequently, planning studies carried out by AMANPB in the 1970s sought to introduce new intense development corridors. The western corridor in particular was planned for new residential areas and for the decentralization of industrial estates.

The intention of the plans was to create a corridor development to which some major uses in the CBD would be decentralized, and to support these corridors with high capacity and high quality rail-based public transport (Babalık-Sutcliffe, 2013). The government was involved in the development of residential areas along the western corridors, and especially in the development of workplaces in that period. The construction of new Industrial Zones such as OSTIM was a major contribution of the plan to reduce the number of commuting trips to the city center. This helped to relocate the industries from the inner city to this new development corridor. In addition to the western development corridor, the 1970s planning studies also proposed growth along the southwestern corridor. It was planned to decentralize such capital city functions like ministries, government offices along this axis. Some university campus areas were also located here together with new residential sites.

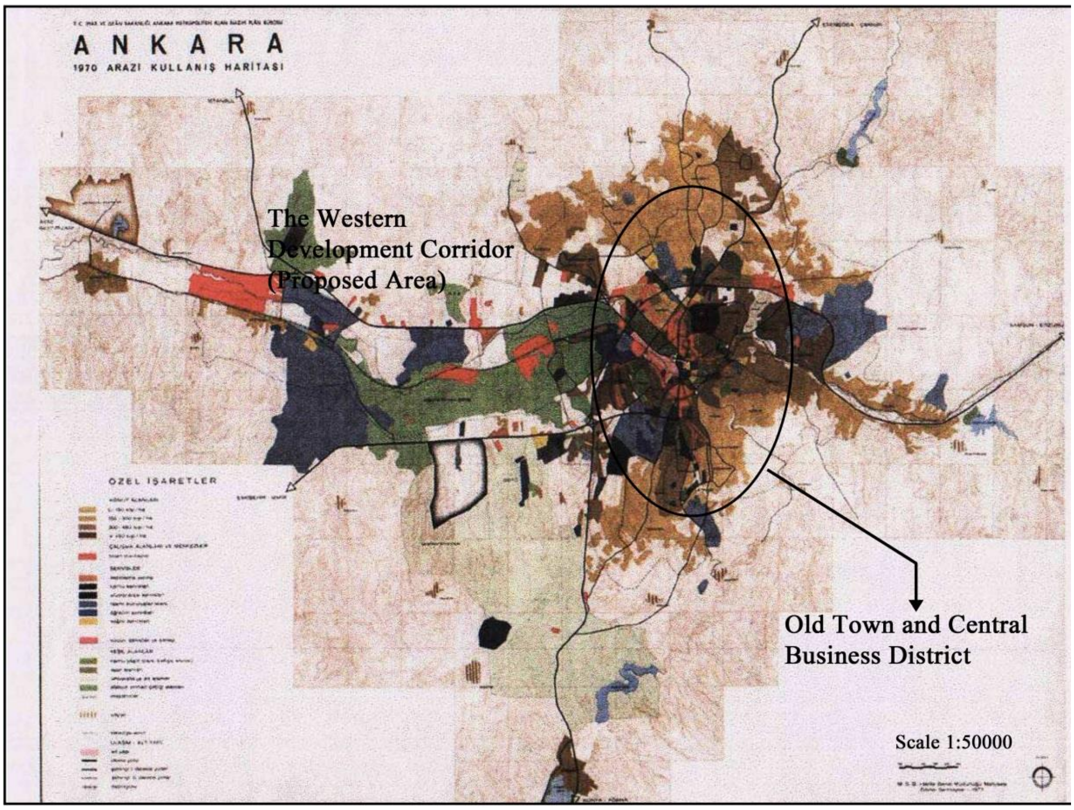

Figure 9. 1970 Ankara Land Use Plan

To support these development corridors, the planning studies in the 1970s also foresaw the development of a heavy rail system. The system would be built along the proposed corridors, providing access from the city center to these new development areas.

Meanwhile, in the second half of the 1970s, the municipality again introduced an attempt for a metro system, this time with the Municipality of Moscow. Even though, the preliminary-agreement was signed between two municipalities, because of the disagreement with the central government, implementation did not take place (Öncü, 2009).

Despite plans for a high-capacity rail-based system, improvement was limited in public transport in practice. As the supply of publicly operated transit was insufficient, public institutions started their own service buses in the 1970s. These services, which are provided to employees of generally large scale institutions and companies, reached to a number, which was twice of the number of EGO buses in 1977 (Öncü, 1979). The only increase in terms of public transport fleet size was realized for minibuses. The number of minibuses increased from 1067 in 1972 to 1127 in 1975. The problematic thing was the fact that travel demand was increasing many times more than the fleet size of public transport vehicles. Meeting that demand, to a certain extent, was possible only by the re-arrangement of working hours of public and private institutions as a remedy to the problem of vehicle waiting times during the peak periods. In the late 1970s for the efficient use of resources the municipality started the first exclusive bus lane implementation between Dikimevi-Beşevler which was a 5.3 km's long line (Öncü, 2009). Compared with the other services in the world with 7,000-9,000 passenger per direction per hour capacity on average, Dikimevi-Beşevler line was carrying 9,000-10,000 passenger per direction per hour, which was quite high (EGO, 1990). Later on, two more bus lanes were introduced between Dikmen and Güvenpark (Kızılay) and Demetevler-Kızılay. The first pedestrianization project in the city center also took place within this period. In 1979, Sakarya Avenue Pedestrianization project was introduced. Unfortunately, again in the second half of the 1970s officials cancelled the operations of trolleybuses.

One of the most important incidents during this period was the engines-off intimidation of the Confederation of the Turkish Drivers and Automobile Association. With this strike of minibus and station wagon drivers, an enormous supply deficit emerged and consequently, EGO started to operate existing public service buses on behalf of the municipality. With a decision in 1979, EGO started to operate 214 public service buses within municipality provision. It was quite important because during a period in which municipality was unable to increase its fleet size, this decision helped to increase the number of EGO buses in a considerable amount (Tekeli, 1987, 69). Furthermore, this strike helped public transport to come to the political agenda and some legal changes were being made by the central government to support three pioneer cities; Ankara, İstanbul and İzmir. Not only in Ankara but also in İzmir and in İstanbul, municipalities benefitted from the budgetary allowances, which were given from the central government. This resulted with the increase of the numbers of publicly owned buses significantly in 1979 and 1980 and following these purchases, the share of publicly operated public transport in total motorized trips reached 30% again (EGO, 1987, 15).

In the beginning of the 1980s, there have been major changes in the transportation network. The first one of them was the abolishment of the decree, which was envisaging the management of the service vehicles under the provision of EGO. After this decision, the number of public services reached 1000 vehicles in 1985 (Tekeli, 1987, 69). The second important decision was the introduction of private buses on January 1982. Private buses began to operate on eight lines with 30 vehicles (EGO, 1987, 15). In a short period, they reached to a number of 91 vehicles on 25 lines. Until the year 1983, they were operating as feeder services of the EGO buses however, after their demand to work on the central lines, they started to operate on the same lines with EGO buses, which are the most profitable ones for municipality operations. While a new type of private mode was introduced, an old one was abolished by the municipality. The municipality canceled the operations of station-dolmuş vehicles in 1983. That decision was quite important because taxi-dolmuş services were providing a transportation service for high and middle-income groups. Because of the insufficiencies and low quality of municipal public transport services (even if the quota for taxis was increased by 3% to meet this demand), these groups were in a way encouraged to buy private cars with this decision. As a subsidy, station-dolmuş operators were given the right to obtain minibus-dolmuş licenses and that increased the number of minibus dolmuş vehicles instantly. Number of dolmuş vehicles increased from 1129 in 1980 to 1901 in 1984 (EGO, 1987, 15). That was the first symptom of losing the innovative characteristic for dolmuş operations. There were two attempts of municipality to replace dolmuş; to substitute dolmuş with a new private entrepreneurship in the same year named private buses and to increase the municipality fleet size in considerable amounts. Nevertheless, as indicated by Tekeli and Okyay (1981), it was not possible to substitute minibus services with bus services.

In this period of the early 1980s, there have been some pedestrian oriented improvements. The EGO Directorate approved three new pedestrianization projects in 1982. Contrary to this, first pedestrian overpasses were built in the city center in the mean time and the movements of the pedestrians were restricted spatially with a municipal decision (Öncü, 2009).

Two important planning studies during this period were the preparation of Ankara Spatial Plan and Ankara Urban Transportation Study. Starting from 1984 Ankara city –with İstanbul and İzmir- became one of the three Greater Municipalities of Turkey. Together with Middle East Technical University's City and Regional Planning Department Working Group, EGO prepared a detailed Spatial Plan proposal for the year 2015. It should be noted that the main motivation for this study was to provide an urban structure plan that could be the basis of the "Ankara Urban Transportation Master Plan and Etude for Urban Rail Feasibility", prepared by EGO with one national and one international company. The importance of this study for Ankara's transportation history was that, it was the first detailed, comprehensive, inter-disciplinary transportation master plan with spatial proposals on it. In addition to this, the importance of integration was underlined in this plan for Ankara transportation network for the first time in the transportation history of Ankara. The sharp increase in private car ownership was firstly evaluated in this plan; and in order to reduce the ever-increasing car usage rates bus lane and car-free city center proposals were made. Unfortunately, it was not possible to legalize the plan because of the problems during the approval processes. Nevertheless, most of the realized transportation related projects that took place in the late 1980s and early 1990s were the proposals of this 1986 Plan, even though the plan was not binding the municipalities legally (Öncü, 2009). This is because, the 1994 Ankara Transport Master Plan, which is described below, was mostly based on the proposals of this 1986 study, although it also contained some significant new proposals, such as the Light Rail Transit line that was not featured in the 1986 plan.

4.2.3. Recent Period (1990-Today)

In the early 1990s the first metro project construction started between the city center and the western corridor. As already mentioned before, one of the objectives behind the construction of the Ankara Metro was to realize the development of the western corridor of the city. Furthermore, it was considered essential to provide a high-capacity and high quality public transport service for the city. The metro would create an accessibility opportunity for all social segments in the society and additionally, with the commuter's trains, buses and other transit options, metro would be an integral part of public transportation system (intermodal system) in Ankara (Tekeli, 2010).

Since the 1986 study was not approved to become an official plan, between the years 1992-1994 EGO prepared Ankara Transportation Master Plan, which was an updated version of the 1986 study (Öncü, 2009). In the new plan, the metro projects proposed in the 1986 study were included and detailed construction plans were made. In addition, during the update of the 1986 study, it was decided to convert the bus lane between Dikimevi and Beşevler into a light rail transit (LRT) line. As a result, the 1994 Master Plan introduced the Ankaray LRT system in addition to the previously proposed metro network.

The 1994 plan also proposed a new ring road for Ankara. In addition, municipality officials suggested an institutional organization that would encompass all transportation operations under one roof. However, this re-arrangement of management offices was not realized (Özalp, 2007).

The Ankara Transport Master Plan of 1994 was approved by the municipality. However, it should be noted that one of the important deficiencies of the plan was the lack of short-term traffic solutions and public transport regulations. In other words, the urban rail components of the plan were much more dominant than traffic management approaches. That deficiency resulted in uncontrolled transportation infrastructure investments of the municipality that focused on just "saving the day"

(Öncü, 2009). Criticisms for this plan also includes the fact that with the construction of light rail transit system Ankaray, one of the most successful bus lanes of the world, Dikimevi-Beşevler bus lane was removed.

The Ankaray LRT construction between Dikimevi and Beşevler started in 1992 and it was completed in 1996. The first metro line construction between the western corridor and the center (Batıkent-Kızılay) started in 1993 and was completed in 1997. The opening of first light rail and metro lines was one of the important turning points for Ankara transportation history because, with the introduction of these urban rail projects, Ankara metro network started to be established.

During the construction of the urban rail line, pedestrianization projects took place in many places in the city center in the first half of the 1990s. Olgunlar, Konur and Karanfil Streets and Yüksel Avenue were pedestrianized. Some other pedestrianization projects were also proposed and partially implemented in the other main commercial zones; however, they were not applied permanently because of reactions of residents and political concerns of governments. In fact both the 1986 urban transport study and the 1994 master plan proposed comprehensive pedestrian-oriented implementation in the inner city, particularly along the main Boulevard (Atatürk Boulevard) from Kavaklıdere to Dışkapı; however, these did not get implemented.

While the LRT and the metro opened to service in the second half of the 1990s, this period also saw the start of extremely motorway oriented transportation applications in Ankara. Even though EGO prepared a study, with two national and one international company, and names the Ankara Transportation and Traffic Improvement Study in 1998, the public transport improvement proposals of this study were not implemented. In fact, apart from the three grade-separated junction projects, municipality implemented none of the proposals of this improvement study (Öncü, 2009).

Car oriented planning approach of this period resulted in severe difficulties faced by pedestrians especially in the city center. Numerous pedestrian overpasses built in the city center eliminated convenient at-grade crossings and increased the distances travelled by pedestrians and created much more difficult access conditions for pedestrians both in cold, rainy, icy, winter days and hot summer days. That resulted in the exclusion of pedestrians, since most city center roads were designed with pedestrian overpasses to increase motorized traffic speeds (Babalık-Sutcliffe, 2006). It should not be forgotten that, problematical pedestrian access conditions indirectly result with the unattractivenes of public transport (Kılınçaslan, 2012, 103). Furthermore, the idea of solving the congestion problem in many junctions by transforming them into grade-separated junctions took place starting in the late 1990s. More than 100 grade-seperated junctions have been built in Ankara since that time, many of them in central boulevards.

On the public transport improvement side, starting from 1997, on 41 lines double decker buses started to serve to provide a high quality public transport service with cleaner vehicles. These green, double-decker private buses operated along the developing south-west corridor for 10 years, and were run by individual private operators. On the southwestern corridor, which was one of the two main decentralization corridors of the city in the 1970s plan of Ankara Metropolitan Development Area Planning Bureau, the existence of these bus services, which also provided express services with limited numbers of stops, helped meeting the mobility demands to a certain extent. However, the transport master plan had envisaged the opening of the second metro line of the city along this southwestern corridor by the mid-2000s, and hence the public transport demand on this corridor was to be met with urban rail rather than buses. Unfortunately, the second metro line got postponed for more than a decade, and although construction had started in the early 2000s, the line opened only in 2014, and even then with many deficiencies in terms of vehicles, capacity, technological infrastructure, etc.

During the 2000s, parallel to technological advances Ankara introduced its first magnetic public transport card in 2001. This card could be used in Ankaray (LRT system), metro and EGO buses. With the introduction of this card, for the first time in Ankara transportation history, regular transportation data collection started. Additionally, with the introduction of Ankara Traffic Information System in 2001, Intelligent Transportation Systems applications were introduced for traffic management (Yardım and Akyıldız, 2005). However, while municipality operations were integrating with each other in terms of routes and fares, dolmuş operations - additionally privately operated buses- were left out of this modal integration process.

On public transport side, as it is mentioned double decker green buses were in use along the southwestern residential areas. This service took place only for 10 years and in substitute for these private buses, in 2008 the municipality introduced a new service, which was again being operated by private bus owners but using smaller vehicles that can be defined as midibuses. Currently, they are operating with 222 midibuses on eight lines (EGO, 2015). Besides, in terms of bus-based service, 490 natural gas operated buses and 690 CNG-operated buses had been introduced in the transportation system in 2007 (EGO, 2015). However, because of the new service areas added to the municipality area of responsibility, the impact of this important increase was limited to the central areas.

Meeting the demand with low-capacity bus services, the absence of the planned metro line on the southwestern corridor and car oriented, grade separated junction investments resulted in an exponential increase in the number of private cars in the late 2000s. The increase in car ownership starting from 2008 be seen in the table below. It should be noted that the chart represents total motorized vehicles in Ankara. The number of private cars encompasses 70% of total vehicle purchases on average (Turkish Statistical Institute, 2015).

Table 2. The Change of the Number of Motorized Vehicles in Ankara (Adapted from Turkish Statistical Institute Annual Motor Vehicles Data)

Year	2008	2010	2012	2014	2015
Number of Motorized Vehicles	780,613	1,285,661	1,436,349	1,538,185	1,603,661

Starting from the early 2010s new developments took place in public transport. In terms of the metro system, in 2014, after the Transportation, Communication and Maritime Affairs Ministry took over the task of construction (due to the greater municipality's inability to complete this construction that was going on for more than 10 years), two new metro lines opened to service: one of them was the line on the southwest (Kızılay-Çayyolu line), which was originally planned to open in the early 2000s, and the second one is an extension of the first metro on the western corridor (Eryaman-Sincan line). The northern line, which was also supposed to open years ago, is still under construction, carried out by the Ministry. With the construction of new metro lines and the widening of bus fleets of municipality, the public competitors of private entrepreneurs got stronger. For the Ankara case, the introduction of Kızılay-Çayyolu metro line developed the accessibility of one of the two main arterials. However, it should be emphasized when the operations of urban rail system started bus and minibus lines should be re-planned as the feeder systems of the metro investment. Additionally, micro-scale design should be re-considered according to the needs of passengers in terms of comprehensibility, easy transfer opportunities etc. (Babalık-Sutcliffe, 2013, 28). None of these happened for the Ankara metro case.

In 2011, the municipality introduced EGO-CEPTE mobile application for public transport passengers. This application enabled bus passengers to reach the line information and location of buses instantaneously. With new features, municipality officials introduced an add-on to mobile application that is enabling to plan travel for the passengers and a system that enables to notify the traffic problems (EGO, 2015). In addition to this, AnkaraKart, which is a developed version of the old magnetic cards, was introduced in Ankara in 2012. As was the case with the previous magnetic cards, this electronic card is valid only on municipality's publicly operated public transport services but not on private buses, dolmuş vehicles or the commuter rail. Unfortunately, it is still not possible to introduce a payment system sensitive to travel time and distance in Ankara.

Another important project of Ankara Greater Municipality was the beginning of Ankara Transportation Master Plan 2038 in cooperation with Gazi University. That was quite important because, the municipality has not prepared a new transportation master plan since 1994.

According to Ankara transportation history, the diversity of the vehicles used in public transport has changed significantly over the years. Dolmuş, the main research topic of this study, on the other hand, increased its share in significant manner from the beginning of the 1930s. The table below shows the share of dolmuş in modal shares regularly after the 1960s (See Table 3). It is also possible to see that private car ownership has regularly increased in each time interval. Besides, the share of metro trips remained almost the same in the last 15 years. It is important to note that, while there has been a decrease of bus services in the last 15 years, the share of private cars have become quite high.

Table 3. Modal Split of Ankara between the Years 1930-2015 (Adapted from Tekeli, 1987; EGO Modal Split Database)

Mode/Year	**1930**	**1940**	**1950**	**1960**	**1970**	**1980**	**1990**	**2000**	**2015**
Commuter Rail	900	8,100	15,600	27,100	31,800	48,000	51,486	100,000	37,000
Municipality Bus	0	36,500	63,000	237,600	388,000	710,000	875,281	1,315,000	748,257
Private Public Bus	0	0	0	0	0	0	182985	0	169,150
District Private Transit Bus+Private Transit Bus	0	0	0	0	0	0	0	0	245,100
Kaptı-Kaçtı	12,500	7,650	20,300	0	0	0	0	0	0
Minibus-Dolmuş	0	0	0	7,500	199,000	385,000	878,331	990,000	960,000
Station-Dolmuş	0	0	0	0	350,000	340,000	0	0	0
Taxi-Dolmuş+Taxi (After 1984 Only Taxi)	2,700	8,800	45,000	136,000	210,000	280,000	152,488	260,000	269,500
Private Car	600	2,000	8,600	28,500	115,000	500,000	515,410	750,000	2,025,420
State Car	500	1,350	2,200	5,800	12,000	30,000	0	0	0
State or Private Service Vehicle	0	0	0	22,000	33,000	50,000	365,971	685,000	670,000
Ankaray	0	0	0	0	0	0	0	175,000	129,358
Metro	0	0	0	0	0	0	0	175,000	269,920
Other Modes	2,000	3,250	6,000	10,000	40,000	90,000	9,149	0	0
Walking	124,800	183,350	301,300	498,000	600,000	609,000	0	0	0
Total Motorized Trips	19,200	67,650	160,700	474,500	1,378,800	2,433,000	3,031,101	4,450,000	5,523,705
Total Trips (Motorized+Walking)	144,000	251,000	462,000	972,500	1,978,800	3,042,000	3,031,101	4,450,000	5,523,705
Share of Walking in Total Trips	0.87	0.73	0.65	0.51	0.30	0.20	0	0	0
Share of Motorized Trips in Total Trips	0.13	0.27	0.35	0.49	0.70	0.80	1	1	1
Population	30,056	157,200	288,500	650,100	1,236,152	1,901,282	2,836,719	3,540,522	5,150,072
Number of Motorized Trips Per Person	0.208	0.626	0.624	0.668	0.6247	0.625	0.935	0.795	0.932

Table 4. Change of Ankara Urban Form and Transportation Network Within Years

TIME PERIOD / TOPIC	Urban Macroform Transformation	Modes of Transportation in the City	Important Incidents Affected Transportation			Issues of Transportation	
1920s	Densely crowded citadel town	Walking, Horsecarts, Private Car, Suburban Train	Small size settlements dominated by pedestrian trips because of topographical thresholds	Preparation of Lörcher Plan and Jansen Plan enabling a planned development		Sharp increase in the number of automobiles as a result of the establishment of the Republic	
1930s	Expansion of Old City towards south and east	Walking, Private Car, Taxi, Suburban Train, Kaptı-Kaçtı, Public Bus	Rapid increase in the motorized transportation demand	Introduction of municipality (public) bus operations		Lack of transportation service through the old city center in the first half	
1940s	Quaquaversal Expansion of old city and the beginning of unauthorized housing	Walking, Private Car, Taxi, Suburban Train, Public Bus, Kaptı-Kaçtı, Taxi Dolmuş, Trolleybus	International transaction difficulties because of budget constraints during Second World War	Fire in the municipality bus garage		Lack of spareparts of the vehicles because of WW II	Insufficiency of Public Bus Fleet in Meeting Demand
1950s	Rapid Authorized / Unauthorized Residential Development of the City	Walking, Private Car, Taxi, Suburban Train, Taxi Dolmuş, Trolleybus, Minibus-Dolmuş	Leibrand's report on inefficient transportation network	Reorganization of public bus operations	Yücel-Uybadin plan transportation proposals	Inefficiency of radially operating bus operations of EGO	The beginning of the private entrepreneurship dominance in urban transport

Table 4. Change of Ankara Urban Form and Transportation Network Within Years (Continues)

TIME PERIOD / TOPIC	Urban Macroform Transformation	Modes of Transportation in the City	Important Incidents Affected Transportation				Issues of Transportation	
1960s	Highway based development of urban macroform	Walking, Private Car, Taxi, Suburban Train, Taxi Dolmuş, Trolleybus, Minibus-Dolmuş, Station-Dolmuş	Establishment of minibus and automobile production factories	Reorganization of dolmuş operations and emergence of a new type of dolmuş		Restriction in the number of taxi and dolmuş vehicles	Rapid increase in the number of motorized vehicles	Decrease in the share of publicly operated public transport vehicles
1970s	Decentralization of Compact and Dense CBD Functions Through Two Main Corridors	Walking, Private Car, Taxi, Suburban Train, Taxi Dolmuş, Trolleybus, Minibus-Dolmuş, Station-Dolmuş, Public Service Shuttles	Establishment of Ankara Metropolitan Area Planning Bureau (AMANPB)	First transportation focused study on Ankara	First heavy rail proposals along development corridors	The Engines-Off Strike of the private transport operators	Insufficient capacity and very low modal share of existing public transport services	Private car and private operators' inevitable dominance in transportation network
1980s	Decleration of Ankara as one of the three Greater Municipalities and enlargement of the city borders to provincial borders	Walking, Private Car, Taxi, Suburban Train, Taxi Dolmuş, Minibus-Dolmuş, Public Service Shuttles, Private Bus	Preparation of Ankara Spatial Plan and Ankara Urban Transportation Study for the year 2015	Preparation of Ankara Urban Transportation Master Plan and Etude for Urban Rail Feasibility by EGO in 1986		Decision of municipality on the first three pedestrianization projects	Sharp Increase in the Number of Service Shuttles and Minibus Dolmuş Vehicles	Introduction of private bus services in the transportation network

Table 4. Change of Ankara Urban Form and Transportation Network Within Years (Continues)

TIME PERIOD / TOPIC	Urban Macroform Transformation	Modes of Transportation in the City	Important Incidents Affected Transportation				Issues of Transportation	
1990s	Rapid Decentralization of Western and Southwestern Corridors	Walking, Private Car, Taxi, Suburban Train, Taxi Dolmuş, Minibus-Dolmuş, Public Service Shuttles, Private Bus, LRT, Metro	Preparation of Ankara Transportation Master Plan as an Updated Version of 1986 study in 1994	Introduction of First Light Rail Transit and Metro Operations	Decision of Municipality on New Pedestrianization Projects	Second Car Oriented Planning Period Starting from the second half of 1990s	Increasing Number of Pedestrian Overpasses and Grade-Seperated Junctions	Lack of short-term traffic solutions and public transport regulation of 1994 Plan
2000s	Uncontrolled and Rapid Urban Sprawl and Shopping Mall Oriented New Subcenter Developments	Walking, Private Car, Taxi, Suburban Train, Taxi Dolmuş, Minibus-Dolmuş, Private Bus, Public Service Shuttles, LRT, Metro	Introduction of First Magnetic Card for Public Transport	Gated community and shopping mall development especially on development corridors	Introduction of Municipality Midibuses Operated by Private Entrepreneurs	Introduction of Ankara Traffic Information System	Disintegration between Private and Public Operators	In construction urban rail investments and rapid increase in the number of private cars
2010s	Great Urban Transformation Projects and Increase in Densities in Significant Amounts	Walking, Private Car, Taxi, Suburban Train, Taxi Dolmuş, Minibus-Dolmuş, Private Bus, Public Service Shuttles, LRT, Metro, Municipality Midibus	Introduction of Smart Card mobile EGOCEPTE application for Public Transport	Preparation of Ankara Transportation Master Plan 2038 by municipality and Gazi University		Introduction of two new metro lines along the western and southwestern corridor	Disintegration between Private and Public Operators and following low share of municipality public transport	Sharp Increase in the Number of Private Cars and Following Road Constructions

4.3. A Discussion on the Future of Dolmuş

In the above sections, the evolution of dolmuş has been presented together with challenges it creates in relation to publicly operated systems, such as buses and the metro. The analysis of this evolution brings about the question of "What will be the future of dolmuş?" Exponentially increasing private car usage is increasing the traffic densities in significant amounts every year. Recent researches show that there is a negative relationship between the quality of life and traffic densities. This phenomenon is not sustainable both because the limited road structure is insufficient for high car ownership rates and because creating a "private car based" urban space contradicts with public interest. According to a survey study, the higher the traffic density in an area the less the will of living for the residents in that particular neighborhood (Kılınçaslan, 2012, 57). On the other hand, the approaches of western countries, which have urban macroforms developed based on private car usage, are not applicable for the countries like Turkey, that is why rather than meeting the demand, managing the demand approach becomes more important (Kılınçaslan, 2012, 180). It is a fact that, privately operated dolmuş with their 2231 number of vehicles cannot be easily removed from Ankara transportation network in the short term. With its 29.7% share in total public transport trips and 17.0% share in total transportation network, dolmuş is currently a major component of transportation supply in Ankara (EGO, 2016).

The foresight of Tekeli et. al. (1976, 159), was that; if better transportation systems are developed in urban networks, dolmuş operators would not be willing to compete with these new modes and that finally would result in the replacement of the dolmuş operatins. Up to now, as is seen from the current situation, that type of development has not emerged. However, as indicated again in the same study by Tekeli et. al. (1976, 159), the enforcements, which aim to remove dolmuş instantly is not realistic or not easy because of the mutualist relationship between dolmuş and urban needs. Nevertheless, there is a fundamental difference between the attitudes of decision makers of transportation about dolmuş in Turkey. Two different positions can be identified regarding dolmuş;

a) One position would be to claim that dolmuş should be eliminated from the system because in reality dolmuş and other privately operated modes are not actually public transport. As in the development of squatter settlements or informal sectors, dolmuş is a transportation solution of the migrants, which should end. Completely formalized and publicly operated transportation system is the key to create a sustainable transportation network. That is why it is not possible to enable dolmuş vehicles to operate in formalized urban environment.

b) The other position would be claim that dolmuş still has the dominance to affect transportation decision in cities. In addition, with its flexibility, its profit-maximizing efficient operations and its self-sustaining characteristics, it can be beneficial for existing transportation network. In other words, it could complete the deficiencies of conventional modes.

Many transportation planners advocate the idea that completely publicly operated transit systems are needed for an efficient public transport system. Actually, this proposition is partially true. According to Cervero (1998, 438-439), the Houston city council experience shows the need for a mixture of systems with these findings:

> *In 1995, Houston city council opened the marketplace to private jitneys, lifting restrictions on fares and services. (Besides meeting driver and vehicle fitness standards, the only restrictions are that jitneys cannot stop at METRO stops and vehicles can be no older than five years.) This has unleashed competition, something sorely needed in suburban markets. Seeing the handwriting on the wall, METRO decided to get a step up on jitney entrepreneurs by contracting out supplemental van-size services for an 8-kilometer stretch of the Westheimer Boulevard corridor.*

In Turkish cities, it is obvious that there is an increasing trend on developing transportation options and giving focus on transportation related issues. Many cities introduced urban rail systems or bus lanes to meet the demand for mobility. That is why public authorities aim to remove dolmuş, which they consider to be a primitive, low capacity and old mode, from the urban networks. On the other hand, as explained in detail, dolmuş still has the certain characteristics that help its survival. In other words, dolmuş provides a different, preferred option for users and has its own lobbying characteristics that make it difficult to negotiate for decision makers. Otherwise, the existence of dolmuş in current networks is unexplainable. As Işık and

Pınarcıoğlu (2013, 35) stated for unauthorized developed housing areas, for dolmuş (which is also a spontaneously emerged informal transportation mode) an analysis that evaluates dolmuş within a permeable relationship with the formal modes is necessary. Dimitriou (1990, 350-351), indicated the lack of understanding of the approach of technical personnel to informal sectors with the following:

> *In many instances these activities are viewed by local governments as a blight on the city, an administrative nuisance and an unnecessary impediment to a "smooth traffic flow". Whereas in fact, they simply reflect the state of the urban economy; they would not exist if they were not necessary. There is a tendency among some economists, as well as officials, to treat the informal sector with contempt regarding its work as unnecessary, inefficient, unprofitable, undignified and even counterproductive...yet it manages to serve the urban poor by providing employment and training opportunities, using appropriate technologies and local resources, recycling material, producing affordable goods and services and distributing profits to those with the greatest need (Werlin, 1982). It is precisely for these reasons that it is so important for planners and engineers to understand and make provision for this type of activity. The economic life of the city may not be best served simply by providing traffic flow at the expense of a large (if un-vocal) section of the community.*

Urban informal sector covers many different activities, namely vending, trades, paratransit modes etc. There are debates that in the 21^{st} Century, their formalization process should take place and local governments should have their policies regarding the formalization process for these types of activities. However, the removal of transportation related operations as other type of urban activities is not that straightforward, because transportation services are mutually related with each other and disposal of one transportation activity directly affects the other related transportation modes, even other related sectors. A similar conclusion may be arrived at for very different reasons, regarding the introduction of a technically superior urban transport system: for example, if it makes a large number of persons unemployed in an economy where unemployment is already very high, it can be called into question on development grounds (Dimitriou, 1990, 390).

Işık and Pınarcıoğlu (2013, 40) in their study on informal sectors indicated specific points for informally developed sectors which are;

a) Structure basis on the fellow countryman
b) Their direct relation with the land and resident market
c) Unequal redistribution of the yields of the sector
d) Political relations which are emerging on the basis of unequal yields

That conceptualization is quite important because especially the last two create the lobbying power of informal sectors. Normally, as in other planning studies, informal sector studies within a framework between formal and informal sectors are necessary for a successful intervention. However, the dynamic structure of cities makes it difficult to understand the real qualifications of the informal sector. Researches on urban planning, whether they are about transport or not, should focus on the different mechanism of the continuity of informal sectors. Dolmuş (like gecekondu) emerged and developed within an informal process. While gecekondu was providing a shelter, dolmuş was providing a sector, which encompasses both transportation opportunity and a job opportunity for these vulnerable groups. To consider dolmuş only as a problem and supporting the removal of it from the system would result with the loss of its potential in the solution of Turkey-specific transportation problems. The importance of a different policy approach is highlighted in the book of Dimitriou (1990, 361) with the following:

> *It was suggested earlier in this chapter that despite considerable local variations, there are recurring street problems common to many Third World cities. These problems are so complex and interrelated that it is difficult to influence them with conventional traffic management approaches. Clearly experimentation is necessary to lead to innovative solutions. A traffic engineer whose education and experience have led him to concentrate exclusively on improving the flow of vehicular traffic may find it retrogressive to encourage street traders by making provision for them. Nevertheless, such measures are necessary if any real progress is to be made.*

At that point, as a common belief among transportation experts, Kılınçaslan (2012, 131/278) states that if main service frequency, convenience, reliability, safety, comfort, accessibility and affordability are essential qualifications of a public transport system then dolmuş has many deficiencies as a transportation mode; but, she also adds that a sustainable transportation network proposal is possible without the removal of paratransit services with;

a) Paratransit systems which are the feeders of the conventional transport
b) Demand responsive transport operations
c) Work-School Services for commuting activities

Currently dolmuş is not only the first type of feeder services especially on the sub-zones not served by the conventional public transport services, but also operating along main demand corridors, providing an alternative service to conventional modes. It is often competing with these conventional modes, but considering its high share in passenger trips, it clearly offers a service that appeals to passengers and meets a mobility need. That is why it is not easy to remove it from the network. The problem in here is the way of integration for that kind of informal transportation mode. The small entrepreneurship of dolmuş has a flexible structure, which eases its adaptability. The first comprehensive study (Tekeli & Okyay, 1981) in the literature on dolmuş shows that the main reasons, which explain the preference of dolmuş, are due to higher operating speeds and flexible getting on-off opportunity when compared with bus operations. Furthermore, passengers complaints about the over-crowded and uncomfortable bus operations also shaped their choice of dolmuş when travelling (Tekeli & Okyay, 1981, 163). Even in that research dated late 1970s, the foresight of the authors was towards the existence of dolmuş in the future depending on the technological development and the reflections of this development on the efficiency of existing public transport networks in Turkey. With the ongoing operations of dolmuş today, this foresight is tested and it is seen that, in many cities but especially in Ankara, public transport services are far from being efficient and reliable. Surely, from the 1940s to today dolmuş evolved, organized and partially lost its flexibility in significant manner. However, its competition with the conventional modes continues. Additionally, today, the Transportation Coordination Centers (UKOME), which is consisting of municipality officials, army officials, state officials and Chamber of Dolmuş and Minibus Operators, organizes transportation operations in urban areas (Resmi Gazete, 2014). Even if there were many decisions taken by these centers, it would not be wrong to say that most of the decisions are not applicable to dolmuş itself. This policy making process of municipality, without an in-depth analysis of dolmuş, was made in the previous years for many times. That is why; it is not surprising that, most of the policies are ineffective on dolmuş. The legislation prepared by the İstanbul Municipality in 1963 is an appropriate example to these ineffective policies. According to the legislation, minibuses were enforced to take at most two students in each trip (İller ve Belediyeler Dergisi, 1963, 207). This did not materialize in practice. Similar to İstanbul, in Ankara too, departures of each dolmuş vehicle were determined as 15 minutes by the municipality in the 1970s (Tekeli & Okyay, 1981, 9). This was also never the case in practice. Those examples show the fact that, policies and projects, which do not familiarize themselves with the stakeholders' needs and nature, and particularly the users' requirements and preferences, are unable to propose realistics and effective solutions.

In short, there is a need for a systematic analysis of dolmuş in the existing situation, particularly in relation to other modes and with reference to users' point of view and preference. As emphasized above, the survival of dolmuş is very much related with its ability to meet the demands of public transport users; and hence policies for the future of this mode cannot be formulated without an in-depth understanding of its role in the mobility and accessibility of its users. To provide a better understanding on this issue, the next chapters explore the role of dolmuş in Ankara by focusing on a particular university campus area within the city and by analyzing the travel patterns and preferences of students of this university.

CHAPTER 5

5. ANALYSIS OF DOLMUŞ USAGE IN ANKARA: A SURVEY ON METU STUDENTS

5.1. Introduction

This chapter presents an analysis based on a survey implemented on students of the Middle East Technical University (METU) in Ankara. The survey was carried out within a study on developing sustainable mobility options at the METU Campus in Ankara, and questions regarding dolmuş formed only a section of this comprehensive survey. Nevertheless, these questions are helpful in understanding the user perspective regarding the role of dolmuş in accessibility of METU students in Ankara.

To provide a better understanding, firstly the current context of public transport in Ankara is presented in the next section, including a description of the campus and its transport connections with the rest of the city. Then, in the third section of the chapter, a descriptive analysis is presented in detail on three main outputs of the survey. These are respectively; information about the participants which could be helpful to evaluate the sample characteristics, information about existing usage of accessible modes by the respondents (a kind of modal split evaluation according to the responses of the students) and views of the students on existing transportation opportunities in accessing to their departments in the campus. Within this part, choices and expectations of the users are examined in detail and with the analysis based on this examination, the guidelines of a proposal will be prepared for dolmuş in Ankara case. Following the third section, which provides a general information about the survey participants, zone based comparison of users' mode choices is made. That fourth part of the survey study is quite important to improve an in-depth understanding of the current situation of transportation opportunities in the first hand.Users' mode choices are emphasized according to travel time, ticket cost and the distance travelled for each user (depending on resident neighborhood). After some standardization process of the survey data, a final evaluation of aggregate results is made in the last part of the chapter.

5.2. Transport Network in Ankara and the Location and Connections of the METU Campus

Specific to this study, additional information about Ankara is useful. Ankara is the capital city and the second most populated city of Turkey. These qualifications of Ankara make the city an attraction point for the middle-class residents, who are mostly government employees. As explained in detail in the previous chapters car ownership rates in Ankara is increasing exponentially. Even if the car ownership rates in Ankara is roughly 234 cars per 1000 population, which is low compared with to the Western European and North American examples, this exponential increase eventually will result with a dramatic congestion problem (Hürriyet Gazetesi, 2015). After all, Ankara has the highest private car ownership rate per 1000 population in Turkey currently. Actually, especially in the last 10 years new road constructions have been made to reduce this congestion problem. Nevertheless, such road schemes as grade-separated junctions and road widening proved to be ineffective in solving congestion and only resulted in more road traffic, diverting passengers from rail based modes to roads.

The city has also witnessed substantial investments in urban rail infrastructure. After the opening of the Ankaray light rail line and the first metro line in 1996 and 1997 respectively, in the first half of 2014, two new metro lines opened with the names of M2 (on the southwest corridor) and M3 (on the west corridor as an extension of the first metro line). Following these investments, a cable car line was introduced on June 2014. As it can be seen from Figure 10, there is also a new metro line between the city center (in which the metro lines are crossing) and the northern parts that is under construction with the name of M4. The local government supports metro investments, by re-organizing the routes of municipality bus services operating parallel to these metro corridors. However, privately operated buses and dolmuş lines have not been reorganized to feed into and integrate with the new metro systems. The lack of the integration projects required during that process resulted with the low metro usage especially on the southwest corridor line (Çayyolu Line) (Öncü Yıldız, 2015).

The integration of public transport also requires an integrated fare system. The city has a smart card system called "AnkaraKart", and this is valid on the Metro and the public buses (run by EGO). However, the card is not valid on dolmuş and privately operated buses, which require cash payment. The smart card provides two free transfers for students, and two transfer costing 67 kuruş each for full fare within 75 minutes of the first travel. However, with municipality's low share in total motorized trips, this transfer opportunity is way off the mark. Without the inclusion of dolmuş with almost 30% share in modal split, and the inclusion of privately operated buses, this integrated ticketing project works with a limited efficiency.

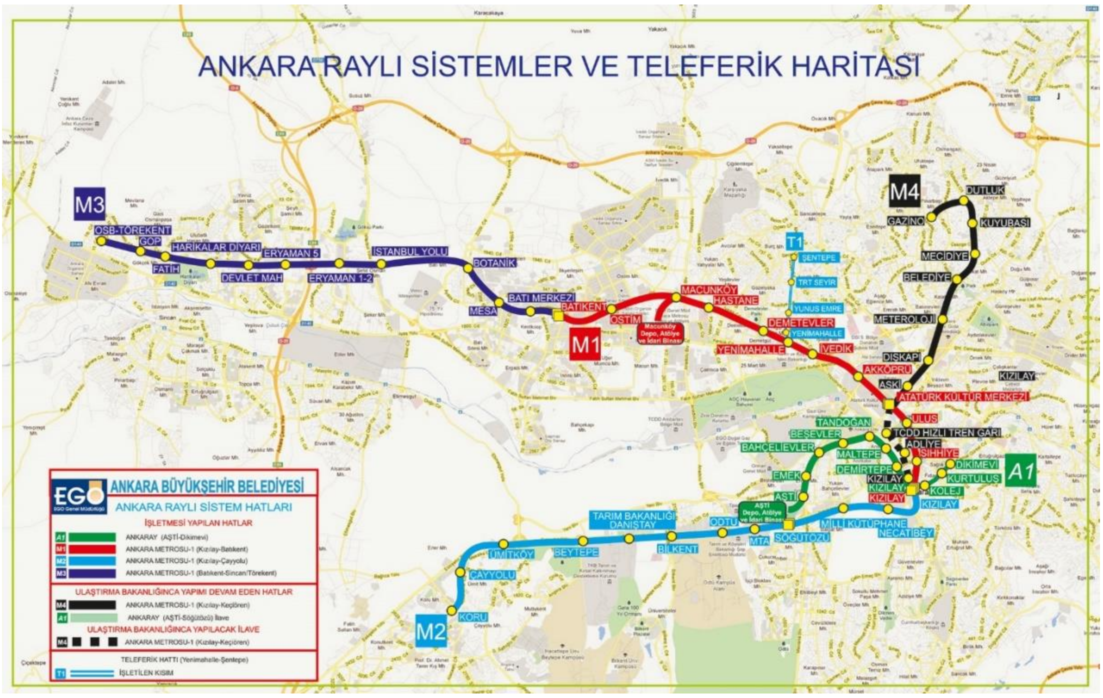

Figure 10. Ankara Rail Systems and Cable Car Map (Ankara Greater Municipality EGO Website)

At this point, it is necessary to explain the location of METU Campus and related to that, the transportation opportunities to METU Campus. METU Campus is on the southwest corridor of Ankara urban area, which is one of the two main development corridors since the 1970s as mentioned in the transportation history section (See Figure 11). As can be seen from the figure below, there are three entrances of METU campus namely A1 (Eskişehir Road) Entrance, A4 (Yüzüncüyıl) Entrance and A7 (Bilkent) Entrance. As will be presented in the upcoming sections, none of the survey participants are using the A7 (Bilkent) entrance. Consequently, the A7 (Bilkent) entrance is not included in the analysis in this study. Besides there is an entrance named as A2 entrance on the Eskişehir Road however, in the current situation, it is not operating. A1 (Eskişehir Road) Entrance is the major gate for many of the students because this entrance has the accessibility by all means of public transport in the city, namely public buses, private buses, dolmuş and now the newly opened M2 Metro line. Public bus operations have been reorganized with the introduction of M2 metro line and currently they are not operating between city center and METU Campus, parallel to metro operations. An important point about the entrances is that most of the campus users use A1 (Eskişehir Road) entrance in accessing the campus. The reason for the high usage rate of this entrance among the students is a direct result of the diversity in public transport choices. Currently, private buses, metro services and majority of the dolmuş services are using A1 (Eskişehir Road) entrance during their operations. Besides, as the metro route is following Eskişehir Road on the southwest corridor, it is important to indicate that out of the routes, which are operating directly to METU campus, there are also other bus and minibus routes, which are passing in front of the campus entrance. Even though these lines are not METU campus lines, they are actually serving the population that is commuting to the campus. Emphasizing that information is important because, the high usage level of A1 (Eskişehir Road) entrance is directly related with these diverse transportation opportunities.

On the other hand, using the A4 (Yüzüncüyıl) entrance is also quite common for two reasons. First one of them is, as can be seen from the name of the entrance, it is directly connected to Yüzüncüyıl Neighborhood, which is an area with dense student population.The second one is, as stated before, many of the public transport services are radially operating from the city center. Along the eastern part of the campus, probably as a result of the demand of the users, some dolmuş vehicles and some private buses are operating between campus and eastern neighborhoods of the city. That is why, even if it is lower than A1 entrance, compared with the other trip attraction zones in the city, A4 (Yüzüncüyıl) entrance has a significant accessibility. In the light of this information, the following sections presents the findings of the survey regarding the access of METU students from the city to the METU campus.

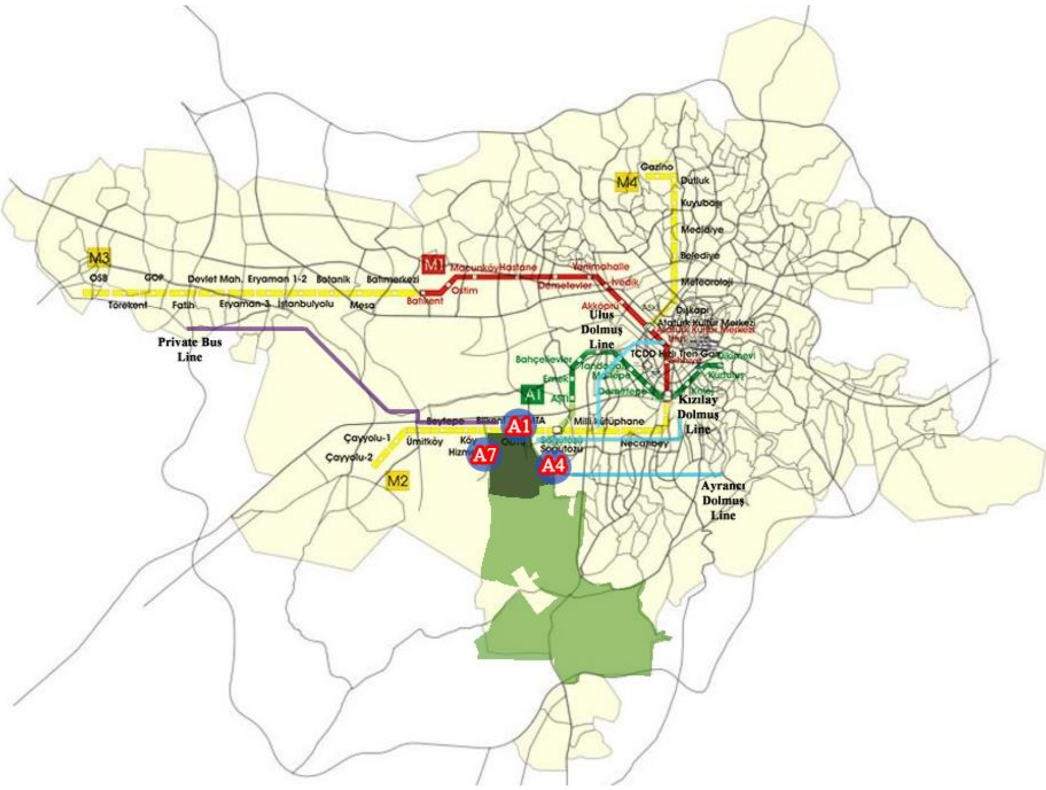

Figure 11. Location of METU Campus and Accessibility Options (Ankara Development Agency Regional Plan , 2014; Middle East Technical University Website, 2016)

5.3. General Information about the Survey

First of all, explaining the reasons to use the survey study for user behavior should be emphasized. Popovic (1999) cited in Toker-Özkurt (2012, 142-143) has mentioned that "interviewing users, aims to identify users‘ needs and better understanding their culture and the contextual environment in which artifacts are going to be used". Therefore, interviewing is one of the most important sources that provide in-depth knowledge about both the cultural and functional needs of user. In other words, to understand the intervention tools for the future of dolmuş vehicles, the most important stakeholders, users’ needs are important.

The survey has been conducted to students face-to-face in METU Ankara campus in two semesters on November 2014 and May 2015. The survey consisted of four parts;

a) Sustainability and Sustainable Transportation (knowledge and perception)
b) Campus Accessibility (from the city)
c) On Campus Accessibility
d) Campus Traffic Safety

Campus accessibility section contained the questions about dolmuş (See Appendix A). While in some questions the respondents were required to make a rating, in others closed ended questions were preferred to shorten the length of the survey. In November 2014, 307 surveys were conducted. After the evaluation of the first survey group, some of the survey questions were modified or removed. After the alterations, 316 additional surveys were conducted in May 2015. After the assessment of second group surveys, a summary can be listed as follows. In total 623 participants were interviewed within the survey process. While transportation choices related questions were answered by all survey groups, the questions about integration were addressed partially to each survey group, the first group answered some of them while some of them were addressed only after the modification of the survey files. Survey results gathered from the METU student interviews were assessed by the SPSS program. With the help of descriptive analyses made by SPSS, identification of transportation choices and expectations has been possible. Additionally, improvements, which can affect the daily transportation choices of the users, have been determined depending on survey results. One of the objectives of this survey, which this study also focuses on, was to identify the share of dolmuş specific to METU (which is one of the important trip attraction-production zones in Ankara). The second objective was to develop an understanding (and possibly to make proposals depending on that understanding) on the expectactations of public transport users about an integration process between formal and informal transportation modes.

While the total student number of METU is 28,000, the number of survey participants is 623 students, making the participants/total students ratio about 2.5%, which is a considerable amount. The campus built environment surface area is 500 hectare, the access from the main entrance to the departments of each individual should be taken into account (METU Department of City and Regional Planning

Website, 2016). That is why; the survey participant numbers from each department were determined depending on the annual student numbers of the departments to create a homogenous sample distribution.

Descriptive analysis of the survey will be made in two parts: in the first part, a modal split study will be made both for first mode choices and for the transfers from this first mode. In the second part, expectations of the participants on possible integration projects are assessed depending on the survey results. Both the first and the second survey groups are evaluated depending on the participant distribution and question types; that is why the number of respondents differentiate significantly.

Another question that comes into mind could be the scope of the study as a case study. If any locality has its own characteristics, how could it be possible to calibrate the METU example for the total Ankara network? Case studies and user surveys have their pros and cons. Case studies in fact, are contextually rich, which makes them positive for a social scientist. They could represent a general tendency of the society, which has occurred in long terms. A case study also helps the researcher to find out the underlying social and political dimensions that are difficult to investigate with the other methods (Seyidoğlu, 1997, 31). As urban planning and urban transportation fields directly relate with the social, economic and political dimensions of any service in urban areas case study method is quite important for the research of a paratransit mode that has emerged automatically because of the lack of transportation service. Furthermore, using the surveying method is quite helpful to gather statistical information about the user preferences and concerns about the transportation in general and paratransit systems in particular. That would help to analyze the current situation of accessibility measures and could help the proposals about the future.

5.3.1. Information about Participants

As stated before, the survey was conducted with 623 participants. As some of the participants did not answer all questions the number of participants differentiate for different questions. Besides, as some of the answers were unable to evaluate, there were missing items in some of the questions (See Table 6).

Gender distribution of participants was 51.4% woman and 48.5% man in total. When the distribution of total gender distribution of METU Ankara Campus is considered, that is an acceptable percentage representing the general distribution.

Table 5. Socio-Demographic Characteristics of Participants

Gender (N = 622)	**Freq.**	**(%)**	**Valid (%)**	**Cumulative Percent**
Woman	320	51.4	**51.4**	51.4
Man	302	48.5	**48.6**	100.0
Total	622	99.8	**100.0**	
Missing System	1	0.2		
Total	623	100		
Age (N = 614)	**Freq.**	**(%)**	**Valid (%)**	**Cumulative Percent**
16 – 25	579	92.9	**94.3**	94.3
26 – 35	34	5.5	**5.5**	99.8
36 – 50	1	0.2	**0.2**	100.0
Total	614	98.6	**100.0**	
Missing System	9	1.4		
Total	613	100.0		
Grade (N = 623)	**Freq.**	**(%)**	**Valid (%)**	**Cumulative Percent**
Prep	38	6.1	**6.1**	6.1
1st Grade	84	13.5	**13.5**	19.6
2nd Grade	152	24.4	**24.4**	44.0
3rd Grade	177	28.4	**28.4**	72.4
4th Grade	137	22.0	**22.0**	94.4
Masters	30	4.8	**4.8**	99.2
PhD	5	0.8	**0.8**	100.0
Total	623	100.0	**100.0**	
Income (N = 615)	**Freq.**	**(%)**	**Valid (%)**	**Cumulative Percent**
Less than 500 TL	141	22.6	**22.9**	22.9
Btw 500 TL – 1000 TL	335	53.8	**54.5**	54.5
Btw 1000 TL – 2000 TL	106	17.0	**17.2**	17.2
Btw 2000 TL – 3500 TL	26	4.2	**4.2**	4.2
Btw 3500 TL – 5000 TL	7	1.1	**1.1**	1.1
Total	615	98.7	**100.0**	
Missing System	8	1.3		
Total	623	100.0		

Table 5. Socio-Demographic Characteristics of Participants (Continues)

Residence (N = 621)	Freq.	(%)	Valid (%)	Cumulative Percent
METU Campus	234	37.6	**37.7**	37.7
Inner-City	387	62.1	**62.3**	100.0
Total	621	99.7	**100.0**	
Missing System	2	0.3		
Total	623	100.0		
Car Ownership (N = 619)	**Freq.**	**(%)**	**Valid (%)**	**Cumulative Percent**
Yes	302	48.5	**48.8**	100.0
No	317	50.9	**51.2**	51.2
Total	619	99.4	**100.0**	
Missing System	4	0.6		
Total	623	100.0		

Secondly, the age distribution of the participants demonstrates that –as survey contains only students, mostly those aged 16-25 were interviewed. For the grade distribution, respondents were mostly undergraduate students; however, there were also participants from prep school and graduate level students, which provide a rich content for further analyses.

While 22.9% of participants have an income level of less than 500 TL, 54.5% have an income level between 500 TL-1000 TL. Participants who have 1000 TL-2000 TL have the share of 17.2%. The share of the participants who have more than 2000 TL is only 5.3% in total. As a result of the fact that the most of the students do not have annual income, monthly expenditure of the students is considered.

When the residences of the participants are examined, it is seen that while 37.7% of the students are staying in dormitories, 62.3% are staying in the inner city.

Lastly, for car ownership –which is a question directly relating with the public transportation choices- 48.5% of the participants have a private car to use in urban traffic.

5.3.2. Modal Split of Participants

In the survey, the students were asked to mark their transportation choices from their trip origin points (homes or regularly visited places for dormitory residents) to their trip end points (METU Campus-departments of each individual or dormitories for

METU Campus residents). Both the first choices of mode and the modes used in transfers have been emphasized. It should be remembered that the survey was conducted on December 2014 and on May 2015, after the introduction of the M2 line (Koru-Çayyolu metro) that provides metro access to METU Campus. Consequently, transportation choices of the students in Ankara transport network, including the metro service, the most reliable, the fastest and highest capacity public transport mode, could be investigated easily. Besides, in the very first hand, it has been possible to emphasize the usage share of metro and other public transport choices namely bus and dolmuş. Depending on the shares of modes, it was possible to emphasize and compare different modes in the current situation.

The students were asked to state the first transport mode that they use in their travels between the city and the campus, together with a follow up question on whether they make a transfer in these journeys and what mode they would transfer to. Consequently, the question revealed their choice of mode(s) from their trip origin (their homes for inner city residents) to their destination (their departments). In here, it is important to indicate that, METU campus (dormitory) residents have also answered this question as their returning back mode choice to the campus from "the most common place they prefer to go regularly". When the outcomes of this question are evaluated, it is seen that dolmuş is quite dominant in the modal split of METU Campus users (See Table 9). Even though there are many access options including the metro, dolmuş still has the highest share with 41.6% in the first trips of first mode used by the students in METU. However, this outcome should be evaluated together with the follow-up question regarding whether there is a mode they transfer – because it is possible that students use dolmuş at the start of their journeys and then transfer to another mode, such as the metro or the reverse is possible. Only after that kind of assessment it will be possible to deduce a model split from the surveys. Private car ranks second in the choice of mode for students, although its share is much lower than that of dolmuş only 17.7% in total. At this point, it is important to emphasize again that one of the four urban rail lines directly connects to the main entrance of METU campus, and that there is also a ring system operating between the main entrance and the departments to support the metro in the peak hours, during which most students come to the campus. This service is provided free of charge by the university. Furthermore, as stated before, there is a smart card system in Ankara that has been in effect since 2012; and this card provides free transfers to students when transferring between metro and public buses (although not valid on dolmuş and privately operated buses).

As a sub-zone, METU campus is one of the most accessible areas for the municipality in terms of transportation services. However, it seems that these improvements alone are unable to encourage the usage of the metro system or buses, and that a high percentage of students prefer dolmuş. If the private buses (on the third rank) are also considered, private entrepreneurs' share increases to more than 50% (See Table 7). Since this question is about the first travel mode used starting from the origin, the outcomes may indicate that most students are not in walking distance to the metro to take this mode as the first travel mode; and that in such cases they prefer dolmuş to both EGO Buses and private buses. Besides, 234 of the respondents of this question are METU campus residents and their trips are not commuting trips actually. As most of them travel out of campus for leisure trips their choice could be misleading.

Table 6. First Mode Preferred from the Trip Origin of the Participants (N= 622)

Transportation Mode	Frequency	Valid (%)
Dolmuş (Minibus - Jitney)	**259**	**41.6**
Private Car	110	17.7
Private Bus	63	10.1
Metro (Kızılay – Çayyolu Line)	44	7.1
Municipality (EGO) Bus	41	6.6
Walking + Bicycle	40	6.5
Metro (Bilkent – Sincan Line)	23	3.7
Hitchhiking	29	4.7
Private Services	4	0.6
Others (Taxi – Motorcycle - Cablecar)	9	1.5
Total	**622**	**100**

Although a high percentage of students choose to use dolmuş at the start of their journey, many users also stated that they use other options, as shown in the above table. As explained above, this may be either because of the lack of dolmuş service in the vicinity to their homes or because there is a more convenient option. However, for a better understanding transfer choices should be evaluated in detail, too. It should not be forgotten that, as the second most populated metropolitan city in Turkey, travelling from one location to another location within one public transpot trip is not common in Ankara.

When the transfers from the first trips of the first choices are considered, out of these 622 students, 176 of them are transferring one time, 50 of them are transferring two times and only 4 of them are transferring three times. The results of transfers show that 51 of the 176 students transfer to the metro after the first leg of their journey. However, still in the second trip of the journey, 54 of the students transfer to the dolmuş after the first leg of their journey. In other words, dolmuş is the most dominant mode both in the first and in the second trips of the participants' travels. When high metro accessibility of METU campus is considered, it is an unexpected result. Hitchhiking, which is a travel method used only within the campus, is also high with 32 of 176 students, showing that some students arrive at the entrances of the campus (possibly using the metro or bus services that do not terminate inside the campus) and then hitchhike to their departments. Only after second transfers in the third and fourth trips, dolmuş becomes the third mostly chosen mode by the students. However, even in the fourth transfers dolmuş becomes the third preference of the students. In total, the share of dolmuş is again not negligible. 50 of 230 total transfers are made by dolmuş in the first choices of students. Although there is poor route integration; and no ticket integration between dolmuş and the conventional public transport network, it would not be wrong to say that, there is still an important percentage of those that transfer to dolmuş (See Table 8).

In the second section of the analyses, with reference to the high share of dolmuş in modal split, inferences of the users about the integration of different transportation options will be evaluated in detail. Especially for dolmuş, it is important to emphasize the integration expectancies of users with such modes as public buses, private buses and the metro. Currently, dolmuş is operating as a mode competing with conventional modes rather than a feeder service to them. Especially, the evaluation of metro and dolmuş comparison was one of the basic research topics for this particular study because, the emphasis of new metro line has not been made yet and the satisfaction level of the new metro line would provide a possible scenario.

Table 7. Transfers from the Firstly Preferred Mode

Mode	Frequency (1st Transfer)	Valid (%)	Frequency (2nd Transfer)	Valid (%)	Frequency (3rd Transfer)	Valid (%)
Municipality (EGO) Bus	3	1.7	0	0	0	0
Private Bus	4	2.3	0	0	0	0
Metro	15	8.5	0	0	0	0
Metro (Kızılay – Çayyolu Line)	51	29.0	7	14.0	0	0
Dolmuş (Minibus - Jitney)	**54**	**10.7**	**6**	**12.0**	**1**	**25.0**
Private Services	3	1.7	4	8.0	0	0
Private Car	1	0.6	0	0	0	0
Walking	12	6.8	9	18.0	2	50.0
Hitchhiking	32	18.2	24	48.0	1	25.0
Taxi	1	0.6	0	0	0	0
Total	**176**	100	**50**	100	**4**	100

5.3.3. Comments of Participants on Possible Public Transport Improvements

In the first part of this section, which is about increasing system performance, the satisfaction levels of the users about the metro usage are investigated. The question about the metro usage has shown that at the date of survey 79% of participants had a trip experience at the Çayyolu Metro Line (M2). Out of these 79 per cent, Metro usage in accessing the METU campus is experienced by 75.7% of the users and almost all of them (99.1%) used METU station on their commuting trips through METU. That shows that most of the users have experienced metro at least once in their lifetime in order to come to METU or other stations (See the Table 9). The survey also revealed that most of the users were unsatisfied about the metro operations that opened shortly before the first survey period. As it can be seen from the table below, most of the users were unsatisfied in terms of speed, travel time, transfer, comfort and reliability.

Table 8. Koru-Çayyolu Metro Experience of the Users

About the Çayyolu – Kızılay Metro Experience;	Freq.	Yes Valid (%)	Freq.	No Valid (%)
a) Have you ever used the line? (N = 615)	485	79.0	130	21.0
b1) Did you use metro in accessing METU Campus? (N = 259)	196	75.7	63	24.3
b2) If yes, did you use METU metro station (A1 Main Entrance)? (N = 213)	211	99.1	2	0.9

It is important to emphasize that transfer from the metro stations are considered as the most important input about the metro satisfaction levels. While 87.2% of the total participants are dissatisfied (the first in the table below) in terms of EGO ring buses transfer opportunities, the dissatisfaction level from transfer opportunities provided by dolmuş is 70.4%. In addition, satisfaction of the users in general and the speed, frequency and reliability of the metro service is quite low. Those that are satisfied with price and safety measures of Çayyolu Metro (M2) are slightly higher than those who are not satisfied, although the share of the latter is still considerable (See Table 10).

Table 9. Satisfaction Levels of the Users about the M2 Line (Koru-Çayyolu Metro)

	Not Satisfied (%)	Satisfied (%)
a) Speed / Time (N = 487)	**60.0**	40.0
b) Price (N = 486)	39.9	**60.1**
c) Service Frequency (N = 483)	**67.7**	32.3
d) EGO Ring Buses from Metro Stations (N = 462)	**87.2**	12.8
e) Other Transfer Opportunities (Minibus-Dolmuş) (N = 470)	**70.4**	29.6
f) Comfort (N = 484)	**57.4**	42.6
g) Safety (Accident risk, personal safety etc.) (N = 481)	46.8	**53.2**
h) Reliability (Delays, Malfunctioning etc.) (N = 479)	**66.6**	33.4
i) Overall Satisfaction (N = 481)	**66.9**	33.1

The survey also investigated the opinions of users regarding system improvement and efficiency, which also included issues of integration. The reason for different participant numbers (N) is a result of the modified or removed questions in the survey. According to these alterations, distinctions of the participants towards different statements, which have the same meaning (but different in mental images), have been examined. It is asked to the participants to determine their views (positive or negative) for each possible metro relevant improvement. As seen in the table below, the first three improvements that would have positive impact on metro mode choices are; cheaper/free transfer opportunity from dolmuş to metro (69.7%), increase in metro service frequency (68.6%) and increase in metro ring service frequency (67.8%). More than one third of the participants considered dolmuş-metro integration as more important than metro system improvements and metro ring service frequency increases. Based on the results, it would not be wrong to say that, as students are much more price sensitive as public transport users, subsidy reduction on dolmuş prices indirectly with ticket integration (which is higher than average transportation cost for students) is a very attractive improvement for students' mode choice (See Table 11).

Table 10. The Improvements Which Would Affect the Metro Preferences of the Participants Positively (More Than One Selection Allowed)

Positive Contribution To Mode Choice (%)	Improvements
68.6	Increase in Metro service frequency (N = 290)
45.9	Increase in Number of Cars (Wagons) (N = 290)
55.2	Provision of More Reliable Service (Punctuality etc.) (N = 290)
67.8	Increase in Metro Ring Service Frequency (N = 289)
59.2	Extending the Metro Ring Service Routes on Campus (N = 289)
56.4	Cheaper/Free Transfer Opportunity to EGO Buses (N = 289)
29.0	Parking Opportunities for Private Cars/Bicycles in Metro Stations (N = 286)
69.7	Cheaper/Free Transfer Opportunity from Dolmuş to Metro (N = 287)

Lastly, overall improvements about transportation options in accessing the METU Campus are evaluated by the participants. As it can be inferred from the table below, "Integration of Dolmuş Vehicles to Ankarakart System" has the lowest share in the whole improvement suggestions with 60.9% importance level (Quite Important + Crucially Important). Likewise, "Provision/Increase of New Minibus/dolmuş

Headway" has the second lowest share with 71.8%. Nevertheless, these results reflect the responses before the modifications of the questions: the statement about ticket integration was asked to the students in the first semester in 2014. The results have shown that most of the participant thought that it was impossible to transfer to dolmuş for free. As it was stated in the previous chapters about dolmuş, profit oriented operation characteristics makes dolmuş a problematic mode in terms of pricing for users, and even in survey interview responses, the effect of this reality on user decision-making processes is easily visible. That is why; in the second survey group this question was changed as "Free Transfer Opportunity from Dolmuş to Metro via AnkaraKart" and surprisingly the results have shown that, with this change the importance level for users on average increased to 91%, in other words the most important improvement. It is important to indicate that, the comparison of dolmuş with conventional transportation options is taken into account specifically. Especially, municipality buses are considered as the major competitor to paratransit services because of their diverse service area in the whole Ankara city and with their share in municipality's budget from the very beginning of Ankara transportation history. As it can be seen, "Free Transfer Opportunity between EGO buses-Urban Rails" is stated as quite important for users with its 87.3% share in all improvements (Currently this application is already in use for municipality public transport services). Likewise, "Provision of EGO District Buses" are determined almost as much important as the free transfer opportunity, which shows that there is a common perception of the users about the inefficiency of municipality buses (See Table 12).

Table 11. The Significance Level of Possible Transportation Improvements for Increasing the Accessibility of METU Campus

	Not Important (%)	Slightly Important (%)	Quite Important (%)	Crucially Important (%)
a) Provision of EGO District Buses (N=598)	4.5	13.4	**39.3**	**42.8**
b) Provision/Increase of New Minibus/dolmuş Headways (N=601)	7.5	20.6	**39.9**	**31.9**
c) Free Transfer Opportunity between EGO buses-Urban Rails (N=598)	3.3	9.4	**34.8**	**52.5**
d) More Frequent Headways for Çayyolu Metro Line (N=311)	2.9	15.4	**41.8**	**39.9**

Table 11. The Significance Level of Possible Transportation Improvements for Increasing the Accessibility of METU Campus (Continues)

e) Improvement of Çayyolu Metro Line (Speed, Capacity, Carriage Number, Punctuality, Reliability etc.) (N = 594)	4.9	13.0	**37.0**	**45.1**
f) The Increase in Metro Ring Services (EGO or METU) Frequency (N=315)	1.6	7.9	**35.2**	**55.2**
g) Extension of Metro Ring Service Area (EGO or METU) (N=313)	1.6	8.3	**32.3**	**57.8**
h) Provision of Car/Bicycle Parks in Metro Stations N=313)	3.5	22.7	**33.5**	**40.3**
i) **Free Transfer Opportunity from Dolmuş to Metro via AnkaraKart (N=313)**	1.6	7.3	**31.3**	**59.7**
j) Improvement of On Campus Pedestrian and Bicycle Accessibility (N=599)	4.8	20.7	**34.2**	**40.2**
k) Introduction of "Carpooling" Systems (N=594)	5.2	19.2	**35.9**	**39.7**
l) Provision/Increase of METU District Buses (N=288)	2.8	10.8	**30.2**	**56.3**
m) Improvement of On Campus Ring Services (N=291)	2.4	7.6	**32.6**	**57.4**
n) **Integration of Dolmuş Vehicles to AnkaraKart System (N=291)**	19.6	19.6	**24.1**	**36.8**

In the current situation, the replacement of dolmuş operations, which have a fleet of 2231 vehicles (EGO Website, 2016) with conventional municipality public transport vehicles does not seem logical economically and socially. Both the removal of the services provided by dolmuş operators and the unemployment problem which will emerge as a result of the cancellation policy of dolmuş are two important possible negative outcomes of such a policy. That kind of replacement project could be realized only in the long term with the supporting policies, which will prevent possible negative outcomes. In the meantime, it is important to point out that; dolmuş differs from the conventional modes as explained in the previous chapters. That makes its service specific to dolmuş and therefore, it is not easy to replace paratransit vehicles with the conventional modes. Surveys results also show that the perception of dolmuş from users' point of view supports its unique operations from its high shares. An interesting finding, which was informally stated by the respondents is that, most of the users, even now sees dolmuş as the only direct transportation option getting to METU campus, because of the radial operational characteristics (first city center Kızılay, then other zones) of the conventional modes. It was an expected result because of the radially working conventional modes however, the statement of this lack of express services to METU Campus by the respondents was quite important for the further sections of this study.

In brief, with its share almost equal to 30% in total motorized trips in the city (EGO, 2016) and its share higher than 40% on travels to specific zones like METU campus, dolmuş does not appear to be an easily dispensible mode. However, its current operation that causes a fragmented public transport service is seen by users as an issue that needs to be addressed; and hence there is a need to integrate this mode to the existing public transport system. For a possible integration scenario, an in-depth and more detailed study on the evaluation of current situation is needed. For that comparison, in the next section there will be a zone based comparison of users' mode choices.

5.2.4. Zone Based Comparison of Users' Mode Choices

Previous sections have given an overview of users' opinions about Ankara transportation network as well as their mode usage patterns. It would not be wrong to say that; paratransit mode dolmuş is quite dominant in trips made to METU campus, as well as being one of the major modes of transport in the whole network. This finding can be understandable in areas that are not served well with high quality public transport alternatives; however, it is a surprising outcome for destinations that can be accessed with many alternative public transport options. Compared with the urban rail systems –which have the highest capacity, the highest speed, the highest reliability in all public transport modes- dolmuş should not be the dominant mode especially on the corridors, which urban rails systems are serving. Furthermore, paratransit as a matter of fact, should be a feeder mode rather than a main axe transportation service (Cervero, 2000; Kılınçaslan, 2012). Its low vehicle capacity, low speed because of the operation characteristics, which have been explained in the third chapter, are expected to be discouraging factors for users when compared with the high capacity trains like metro and light rail transit. Nevertheless, the current mobility patterns indicate that eliminating dolmuş altogether from the Ankara transport network is not a viable option considering the dependence and preference of many users.

Consequently, this section of the chapter aims to answer the questions of why dolmuş is being preferred by many users, and in view of the presence of the new metro systems, what the role of dolmuş should be. It is necessary to explore whether an integrated transportation network can be planned and whether it is possible to create such an integrated transportation network that consists of dolmuş as one of the components. Descriptive statistics proved that there is a demand of users about the integration between privately operated and publicly operated public transport services. Especially ticket integration similar to EGO buses-metro transfers with dolmuş vehicles are widely demanded. However, in order to be able to discuss integration scenarios, it is important to answer the following questions: what is the reason that makes dolmuş so much preferable by people? What are the reasons behind the mode choice decisions? Is there rationality in users' choices as expected, or are there any other reasons for the dominance of dolmuş operations? For developing a better understanding, further study on details of chosen modes is needed. This section will focus on detailed analysis of different mode choice decisions in trios made from different zones to the METU campus.

Before starting the analysis part, it is important to give information about some previous researches on mode choice decisions. In transport economics literature, demand to any mode differentiates with trip cost and users decide according to four main variables, which are ticket cost, travel time, comfort and convenience of alternative modes (Mills, 1972; Quandt, 1970). According to the mathematical conceptualization of the concept, the demand for one mode as follows:

$$\frac{N_1}{N} = f\,(p_1, p_2, t_1, t_2, C_1, C_2, S_1, S_2) \qquad (1)$$

This assumes that the commuter has two modes to choose between. The demand for mode 2 is equal to $1-(N_1/N)$. If there are more modes, additional variables for each mode must be included. N_1/N is the fraction of the workers making the trip that choose mode 1; p_i the price of mode i for the trip; t_i the time required; C_i its comfort; and S_i its convenience (Quandt & Baumol, 1966; Mills, 1972; 199). The measurement of each variable necessitates additional and detailed work. Preference of the users of one mode to its substitute is directly affected by these inputs. That is why during transportation planning processes, either to decide on a new transportation investment or to re-distribute the xisting services; planners should have the knowledge about user preferences on different transportation services. In studies on demand, ticket price and travel time are two main losses of the passengers. Different from comfort and convenience, these two are costs that are paid for each trip by the passenger. In other words, these two inputs are costs while comfort and convenience measures are benefits of the user. User's mode choice constitutes depending on a pro-con analysis between these inputs. Consequently, similar to any good or service, in transportation supply and demand relation too, (compared with the substitutes) higher costs result with a decrease in demand. For this particular case, paratransit services and conventional transit services are competing services in city's transportation network. That is why their comparison based on four main titles can lead to better and standardized results. In this section of the chapter details of the survey study are emphasized step by step.

As stated before, METU Campus Transportation Survey covers many different dimensions of transportation. Within the "Accessibility of Campus" section of the survey, the participants have been asked to answer questions about their commuting travel decisions. This part was covering the questions about resident addresses (neighborhood level), commuting mode choices, mode transfers (if they are using multimodal patterns like "Ankaray + Public Bus", "Dolmuş + Private Bus" etc.), alternative mode choices (if any), frequency of each mode choice, travel times for each mode choice (including transfer detail), ticket cost for each mode choice (including transfer detail) and finally the characteristic that affects respondents' first choices namely speed, comfort, convenience etc. In the light of this knowledge, mode choice analysis aims to deduce the reasons behind the preference of any choice to an alternative or, for that particular study for example, to understand the reasons behind the choice of patterns that include dolmuş or exclude dolmuş in different zones.

Analysis of zone based mode choice can be divided into two. The first part of mode choice analysis covers the collocation of survey data. Only after this arrangement, it is possible to make comparisons between different choices. As it is mentioned before in the beginning of this chapter, the number of survey participants is 623 students. Types of transportation modes that 623 users expressed can be seen from the table below:

Table 12. Modes Used By the Survey Participants

#	Transportation Mode	#	Transportation Mode
1	Public Bus	**8**	Ring Bus
2	Private Bus	**9**	Private Car
3	Ankaray	**10**	Motorcycle
4	Batıkent Metro	**11**	Bicycle
5	Cayyolu Metro	**12**	Walking
6	Dolmuş	**13**	Hitchhiking
7	Cablecar	**14**	Taxi

Out of total 623 participants, 2 participants did not give any information about their resident addresses. Additionally, out of these 623 participants, 234 were METU Campus Dormitory residents, in other words; they were not making any commuting trips. Consequently, these 236 (2+234) participants are excluded from mode choice analysis part. In other words, the analysis of this chapter is based on the answers of the remaining 387 participants. In these 387 all modes are included at first. As this analysis focused on possible integration strategies of public transport modes; only transportation modes on the left side of the above table are included. However, most of the participants were using more than one trip (multimodal trips) for their commuting travel when reaching the METU campus. 44 travel pattern variations emerged as a result of different combinations of these modes. To give an example, while some of the users coming from close neighborhoods were using single modes like “Dolmus” or “Bus” to reach the campus, some other users coming from further neighborhoods were using 4 different modes to reach the campus like “Public Bus + Batikent Metro + Cayyolu Metro + Dolmus”. That is to say, collection of different patterns under main titles became a necessity for a comparison. All 387 users have been gathered under these 44 travel patterns. Nevertheless, it was a difficult process to gather them all under the same title. As private car usage from further zones and walking and bicycle usage from closer zones cover a wide range of users (more than 150 of the users) it was inevitable to search for new strategies to increase the sample size. For the solution of that problem users’ second and third choices (if any) have been merged with the first choice. At this point, it is important to give information about the frequency of first, second and third choices. On average, frequency of first choices is 5.24 days per week, frequency of second choices is 2.63 days per week and frequency of third choices is 1.71 days per week. That means even the third choices are used more than once per week on average, which shows that it is logical to include them. In total, there were 387 first choices, 231 second choices and 73 third choices gathered from the respondents. However, as it is explained recently, these 691 choices were including non-transit usages. Out of these 691 choices, 444 of them were transit choices. It was the first phase of data collocation. To eliminate double counting problem, no personal input like income, age, gender is included in the further evaluations based on these sample. To merge different travel choices of same users was beneficial for data quality from another perspective too. If one user’s first choice is private car at first; that could mean that there is relatively low accessibility of public transport services rather than another user with first choice of metro. In other words, with that merge operation in similar neighborhoods more reliable data can be gathered for each pattern. On average values are gathered from each similar location. As would be expected, merge operation of three choices resulted in the loss of two inputs of mode choice calculations which are comfort and convenience. Perceptions of the students on comfort and convenience measures are gathered with the question “Which mode characteristics are important for you in your first transportation choice?” which covers only the first choices. Besides, in the first survey group the answers are gathered in binary format (Yes – No question), while in the second group the answers are gathered in scaled format (Not Important, Partially Important, Quite Important, Very Important). These two types are impossible to merge with; on the other hand, just to use characteristics of first mode choices the number of first choices is not suitable to make a comprehensive mode choice analysis. That is why; after that decision, a mode choice analysis based on travel time and ticket costs are made. However, that does not create an insurmountable problem because; numbers of researches show that time and ticket cost relationship is likely to be the dominant impact on user decision making (Mills, 1972; O'Sullivan, 2012; Victoria Transport Policy Institute (VTPI), 2013). Consequently, after that an approach based on trip cost is decided upon:

$$\text{Trip Cost} = m + (T_a{*}d_a) + (T_v{*}d_v) \tag{2}$$

where *m* is monetary cost (is either transit fare or the cost of operating an automobile like cost of gas, oil, wear and tear), T_a is access (out of vehicle) time, d_a is the marginal disutility of access (out of vehicle) time, T_v is in-vehicle time, and d_v is the marginal disutility of in-vehicle time (O'Sullivan, 2012, 291-292). In this novel type of mode choice emphasis the formula was constituted for trip cost rather than demand for a mode. As transportation is a service and cost is the major input, which affects the choice of any service in here too demand for any mode choice is emphasized as well. As in this particular survey, there is no in-vehicle and out-of-vehicle travel differentiations; so the formula for trip cost calculations for this particular study takes a final form, which is:

$$\text{Trip Cost} = m + (T_{tt}{*}d_{tt}) \tag{3}$$

where *m* is monetary cost (is either transit fare or the cost of operating an automobile like cost of gas, oil, wear and tear), T_{tt} is travel time (including out of vehicle and in-vehicle time), d_{tt} is the marginal disutility of travel time (including out of vehicle and in-vehicle time). This final section of the chapter will focus on those two variables, which affect directly trip cost and relatedly mode choice of the users. Normally, access time marginal disutility value is higher than in-vehicle time marginal disutility. Actually, that difference between two travel times is advantageous for dolmuş because its flexibility measures normally reduce access time of transit vehicle compared with metro and buses. Based on author's personal experience during METU campus travel analysis from different zones, perceived travel times show that most of the users actually indicated a travel time value including access time and in-vehicle time together, which means that marginal disutility value will be between these values of access and in-vehicle times. In the upcoming parts, that calculation will be explained in detail.

In the second phase of data collacation, gathering of the modes is needed. As there were two survey groups (November 2014 and May 2015) and especially in the first group there were some deficiencies in mode choice part, it was quite difficult to determine the exact trip origin and trip destination of the trips. While some users have given details of their travels until their department building in the campus, some of them have given details of their travels until A1 (Eskişehir Road) and A4 (Yüzüncüyıl) entrances of METU Campus. For the standardization of the travel end points all patterns are fixed to entrances of the campus. That fixing operations made further calculations on travel time and ticket cost more compatible. During that process, for users who gave the details until the campus entrances like "Dolmus + Cayyolu Metro" which ends on A1 door, no editing is made. Barely, for users who gave the details of their travel until their department buildings last modes are subtracted. For example, if one's commuting travel pattern is "Public Bus + Cayyolu Metro + Hitchhiking" and travel time is 40 minutes (30 minutes is for travel time from home to A1 (Eskişehir Road) Entrance and 10 minutes is for average travel time of hitchhiking from A1 to the department (See Table 14)) in total, the last trip and travel time of the last trip is subtracted and travel pattern is written as "Public Bus + Cayyolu Metro".

Table 13. Intrazonal Modes Travel Times

In_Campus_Travel_Mode	Number_Of_Users	Average_Trip_Time(Min)	MIN_Trip_Time(Min)	MAX_Trip_Time(Min)
Dolmus	4	5,6	5	7,5
Bus-Ring	5	6,6	3	10
Hitchhiking	16	9,5	5	15
Walking	10	13,7	5	25

Surely, also travel time is decreased to 30 minutes. It is important to indicate that, as dolmuş transfer has a 1.00 TL in-campus payment, it is different from ring service, hitchhiking and walking choices within the campus. If the users get-in dolmuş from

A1 (Eskişehir Road) entrance, also 1.00 TL is subtracted from total ticket cost. However, there were some modes in which in-campus trip details are not represented. For example in “Batikent Metro + Public Bus” or “Public Bus + Dolmus” trips, user penetrates into METU Campus and there is no division between out of campus and in campus travel times. That is why; standardization is made. From all trips starting from campus entrances, minimum and maximum travel time values are calculated. As can be seen from the table below, with that method, it was possible to deduct in-campus trip travel times and to subtract them from the whole travel time, which is home to university department.

After that deduction about in-campus trips, all 444 trips have been standardized to the METU Campus entrances. The analysis continued with the zoning of the existing 444 travel choices. Within that part, similar addresses are gathered together under 21 different zones. Zones are proposed according to similar neighborhood addresses and common mode choices. That is why; sizes of the zones sometimes differentiate much with each other. However, the important thing is that, users in each zone were representing similar choices, which make it easier to reach average values with little differentiations. Travel time and ticket cost values of similar zones made it easier to merge different users under the same title. Besides, as zones cover a large area in the whole city, they were representing a big picture about Ankara transportation network. Surely, it should not be forgotten that survey is made in METU campus and results are based on student perceptions. Only after that kind of totaling process, it has been possible to compare different modes at the same time. Additionally, zones are enumerated according to their distances (See Table 15). Calculations of the distances are made from a center of gravity of each zone (which is determined according to the answers of the students), to the entrances (A1 or A4), which is used most common by the users of that particular zone. To make it more clear, a brief explanation would be beneficial. As stated in the previous sections, there are two main entrances to the campus: one of them is on the northern side of the campus and it is known as the A1 (Eskişehir Road) entrance; while the other one is on the eastern side of the campus, known as A4 (Yüzüncüyıl) entrance. Again stated previously, depending on the location of the zone in city, rubber tired public transport vehicles use different routes and naturally different entrances. These rubber tired public transport vehicles’ routes are the basis of the calculation of the distance from campus. As surveys are conducted for commuting trips to METU campus, it was possible to know all variations of possible pattern routes. Additionally, each distance is calculated depending on participants' responses. That double check made it possible for these distances to represent a true value. Depending on that knowledge, the closest zone is *Yuzuncuyil, Cigdem, Isci Bloklari* with 1 km distance from A4 entrance and the farthest zone is *Pursaklar, Fatih* with 26 km distance from A1 entrance. Additionally, each zone (excluding the last one) is represented on a basemap of Ankara city to give an idea to the reader about the approximate locations with respect to METU campus (See Figure 12).

Table 14. Zone Names and Distances of These Zones from METU Campus

#	Zone Name (Distance)	#	Zone Name (Distance)
1	Yuzuncuyil, Cigdem, Isci Bloklari (1 km)	12	Mamak (14 km)
2	Sogutozu, Cukurambar (2 km)	13	Altindag (15 km)
3	Balgat, Ovecler, Cevizlidere (4 km)	14	Yasamkent, Baglica (15 km)
4	Bahcelievler, Emek (5 km)	15	Kecioren, Etlik (16 km)
5	Cankaya, Ayranci (6 km)	16	Oran, Yildiz, Birlik, Tinaztepe (16 km)
6	Kizilay, Kolej, Tandogan (8 km)	17	Batikent, Eryaman (17 km)
7	GOP, Seyranbaglari, Esat (9 km)	18	Golbasi (18 km)
8	Dikmen, Keklik (10 km)	19	Etimesgut, Sincan (22 km)
9	Yenimahalle, Demetevler (11 km)	20	Pursaklar, Fatih (26 km)
10	Kurtulus, Dikimevi, Cebeci (12 km)	21	Incek (18 km)
11	Cayyolu, Umitkoy (12 km)		

Even though at first, there were 21 zones with 444 travel patterns in it, users of last zone have been subtracted from the survey. Due to the user count in that zone, which was 1 user only, it was not possible to take that zone as another part. Additionally, because of its location it was not possible to add the user of that zone to another zone. In other respects, some responses of the participants were outliers. To give an example, there were answers like 5 minutes travel time from a 5 km distance zone which is impossible in reality. That is an expected result of a survey based approach that some of the respondents could give wrong or misleading answers to the question. After an outlier detection process, 43 of the responses are removed from the sample. In the final situation there was 400 users (or responded travel patterns), 44 travel pattern variations and 20 different zones in the sample.

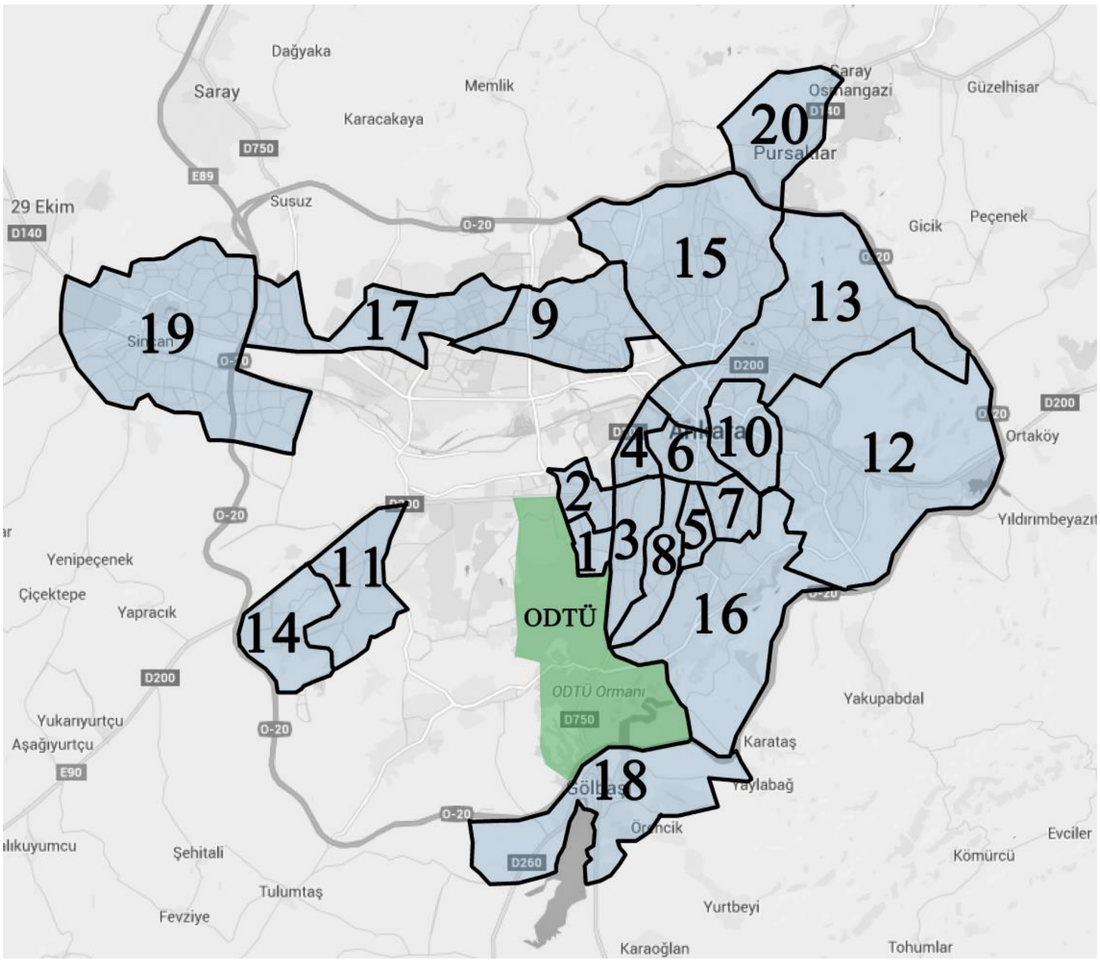

Figure 12. Zone Locations in the City With Respect to METU Campus

In the final part of data collocation process, 44 travel pattern variations have been gathered under eight main titles to enable the comparison of travel patterns in different zones with different distances. These eight titles were covering all of the travel patterns indicated by the users. The table below shows the details of each one of them. As can be seen, there are four totally conventional modes which are benchmark patterns of this analysis, respectively "Bus", "Bus + Bus", "Bus + Metro" and "Metro" and four dolmuş related ones respectively "Dolmus", "Dolmus + Bus", "Dolmus + Metro" and "Dolmus + Dolmus" (See Table 16). During this gathering process, a variety of operations are applied to the travel patterns for the simplification. It is also important to point out that, the order of multi-trip travels are ignored. Furthermore, some of the different transportation modes namely metro, LRT and cablecar are merged under the same title “Metro” to ease the comparison. Even though the payment method is different, private bus and public transport options are merged under the title “Bus” to enable the paratransit mode dolmuş and conventional public transport mode comparison.

With the last gathering operations; for the interpretation of the results there were 400 users (or responded travel patterns), 8 main travel patterns and 20 different zones in the sample. This standardization enables the comparison of different patterns and enlightens the differences between conventional and paratransit modes in terms of travel time and ticket cost.

Table 15. Operations Which Gathered All Patterns Under Eight Titles

Pattern Name	Operation 1	Operation 2	Operation 3
Bus	Public buses and private buses represented as Bus only	-	-
Bus + Bus	Public buses and private buses represented as Bus only	Public Bus + Private Bus / Private Bus + Public Bus patterns are gathered together	-
Bus + Metro	Public buses and private buses represented as Bus only	Bus + Metro / Metro + Bus orders are gathered together	Cablecar, Batikent Metro, Cayyolu Metro, Ankaray are taken as a one metro trip because of similarities in their operations

Table 15. Operations Which Gathered All Patterns Under Eight Titles (Continues)

Metro	-	-	Cablecar, Batikent Metro, Cayyolu Metro, Ankaray are taken as one Metro trip because of similarities in their operations
Dolmus	-	-	-
Dolmus + Bus	Public buses and private buses represented as Bus only	Bus + Dolmus / Dolmus + Bus patterns are gathered together	-
Dolmus + Metro	-	Dolmus + Metro / Metro + Dolmus orders are gathered together	Cablecar, Batikent Metro, Cayyolu Metro, Ankaray are taken as one Metro trip because of similarities in their operations
Dolmus + Dolmus	-	-	-

5.2.4.1. Average Travel Time According to Defined Zones

After the collocation of the data, there will be four different analysis about the travel time/ticket cost and distance relationship. The first analysis is about travel time comparisons between different patterns according to defined zones. As this study's benchmark is conventional public transport modes, their comparison with the dolmuş related patterns is investigated in that part.

As it is explained previously, there are 20 zones of the survey. Firstly, average travel times are compared according to defined zones (See Table 17 and Figure 13). Looking at the closer zones, it can be said that single modes are preferred by the users up to 5 km where distance is lower. "Dolmus" travel time, when compared with the "Bus" is slightly higher in 2 km distance. Between 5 to 8 km distance, if there are "Bus" or "Metro" services available, they have lower travel times, but for example in *Cankaya, Ayranci (6 km)* zone, "Dolmus" has the lowest travel time value. This is due to the presence of direct dolmuş services between Ayrancı (an eastern district on the eastern side of the campus) and METU Campus, which appears to have a time advantage over a possible pattern of bus trip and transfer to the metro in reaching the campus. As it is mentioned in the previous sections, some of the zones on the eastern side of the campus have direct connections to the campus with two privately operated public transport modes namely; dolmuş and private buses. That is why, it is not surprising to see that in some zones there is significant travel time differences between different patterns.

It is important to point out that, *Kizilay, Kolej, Tandogan (8 km*) zone, which is the most central zone in the whole survey because of the radial transportation network of Ankara, provides interesting findings. As Kızılay is the Central Business District (CBD) of the metropolitan area, all metro, bus and most dolmus networks combine here. Even though according to Chart 1 metro has a lower travel time compared with the "Dolmus", it should be indicated that, all travel times are standardized with the trip end at A1 or A4 entrances of the campus. In other words, if door to door travel times were the basis, "Dolmus" could have the lowest travel time value. Additionally, as disutility of access time is higher than disutility of in-vehicle time dolmus increases its advantage one more time. After 8 km distance almost in all of the zones "Dolmus" or dolmus related other three patterns; "Dolmus + Bus", "Dolmus + Metro" and Dolmus + Dolmus" have the lowest values (i.e. an advantageous position) in terms of average travel time. Only in three zones namely *Kurtulus, Dikimevi, Cebeci (12 km), Mamak (14 km)* and *Yasamkent, Baglica (15 km)* "Metro" choices has a lower travel time value. However, the same case in *Kizilay, Kolej, Tandogan (8 km*) zone is valid for these three zones, in other words, inclusion of the in campus travel times will change the situation on behalf of dolmus related patterns' users. Definitely, transportation service type is directly related with these results. As metro service is radially working from city center, especially on western and southwestern corridors direct accessibility is possible only by travelling the whole metro network and transferring from Kızılay (city center). However, some dolmus services are not radially working. If needed, they can serve between two west side corridors without coming to the city center. That explains the situation about travel time differentiations between “Metro” and “Dolmus” especially in the zones with high metro accessibility namely *Yenimahalle, Demetevler (11 km)* and *Batikent, Eryaman (17 km)*.

At that point, it is important to indicate that even though, to ease the evaluation of all zones in a single graph, all values are represented in single graphs, in the appendices part there are detailed analysis of all zones under five main groups, which are determined with respect to accessibility similarities of the users. To make it more clear, users in each zone have different travel patterns because of their resident location, unequal distribution of rail systems within the city etc. Furthermore, while some zones are quite far from the campus, some of the zones are very close to the campus (almost within walking distance). That is why, grouping similar zones enabled better and more beneficial results. However, within the context of the study, these analyses would be to much detailed. Nevertheless, to provide a better understanding about the survey results these detailed analyses are attached in the appendices part.

Table 16. Average Travel Time According to Defined Zones (Min)

Zone Distance From Campus / Travel Pattern	Bus	Bus + Bus	Bus + Metro	Metro	Dolmus	Dolmus + Bus	Dolmus + Metro	Dolmus + Dolmus
Yuzuncuyil, Cigdem, Isci Bloklari (1 km)	6.0				7.0			
Sogutozu, Cukurambar (2 km)	15.0				17.5			
Balgat, Ovecler, Cevizlidere (4 km)					17.0			27.0
Bahcelievler, Emek (5 km)	12.5			18.2	20.2			
Cankaya, Ayranci (6 km)			58.4		20.0	30.0	35.2	47.5
Kizilay, Kolej, Tandogan (8 km)	25.2			15.5	20.0			
GOP, Seyranbaglari, Esat (9 km)			27.7	45.0	38.2	35.5		25.0
Dikmen, Keklik (10 km)			41.8		23.3	25.2	47.0	41.7
Yenimahalle, Demetevler (11 km)			50.0	43.1		48.0	29.0	40.4
Kurtulus, Dikimevi, Cebeci (12 km)	35.0	40.0	60.0	27.7		40.0	43.8	
Cayyolu, Umitkoy (12 km)	19.7		41.5	25.4	26.5			24.0
Mamak (14 km)		40.0	30.5	26.1	35.0		27.7	
Altindag (15 km)	60.2		61.7			55.0	60.0	47.5
Yasamkent, Baglica (15 km)			37.7	35.2	36.4			40.0
Kecioren, Etlik (16 km)	66.7	85.0	68.9			67.7	35.5	50.0
Oran, Yildiz, Birlik, Tinaztepe (16 km)					20.0	52.5		40.0
Batikent, Eryaman (17km)	45.7		56.8	68.2	40.5		55	55.0
Golbasi (18 km)			70.2			53.3		
Etimesgut, Sincan (22 km)	42.5		45.4	40.5	36.8			
Pursaklar, Fatih (26 km)			101.4					45.0

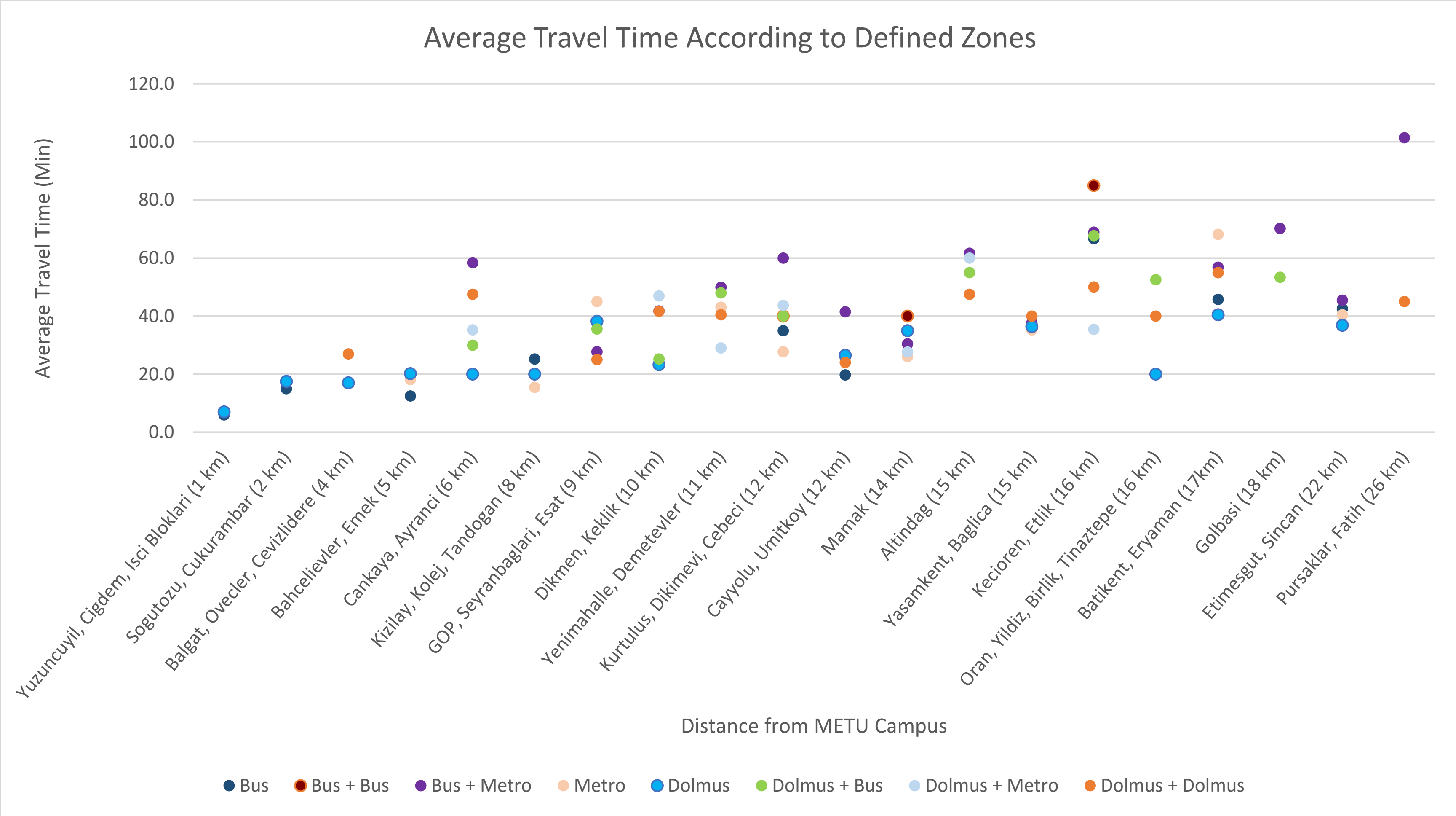

Figure 13. Average Travel Time According to Defined Zones

5.2.4.2. Average Travel Time Per km According to Defined Zones

For developing a better understanding, per km values of travel time should be taken into account because; without standardization of the value, because of enormous distance differences between the closest and the farthest zones, differences between patterns become exaggerated. In other words, this standardization enables the comparison both on vertical (y) axis and horizontal (x) axis; verbally between different modes and between different zones.

There are 20 zones again in the survey and the graph shows that –as expected- the more the distance is the less the travel time per km most of the time. However, there are some outliers (See Figure 14). Up to 5 km distance "Dolmus" has a higher travel time value compared with the conventional options. Between 5 km to 8 km distance, as "Bus" and "Metro" services have a significant travel time advantage against "Dolmus" as represented previously, they have lower per km travel time values. Nevertheless, in *Cankaya, Ayranci (6 km)* zone, "Dolmus" has the lowest travel time value per km. Service routing flexibility and adaptability of "Dolmus" provides that advantage against conventional modes. Again in here, it is important to indicate that residents who live on eastern side of the campus, other choices mostly require a transfer from the city center Kızılay and hence "Dolmus" service's direct operation provides an advantage. Between 2 km-10 km distance, per km travel time of "Dolmus" reduces with respect to distance. However, the only outlier is *GOP, Seyranbaglari, Esat (9 km)* zone. The reason behind this is that; respondents in that zone counted in access time to total travel time, because there is no direct dolmus connection from that zone to METU campus.

An important finding of per km calculations is the fact that; per km values of dolmuş related modes decreases to an average of 4 minute per km after 8 km distance. It is an interesting finding for a paratransit mode because; as paratransit modes are mostly referred as low speed modes, which are unable to compete with their conventional competitors, long distances are disadvantageous for them. Supporting argument for that is its frequent stops depending on users' needs and its slowness against high capacity, high speed urban rail systems. However, both total travel time and per km travel time values show that after 8 km distance "Dolmus" or dolmus related other three modes; "Dolmus + Bus", "Dolmus + Metro" and Dolmus + Dolmus" provide a service which protects its average speed and more importantly faster than conventional public transport vehicles. For the outliers in this chart too, which are *Kurtulus, Dikimevi, Cebeci (12 km), Mamak (14 km)* and *Yasamkent, Baglica (15 km)* "Metro" choices have these different results because of survey respondents' campus entrance standardized answers. It should not be forgotten that, these results (standardized to entrances) increases the advantage of non-flexible routed metro and light rail transit systems. An interesting finding about different travel patterns is the fact that, both "Bus + Bus", "Bus + Metro" and "Dolmus + Bus" travel patterns have relatively higher travel time per km values in *Kecioren, Etlik (16 km)* zone. That could be an indicator of traffic congestion and low travel speeds of that particular zone. This finding is quite important because, it shows that buses' operating speed are quite low compared with the paratransit mode dolmuş choices (as can be seen dolmuş related patterns are the fastest two alternatives) and progressing metro construction named M4 line is quite essential for that area to increase the competitiveness of municipality public transport. Besides, it is important to emphasize that dolmuş as a paratransit mode is even advantageous in the second farthest zone of the survey, which is *Etimesgut, Sincan (22 km)*. The adaptability-flexibility characteristic of dolmuş shows its ability to meet the demand as much as possible. From 1 km to 26 km distance, to compete with conventional modes in terms of time saving, dolmuş operators use many different strategies namely to provide a service, which will minimize the access (out of vehicle) time of the users or to provide express, direct services to the trip end. As stated before, that characteristic of dolmuş is possibly the characteristic, which still helps the survival of dolmuş in transportation network.

Table 17. Average Travel Time Per km According to Defined Zones (Min)

Zone Distance From Campus / Travel Pattern	Bus	Bus + Bus	Bus + Metro	Metro	Dolmus	Dolmus + Bus	Dolmus + Metro	Dolmus + Dolmus
Yuzuncuyil, Cigdem, Isci Bloklari (1 km)	6.0				7.0			
Sogutozu, Cukurambar (2 km)	7.5				8.75			
Balgat, Ovecler, Cevizlidere (4 km)					4.3			6.8
Bahcelievler, Emek (5 km)	2.5			3.6	4.0			
Cankaya, Ayranci (6 km)			9.7		3.3	5.0	5.9	7.9
Kizilay, Kolej, Tandogan (8 km)	3.15			1.9	2.5			
GOP, Seyranbaglari, Esat (9 km)			3.1	5.0	4.2	3.9		2.8
Dikmen, Keklik (10 km)			4.2		2.3	2.5	4.7	4.2
Yenimahalle, Demetevler (11 km)			4.5	3.9		4.4	2.6	3.7
Kurtulus, Dikimevi, Cebeci (12 km)	2.9	3.3	5.0	2.3		3.3	3.6	
Cayyolu, Umitkoy (12 km)	1.6		3.5	2.1	2.2			2.0
Mamak (14 km)		2.9	2.2	1.9	2.5		2.0	
Altindag (15 km)	4.0		4.1			3.7	4.0	3.2
Yasamkent, Baglica (15 km)			2.5	2.3	2.4			2.7
Kecioren, Etlik (16 km)	4.2	5.3	4.3			4.2	2.2	3.1
Oran, Yildiz, Birlik, Tinaztepe (16 km)					1.3	3.3		2.5
Batikent, Eryaman (17km)	2.7		3.3	4.0	2.4		3.2	3.2
Golbasi (18 km)			3.9			3.0		
Etimesgut, Sincan (22 km)	1.9		2.1	1.8	1.7			
Pursaklar, Fatih (26 km)			3.9					1.7

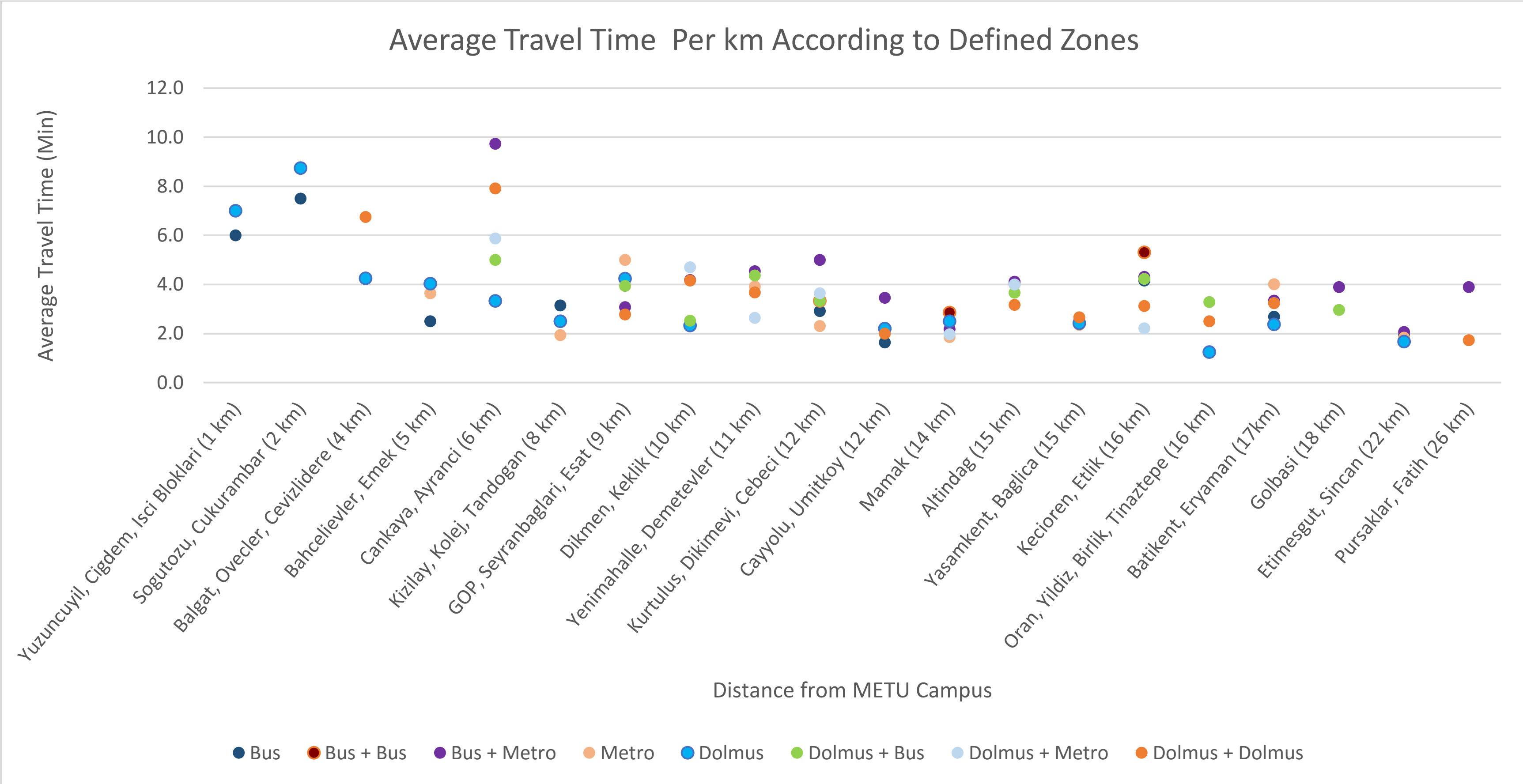

Figure 14. Average Travel Time Per km According to Defined Zones

5.2.4.3. Average Ticket Cost According to Defined Zones

In addition to travel times, the other variable of decision-making, monetary (ticket) cost, should be analyzed as well. For the period when the survey took place; ticket cost of EGO Ankarakart, which covers both metro and municipality bus services was 1.50 TL for students (2.00 TL for full ticket), ticket cost of private buses was 1.50 TL for students (2.00 TL for full ticket), ticket cost of average dolmuş travel was 2.25 TL (Dolmuş has a much more distance based pricing) for all users. To explain the ticketing logic of in of dolmuş services further explanation is necessary. Dolmuş services to increase their profits can propose lower ticket costs to attract passengers to dolmuş as in other paratransit options in the world. For example, *Yuzuncuyil, Cigdem, Isci Bloklari (1 km)* zone is the closest zone to the METU Campus. As it is a residential area with high accessibility, student population is quite high in that particular area. Consequently, there is a significant demand for short distance commuting trips from that zone to the university. In that situation, dolmuş operators –to attract the bus passengers or even the hitchikers or walking students- provide a kind of campus ring service, which is attractive for the students. Two other examples to that situation are in *Yenimahalle, Demetevler (11 km)* and *Batikent, Eryaman (17 km)* zones. As can be seen from the Chart 3 below, there is ticket cost differentiation for "Dolmus + Dolmus" choice. As the size of these two zones are quite higher and some users are travelling far locations with low demand (because of low density in some particular districts of Ankara especially on the fringe) –to reduce extra costs-dolmuş operators was applying a ticket price higher than the existing one, which is 2.30 TL. In the scope of this survey, there is no such ticket cost differentiation for dolmuş operations in other zones, however; to give an idea about possible ticket regulations of dolmuş operators, including those three particular zones was quite important. In short, the differences between above ticket costs and the values in the chart is a result of two main reasons; the first one is ticket cost variability of dolmuş in *Yuzuncuyil, Cigdem, Isci Bloklari (1 km), Yenimahalle, Demetevler (11 km), Batikent, Eryaman (17 km)* zones, the second one is the average of full-student tickets for conventional modes.

As can be seen from the graph below (See Figure 15), "Dolmus" or dolmus related other three modes; "Dolmus + Bus", "Dolmus + Metro" and Dolmus + Dolmus" have higher ticket costs when compared to conventional modes. For example, “Dolmus” users pay only in closer zones less than 2.25 TL. After 2 km distance, all of the users pay same ticket cost for using dolmus. With that kind of pricing for dolmuş operations, it is possible to say that, after 8 km distance travel time increases according to the distance travelled and short distance users create additional burden on operators. In other words, while the users are using dolmuş vehicle for larger distances, their payment remains the same. For ticketing, an important point that should be emphasized is that; as dolmuş and private bus vehicles are not included in integrated ticketing, using privately operated modes increases monetary cost of a commuting trip in significant amounts. For example in *GOP, Seyranbaglari, Esat (9 km)* and *Pursaklar, Fatih (26 km)* zones difference between “Bus + Metro” (1.50 TL) and “Dolmus + Dolmus” (4.50 TL) is 3.00 TL which is equal to double of the AnkaraKart student ticket cost.

Nevertheless, both paratransit and conventional public transport modes have fixed cost in many zones and with the difference variability in a city as large as Ankara that creates budget burdens on users. As public transport operators provide a service with fixed cost in higher distances –to ensure the attractiveness of their privately operated public transport services- they determine a price, which would compensate their increasing operational costs in further zones and which would not discourage the short distance user to use public transport. Consequently, short distance users compensate long distance users. Creating a distance based pricing for a large city (for Ankara case two main corridors are suffering from urban sprawl as explained in transport history chapter) could lead to a significant decrease in ticket costs especially in the short distances. Figure 15 shows the importance of lack of distance based ticketing for each public transport mode. About ticket costs and travel times relationship, an important issue is that, the route design creates significant advantages for paratransit mode users (in whole trip or in transfers). To make it more clear, as there is single dolmuş or dolmuş related travel patterns, which provide direct, more convenient accessing opportunity without passing from city center Kızılay, for the service’s very nature, users have a tendency to travel with less transfers with that direct patterns. For example, for a user in *Yasamkent, Baglica (15 km)* zone, even if the ticket cost of “Dolmus” choice is higher than “Bus + Metro” choice, it enables great time savings to its users.

Table 18 Average Ticket Cost According to Defined Zones (TL)

Zone Distance From Campus / Travel Pattern	Bus	Bus + Bus	Bus + Metro	Metro	Dolmus	Dolmus + Bus	Dolmus + Metro	Dolmus + Dolmus
Yuzuncuyil, Cigdem, Isci Bloklari (1 km)	1.10				1.51			
Sogutozu, Cukurambar (2 km)	1.50				2.25			
Balgat, Ovecler, Cevizlidere (4 km)					2.25			4.50
Bahcelievler, Emek (5 km)	1.50			1.63	2.25			
Cankaya, Ayranci (6 km)			2.00		2.25	3.75	3.75	4.50
Kizilay, Kolej, Tandogan (8 km)	2.00			1.50	2.25			
GOP, Seyranbaglari, Esat (9 km)			1.50	1.50	2.25	3.75		4.50
Dikmen, Keklik (10 km)			1.88		2.25	3.75	3.75	4.50
Yenimahalle, Demetevler (11 km)			2.17	1.75		3.75	3.75	4.54
Kurtulus, Dikimevi, Cebeci (12 km)	1.50	3.00	1.50	1.50		3.13	3.75	
Cayyolu, Umitkoy (12 km)	1.71		1.50	1.50	2.25			4.50
Mamak (14 km)		3.00	1.50	1.50	2.25		3.75	
Altindag (15 km)	1.50		3.00			3.75	3.75	4.50
Yasamkent, Baglica (15 km)			2.10	1.50	2.25			4.50
Kecioren, Etlik (16 km)	1.50	3.00	1.76			3.82	3.75	4.50
Oran, Yildiz, Birlik, Tinaztepe (16 km)					2.25	3.75		4.50
Batikent, Eryaman (17km)	1.60		2.61	1.90	2.25		3.75	4.63
Golbasi (18 km)			1.50			3.75		
Etimesgut, Sincan (22 km)	1.55		1.79	1.50	2.25			
Pursaklar, Fatih (26 km)			1.50					4.50

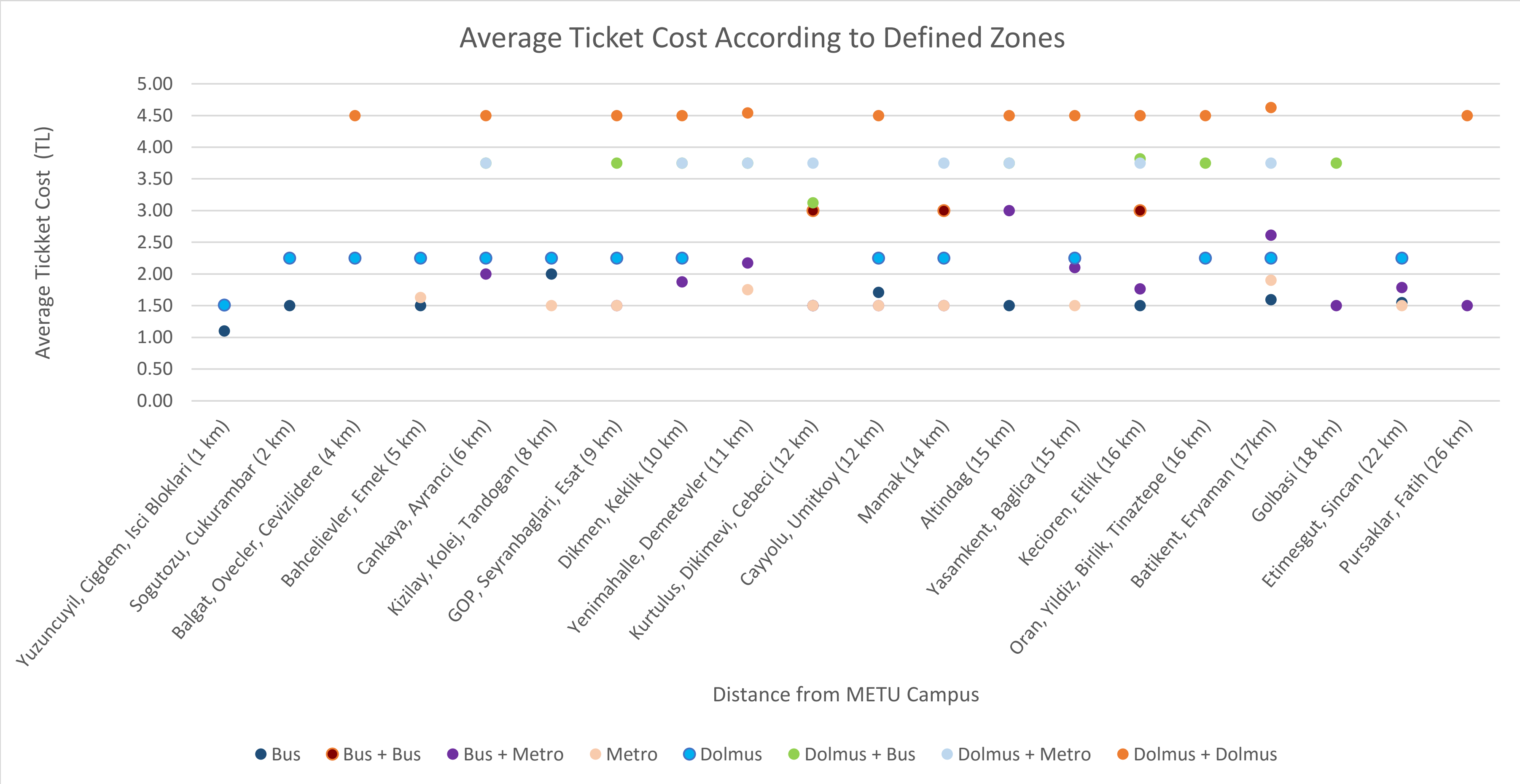

Figure 15. Average Ticket Cost According to Defined Zones

5.2.4.4. Average Ticket Cost Per km According to Defined Zones

A further analysis of monetary cost is needed to figure out the ticket cost per km values. It is important, because, as in travel time values, it can give a better understanding about the comparison of each traveler in the same zone and between different zones.

As expected the more the distance is the less the ticket cost per km is for all 8 patterns (See Figure 16). When compared with each other in the same zones, an interesting finding appears. As distances vary from 1 km to 26 km, and the costs vary between 1.50 TL and 4.50 TL; high increase in distances reduces the ticket cost differentiation between two different patterns in the same zone to very low levels. For example, in *Batikent, Eryaman (17 km)* zone, there is only 0.04 TL difference between "Bus" and "Dolmus". In other words, if there is single mode pattern like "Bus", "Metro" and "Dolmus" ticket cost differentiation is very little for user and definitely has a lower impact on user's decision making. That means, especially for the zones with lower ticket cost differences value of 1 minute travel time, comfort and convenience measures of the users should be taken into account much more carefully for healthy results.

Another important deduction is between the dolmus related other three modes; "Dolmus + Bus", "Dolmus + Metro" and Dolmus + Dolmus" and the other five patterns including single "Dolmus" choice. As it is shown in the graph below, after 10 km distance all other five modes' users ticket cost per km decreases under 0.20 TL per km. If this level is taken as a threshold for per km ticket cost values, the other three modes (which are actually transfers' not including free transfer opportunity) represented in the beginning of this paragraph, could reach this level only after 18 km distance. It would not be wrong to say that, for Ankara Case integrated ticketing is a necessity especially for up to 18 km distanced zones from METU campus since there are users who pay quite higher because of their low level of accessibility to the campus from their homes. Surely, METU campus case could not be taken as a base point; however, it should not be forgotten that, it is one of the few highly accessible areas both by metro, bus and dolmuş network because of its close location to southwestern Eskişehir Road Corridor. Yet still, this approach could be used for an analysis of public transport monetary cost of users with more samples from the whole city.

Compensation problem of short distance users of long distance users can be seen much more easily in this graph. It was stated in the previous section that dolmuş and private buses has a much more distance based pricing than conventional modes. Even if there are efforts of operators to increase their competitiveness, the graph shows that ticket prices are still quite high compared with the distance. In short, even if the private buses regulates their payments within 1 km radius as 1.00 TL or 1.50 TL, when the distance covered after passengers' getting on, the pricing is still quite high. That shows especially within the short distances the disadvantageous situation of public transport options. That also explains respondents –of record- statements which are stating that, if they have the chance to purchase a private car, they definitely would buy one to get rid of public transport "ordeal". That also demonstrates that expensive but relatively low quality of public transport in Ankara indirectly maintains the sharp increase in the private vehicle ownership. Besides, as can be seen from the chart, up to 5 km distance per km ticket cost is quite high for the users. According to the ticket cost per km values deducted from the participant responses, even the users of bus are paying very high fares for the transportation services they get. It would not be wrong to state that, the need for distance based pricing from each particular zone and integrated ticketing between transfers (including dolmuş) are two main findings of the ticket cost according to defined zones study. At that point, to understand the logic behind the usage of for example "Dolmus + Dolmus" pattern is not visible with emphasizing only ticket cost values. However, an aggregate study is needed for comparing eight common travel patterns through METU campus. The relationship between travel time and ticketing will provide better insights and only after that kind of analysis per km values of ticket cost would be much more meaningful.

Table 19 Average Ticket Cost According to Defined Zones (TL)

Zone Distance From Campus / Travel Pattern	Bus	Bus + Bus	Bus + Metro	Metro	Dolmus	Bus + Dolmus	Dolmus + Metro	Dolmus + Dolmus
Yuzuncuyil, Cigdem, Isci Bloklari (1 km)	1.10				1.51			
Sogutozu, Cukurambar (2 km)	0.75				1.13			
Balgat, Ovecler, Cevizlidere (4 km)					0.56			1.13
Bahcelievler, Emek (5 km)	0.30			0.33	0.45			
Cankaya, Ayranci (6 km)			0.33		0.38	0.63	0.63	0.75
Kizilay, Kolej, Tandogan (8 km)	0.25			0.19	0.28			
GOP, Seyranbaglari, Esat (9 km)			0.17	0.17	0.25	0.42		0.50
Dikmen, Keklik (10 km)			0.19		0.23	0.38	0.38	0.45
Yenimahalle, Demetevler (11 km)			0.20	0.16		0.34	0.34	0.41
Kurtulus, Dikimevi, Cebeci (12 km)	0.13	0.25	0.13	0.13		0.26	0.31	
Cayyolu, Umitkoy (12 km)	0.14		0.13	0.13	0.19			0.38
Mamak (14 km)		0.21	0.11	0.11	0.16		0.27	
Altindag (15 km)	0.10		0.20			0.25	0.25	0.30
Yasamkent, Baglica (15 km)			0.14	0.10	0.15			0.30
Kecioren, Etlik (16 km)	0.09	0.19	0.11			0.24	0.23	0.28
Oran, Yildiz, Birlik, Tinaztepe (16 km)					0.14	0.23		0.28
Batikent, Eryaman (17km)	0.09		0.15	0.11	0.13		0.22	0.27
Golbasi (18 km)			0.08			0.21		
Etimesgut, Sincan (22 km)	0.07		0.08	0.07	0.10			
Pursaklar, Fatih (26 km)			0.06					0.17

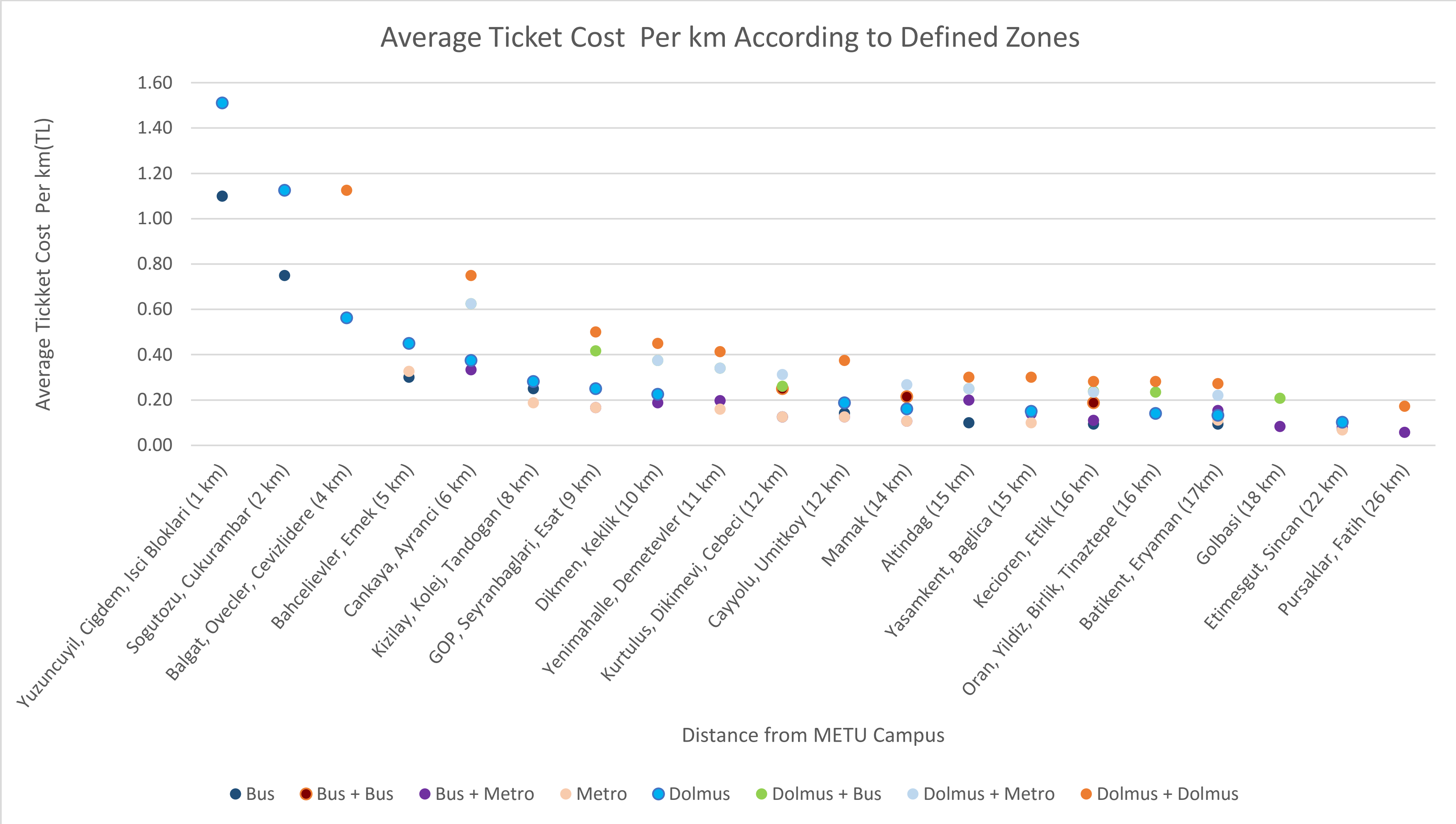

Figure16. Average Ticket Cost According to Defined Zones

5.2.5. Findings and Summary

Within this chapter firstly, the contemporary situation of transportation services in Ankara and METU campus connections are presented. Secondly, a descriptive analysis section covering the survey participants' characteristics, their commuting trip mode choices, their views and satisfactions on newly opened M2 metro line, their expectations on possible transportation improvement projects about metro and other public transport options is presented. Based on the findings of that descriptive analysis part, it is seen that there is need for a detailed analysis on the reasons of students' mode choice. That is why, in the previous section of the chapter, a zone based comparison has been made between the eight travel patterns.

In terms of travel time, it is obvious that there is a transport network, in which dolmuş operators supply a more attractive service. Radially distributing, city center based metro network is far from meeting the expectations. On the other hand, because of traffic congestion buses are unable to operate in high speed. Furthermore, the consequences of profit maximization aim of dolmuş, such as frequent stopping and speed (even though the latter may reduce traffic safety) and its vehicular advantages (small, easily maneuvering vehicles) encourage users to use dolmuş as opposed to bus services. Furthermore, as dolmuş creates demand responsive routes there are cross-routes (between main axes) different from metro, and these can easily lower travelled distance in significant manners. It is important to indicate that, dolmuş direct service to the METU Campus without passing from city center, provides a remarkable advantage to it compared with the conventional competitors. That research enabled an unexpected result on behalf of the operators. Dolmuş operators, provide a transportation service with an average per km travel time value (4 minute per km) to its users, in zones with more than 8 km distance from campus. It is important to deduce that because, it shows that dolmuş vehicles, contrary to the expectations, in further distances as much competitive as in shorter distances. Furthermore, in zone further than 8 km distance from METU campus, "Dolmus" or dolmus related other three modes; "Dolmus + Bus", "Dolmus + Metro" and Dolmus + Dolmus" are faster almost in all zones. That rationalize the dolmuş choice of the users from many different zones and also demonstrates one of the reasons which helps the survival of dolmuş in transportation network.

In terms of ticket cost, excluding reduced ticket cost applied by private operators dolmuş and private bus in 1 km radius from METU campus, there is fixed cost from 2 km to 26 km distance from METU Campus. Dolmus" or dolmus related other three modes; "Dolmus + Bus", "Dolmus + Metro" and Dolmus + Dolmus" have higher ticket costs in all zones compared because of lack of ticket integration and higher ticket costs compared with conventional modes. However, as it is shown that in the previous section in long distances high ticket cost of paratransit operators do not discourage users to use these vehicles, because they are extremely advantageous in terms of time saving compared with the competitors. However, the problem about the fixed cost of public transport is that long distance commuters' relatively low ticket costs lays a burden on short distance commuters. Ticket cost evaluation provided another important finding about dolmuş operations. As ticket cost of dolmuş operations is equal to 2.25 TL in almost all zones, the further the distance is users are advantageous. Nevertheless, that also shows that the more the distance is because of the increase in operational costs operators are actually disadvantageous.

In brief, this chapter provided an insight about the reasoning of the dominance of dolmuş operations in almost all of the zones in Ankara network. Nevertheless, users are paying quite high than conventional modes to use dolmuş and dolmuş related patterns. That is why an additional study is needed before developing a policy argument for the solution of dolmuş related money loss, safety loss and low conventional transport efficiency problem. In that additional study, the question is; what is the relationship between travel time savings and ticket (monetary) cost? Are they balanced with each other or are there other characteristics of paratransit mode dolmuş, which makes it preferable? That analysis in the next chapter will provide an in-depth understanding of the possible approaches for the integration of dolmuş operations to the existing operations.

CHAPTER 6

6. NEW TICKET INTEGRATION PROPOSAL FOR DOLMUS

6.1. Joint Evaluation of Travel Time-Ticket Cost

Previous chapter showed that there is a need for the integration of all public transport operations. Surveys demonstrated that it is very difficult to cancel dolmuş operations in the short term. The reason for this necessity emerges because of the service that they provided is difficult to replace because of budget constraints and because of its operational characteristics. However, it is obvious that there is a significant ticket cost difference between dolmuş's competitor conventional modes especially in the long distances. As a result of direct route determination, of dolmuş operators and operational (vehicle capacity and maneuverability) advantages, dolmuş users have time advantage compared with the conventional modes. At the same time, they are paying more due to lack of ticket integration. That is why; it is a necessity to develop methods for the possible integration strategies of dolmuş operations into the conventional network. However, it is only possible by the deduction of the relationship between different transportation choices. With that understanding, it is possible to develop a suggestion. The relationship between travel time and ticket cost are requiring an additional work, as a result of the differentiation of units, namely minutes and Turkish Liras. Each minute of travel time could be translated into Turkish liras and with that way time savings (money savings) and ticket costs (money costs) could be added up to each other. As indicated by Mills (1972, 216), choice of mode depends on prices, time, comfort and convenience of alternative modes and among realistic alternatives in U.S. urban areas, time is likely to be the dominant consideration. That is why; as indicated before the final part of the study will focus on the first two inputs. However, at this point it is important to emphasize one more time that comfort and convenience are two other elements that should be included to the calculation about mode choice, nevertheless, the outputs of the survey on these two titles were not applicable for all the choices used. In summary, this part will be a calculation comparison result. The first calculation will be the standard calculation of 1 minute travel time according to the minimum wages. Normally, marginal disutility of access time is larger than marginal disutility of in-vehicle time. However, in this particular case it would not be possible to get information in that detail level. The second part of this chapter continues with the calculation of monetary value of 1 minute travel time. Nevertheless, survey data should be standardized again for a more aggregate comparison. As there are 20 zones in the survey, it is very difficult to compare different patterns at the same time. To overcome this problem each travel pattern should be standardized. The aim of this sixth chapter, is to prepare aggregate results at first, and then to propose integration policies according to these results. The loss and the saving values of users are calculated with these aggregate numbers.

6.1.1. Calculation of 1 Minute Travel Time

There are similar methods for the calculation of 1 minute travel time in economics (Mills, 1972; O'Sullivan, 2012; Small and Verhoef, 2007). The value of 1 minute travel time is calculated by the monetary value of 1 minute working time based on minimum wage of the country in question. For the calculation of 1 minute, number of working minutes should be deducted. First of all, each worker works for 22-23 days monthly (22 days for months with 30 days, 23 for months with 31 days). It could be taken as 22.5 day per month on average. Legal working hours per day (excluding relaxation allowance) is 8 hours a day. With that knowledge, value of 1 minute can be calculated with the method below:

$$\text{Wage Value of 1 Minute} = \frac{\text{Minimum Wage}}{\text{60 Min*8 Hours Daily Working*22.5 Day Per Month}} \quad (4)$$

$$\text{Wage Value of 1 Minute} = \frac{1000}{60*8*22.5}$$

$$\text{Wage Value of 1 Minute} = \frac{1300}{10800}$$

$$\text{Wage Value of 1 Minute} = 0.09 \text{ TL}$$

In the literature there are different approaches of the valuation of travel time savings. The US Department of Transportation (1997) recommends using 100% of the wage rate for time spent walking and waiting and 50% of the wage rate for time spent in transit vehicles. The UK Dept. for Transport (2001) also adopts a value for out-of-vehicle time that is double the in-vehicle time value. However, Cal-B/C uses 50% of the wage rate for all transit travel time. Nevertheless, for this particular study, it is indicated in the previous chapter that, in-vehicle and access (out of vehicle) travel times) are not gathered seperatedly from the survey. However, to increase the reliability of a data, using an interval rather than a single value would be better. That is why; Quandt's conceptualization will be used for the calculation of 1 minute travel time. According to Quandt (1970), travel time is valued between one third and one half of the wage rate, the fraction increasing with the wage rate. If the Full wage is taken as 0.090 TL, then the Half Wage would be **0.045 TL** and One Third Wage would be **0.030 TL**. In the forthcoming sections, these two wage rates for Value of 1 Minute Travel Time will be used.

As explained previously, there are eight main titles which are representing the whole public transport travel patterns through METU Campus; "Bus", "Bus + Bus", "Bus + Metro", "Metro" (These are benchmarks for the evaluation of dolmuş) and "Dolmus", "Dolmus + Bus", "Dolmus + Metro" and finally "Dolmus + Dolmus". It is important to indicate that, even though "Dolmus + Dolmus" alternative is a pattern commonly used by the users, as this study aims to provide an insight on possible integration methods of formal and informal transportation modes, this pattern is excluded from further analyses.

As there were 20 different zones, which were discussed in detail in previous reports, an aggregate evaluation is necessary to ease the comparisons between different patterns. In this part of the study, the relationship between travel times and ticket costs are emphasized. There are seven transportation patterns, which will be considered and these seven patterns are divided into two groups. The first group is single mode patterns, namely Dolmus-Bus comparison and Dolmus-Metro comparison. The second group is multimodal patterns namely: Dolmus + Bus, Bus + Bus comparison and Dolmus + Metro, Bus + Metro comparison. Firstly, travel times and ticket costs for each mode are calculated and then, the differences of ticket costs divided to the differences of travel times between compared modes. Division of the ticket cost difference to travel time difference represents the perceived value of 1 minute travel time. After then, this second travel time calculated is compared with the ones which were calculated earlier (Half Wage 0.045 TL, One Third Wage 0.030 TL). It is better to represent this comparison with the formula representation showing each step in detail below:

New calculation is:

1. $$\text{Perceived Value of 1 Minute TT} = \frac{\text{Time Saving Relative to Other Choice}}{\text{Ticket Cost Difference with Other Choice}} \quad (5)$$

Old Calculations were (In the previous page in detail):

2. $Wage\ Value\ of\ 1\ Minute\ Working\ Time = 0.09\ TL\ (Full\ Wage)$

$Maximum\ Value\ of\ 1\ Minute\ TT = 0.045\ TL\ (Half\ Wage)$

$Minimum\ Value\ of\ 1\ Minute\ TT = 0.030\ TL\ (One\ Third\ Wage)$

Finally the comparison of the second and third sections will be:

3. $Perceived\ Value\ of\ 1\ Minute\ TT \Leftrightarrow Old\ Value\ of\ 1\ Minute\ TT$

The relationship between the perceived and calculated value of 1 Minute Travel Time will show the direction for the next step. If the values are lower than calculated, then people have a lower value of 1 minute travel time than expected. That means people pay the additional ticket price to dolmuş service and there is a reasonable time saving. However, if the values are higher than the calculated values, this will show that comfort and convenience measures have a lot more importance than expected or perceived travel times are not reliable. However, before that calculation, mean values for seven travel patterns should be calculated.

6.1.2. Calculation of Mean Values for Seven Travel Patterns

Perceived travel time values and ticket cost should be standardized before the comparison of each one with the other. To get aggregate totals, a new comparison type is used. There are four patterns that are compared: Dolmus - Bus comparison, Dolmus - Metro comparison, Dolmus+Bus - Bus+Bus comparison and Dolmus+Metro – Bus+Metro comparison. For each one of the groups compared a simple gathering process is made. For each travel pattern comparison, distance of the zones, which have two patterns at the same time a summed up and divided to number of zones. Furthermore, for those particular zones travel time per km, ticket cost per km values are summed up and divided to number of zones with competition. This mean distance travelled value is multiplied with the mean travel time per km to find mean travel time value according to zones in which competition take place. These calculations are shown in detail one by one below:

$$\text{Mean\_km\_Travelled (km)} = \frac{\text{Addition of all zones which includes compared patterns at the same time}}{\text{Number of zones which includes compared patterns at the same time}} \quad (6)$$

$$\text{Mean\_Travel\_Time\_Per\_km (Min)} = \frac{\text{Sum of Travel Times per km in Related Zones}}{\text{Number of Travel Times in Related Zones}} \quad (7)$$

$$\text{Mean\_Ticket\_Cost\_Per\_km (TL)} = \frac{\text{Sum of Ticket Costs per km in Related Zones}}{\text{Number of Ticket Costs in Related Zones}} \quad (8)$$

$$\text{Mean\_Travel\_Time (Min)} = \text{Mean\_km\_Travelled*Mean\_Travel\_Time\_Per\_km (Min)} \quad (9)$$

$$\text{Mean\_Ticket\_Cost(TL)} = \text{Mean\_km\_Travelled*Mean\_Ticket\_Cost\_Per\_km (TL)} \quad (10)$$

According to these five formulas, a final table is prepared (See Table 20). In here, it is important to point out that for “Dolmus” choice as there are two different comparisons with same pattern there is two different value columns for it. In the first part of the table values of “Dolmus” is given for “Bus” comparison. In the other table, values of “Dolmus” are different than the first one and it is for “Metro” comparison. For the rest two comparisons, as can be seen from the table, mean km travelled per mode row is same for the compared patterns. The aim of this operation is to gather aggregate values of distance travelled, travel time spent and ticket cost paid for the mean of the zones and to be able to compare each pattern according to these values easily.

Table 20. Comparative Means Per Mode in Zones with Real Competition

MEAN_DATA/MODE NAME	Bus	Dolmus	Bus + Bus	Dolmus + Bus	Bus + Metro	Dolmus + Metro
Mean_km_Travelled_Per_Mode (Km)	9.6	9.6	14.0	14.0	12.6	12.6
Mean_Travel_Time_Per_KM_Per_Mode (Min)	3.6	4.1	4.3	3.8	4.7	3.5
Mean_Ticket_Cost_Per_KM_Per_Mode (TL)	0.39	0.54	0.22	0.25	0.18	0.34
Mean_Travel_Time_Per_Mode (Min)	34.8	39.0	60.5	53.0	59.0	44.6
Mean_Ticket_Cost_Per_Mode (TL)	3.70	5.18	3.06	3.49	2.23	4.24

MEAN_DATA/MODE NAME	Metro	Dolmus	
Mean_km_Travelled_Per_Mode (Km)	12.8	12.8	FOR DOLMUS-METRO COMPARISON ONLY
Mean_Travel_Time_Per_KM_Per_Mode (Min)	2.8	2.7	
Mean_Ticket_Cost_Per_KM_Per_Mode (TL)	0.15	0.21	
Mean_Travel_Time_Per_Mode (Min)	36.3	35.0	
Mean_Ticket_Cost_Per_Mode (TL)	1.90	2.73	

After the preparation of this aggregate table, the comparison of competing modes will be made in two parts. First comparison is between single mode patterns; "Dolmus-Bus" and "Dolmus-Metro" and the second comparison is between multimodal patterns; "Dolmus+Bus"-"Bus+Bus" and "Dolmus+Metro"-"Bus+Metro". These comparisons are made both for per km and total km (per km values * mean km travelled) values. As the focal point is dolmus in the whole study, the basis perspective is based upon dolmus users' travel times and ticket costs. In other words, travel time and ticket cost values of bus and metro users are subtracted from dolmus users' values. That is why, some values are positive and some values are negative. In the upcoming column charts, green color represents positive and red colors represent negative results. To make it more comprehensible, positive values represent time saving of dolmuş users this is parallel to expectation of this study. On the other hand, negative value represents time loss of dolmuş users, which needs further study. As (explained in the previous part) dolmuş or “Dolmus” or dolmus related other three modes; “Dolmus + Bus”, “Dolmus + Metro” and Dolmus + Dolmus” have a higher ticket cost than the benchmark conventional modes both time loss and monetary loss is unable to explain the usage of dolmuş. In other words, negative values represent a null hypothesis. The comparison of each travel pattern is explained in detail one by one in the section below. It is important to point out that, these aggregate results show the real perceptions of users and that is why, they show the real situation according to surveys.

6.2. Single Mode Patterns Comparison

6.2.1. Per km Comparisons

The basis perspective will be to investigate how much more are users paying for one minute of time saving? In other words the values of bus and metro subtracted from dolmuş values. As can be seen from two charts below dolmuş users are disadvantageous against bus users while they are advantageous against metro users. However, a detailed explanation is needed for that kind of difference between bus and metro comparison.

To start with “Dolmus” and “Bus” comparison, as can be seen from the charts below, per km “Dolmus” is disadvantageous against “Bus” in terms of travel times. There is 0.45 minutes time loss per km for “Dolmus” (See Figure 17). Besides “Dolmus” has a 0.15 TL higher ticket cost per km against bus (See Figure 18). In short, “Dolmus” user is losing both time and money against “Bus” user. Continuing with the “Dolmus” and “Metro” comparison; as can be seen from the charts below, “Dolmus” users are saving 0.10 Minutes by paying 0.07 TL per km (See Figure 17 and Figure 18). As these aggregate calculations are made in the zones in which two patterns’ modes are really competing with each other, it would not be wrong to say that, these results are quite close to the real situation. The important point in here, which should be emphasized again is that these results are standardized to the entrances of METU campus. That is to say, the difference between “Dolmus” and “Metro” can be expected higher than represented here.

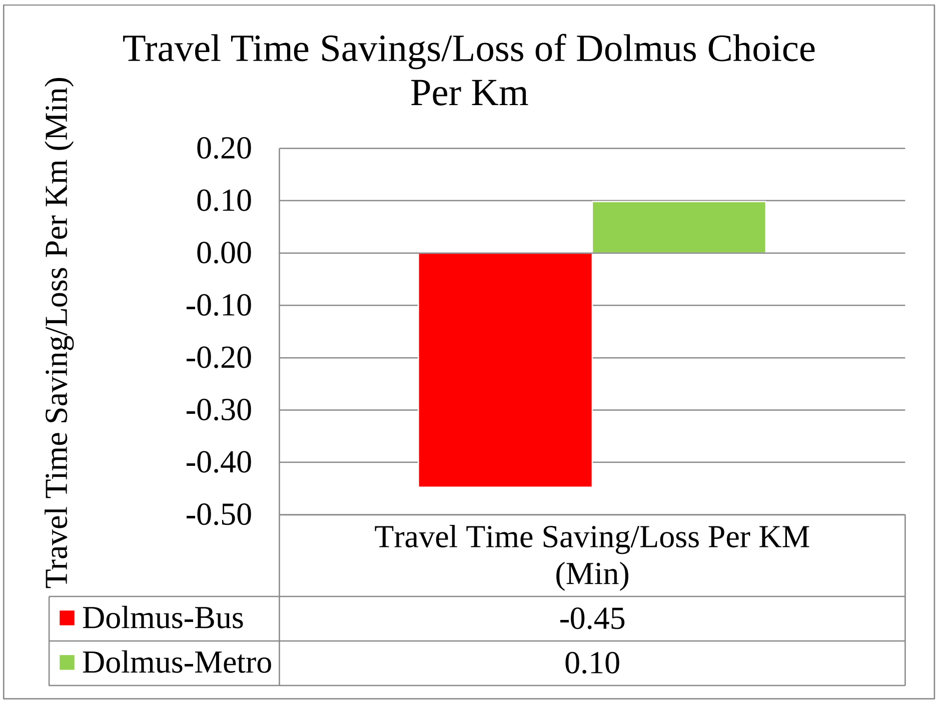

Figure 17. Travel Time Savings/Loss of Dolmus Choice Per Km

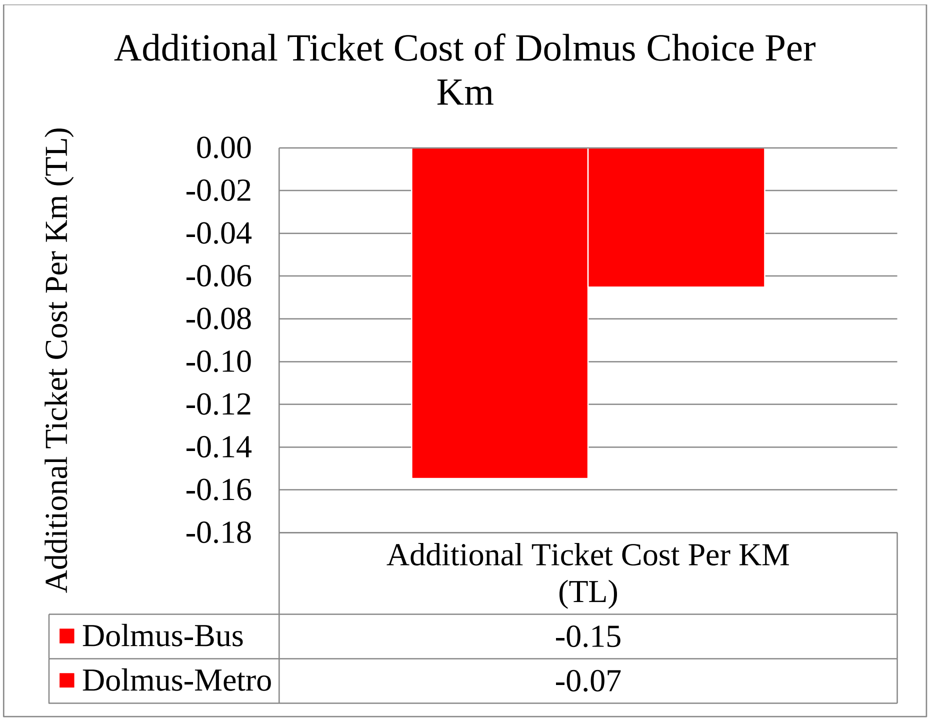

Figure 18. Additional Ticket Cost of Dolmus Choice Per Km

It was explained previously that perceived 1 minute travel time values according to answers of the participants will be calculated. As can be seen from the table below, the ones who prefer dolmuş lose either travel time or money against bus users. In that comparison, the value of travel time per minute is -0.33 TL (See Table 21). This means there is negative travel time value. “Dolmus” becomes an irrational choice in here compared with the “Bus” choice because, as farr as the literature research showed, transportation service is an economic commodity and there should be a balance between benefits and costs of each choice. As users who prefer dolmuş against bus choice has no advantage in terms of travel time and monetary cost, there is no appointed reasining in here. Yet still, when total km comparisons are made, a better explanation is possible.

Table 21 Value of 1 Minute Travel Time Per km According to the User Perception (Dolmus-Bus)

DOLMUS-BUS COMPARISON	
Time Loss Per Km (Min)	-0.45
Additional Ticket Cost Per Km (TL)	0.15
Value of 1 Minute Travel Time (TL)	-0.33

Coming to “Dolmus” and “Metro” comparison, as can be seen from the table below, travel time saving value of 1 minute is equal to 0.70 TL (See Table 22). This 1 minute value is quite high for either “Dolmus” or any other comparison. There are two possibilities for the explanation of this high travel time value. First one is, as comfort and convenience is not included to the calculations, it is possible that, this high ticket value is containing the comfort and convenience measures of “Dolmus” users, which can be explained with the comfort measures of on-surface transportation opportunity and door-to-door similar transportation opportunity of dolmuş operations. Second explanation is, maybe travel time value for each student is higher than expected. However, being higher and lower of the 1 minute travel time values will be emphasized together in the upcoming section. It is possible that maybe total km comparisons can give a better clue, and these are analyzed below.

Table 22. Value of 1 Minute Travel Time Per km According to the User Perception (Dolmus-Metro)

DOLMUS-METRO COMPARISON	
Total Time Saving Per Km (Min)	0.10
Additional Ticket Cost Per Km (TL)	0.07
Value of 1 Minute Travel Time (TL)	0.70

6.2.2. Total km Comparison

It is important to see the relationship between mean travel times and mean ticket costs. As mean km travelled calculations are made in zones in which competition take place there is no difference between the distances of compared travel patterns. Consequently, there would not be significant differences between per km and total km values namely change of the positivity or negativity of the value or an exponential increase in the total km values. Nevertheless, it is important to see the relationship of competing patterns in the zones, which they are competing with total km values. These second type of calculations are made with the multiplication of per km values with total km travelled in related zones by each mode.

For mean values as can be seen from the table below, “Dolmus” users again have 4.29 minutes disadvantage against “Bus” users (See Figure 19). Besides, on average there is 1.48 TL additional ticket cost emerging for “Dolmus” users against “Bus” users (See Figure 20). As in per km calculations, in here too, “Dolmus” users are losing both time and money by not choosing “Bus”, which is quite irrational choice for public transport mode choice. On the other side, between “Dolmus”-“Metro” the situation is again parallel to the per km value. Travel time saving of “Dolmus” users is 1.26 min for mean km values (See Figure 19). For that time saving value each

"Dolmus" user pays additional 0.83 TL in total (See Figure 20). The emphasis in here is the fact that, especially for additional ticket cost values the result could look like quite high. However, it should not be forgotten that, in this chapter the values are calculated with mean km calculations. In other words, they do not represent actually paid values but values, which are the multiplication of value of mean km travelled with the value of mean ticket cost per km. To make it more clear, the values are aggregate values to ease the comparison of different calculations in total km travelled. That is why, as will be explained further, per km comparisons would give better results for a zone based calculation at the end of the chapter.

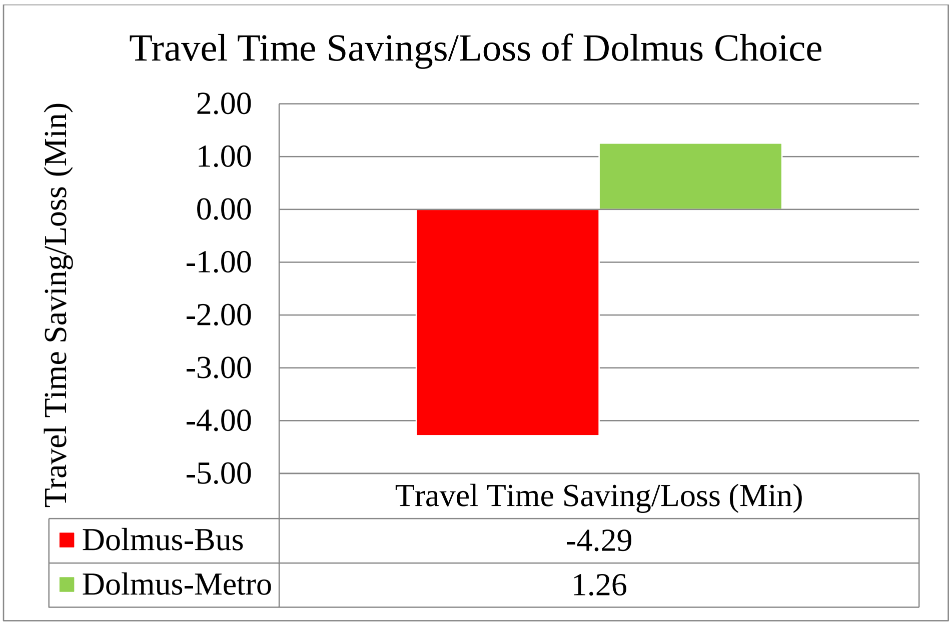

Figure 19. Travel Time Savings/Loss of Dolmus Choice

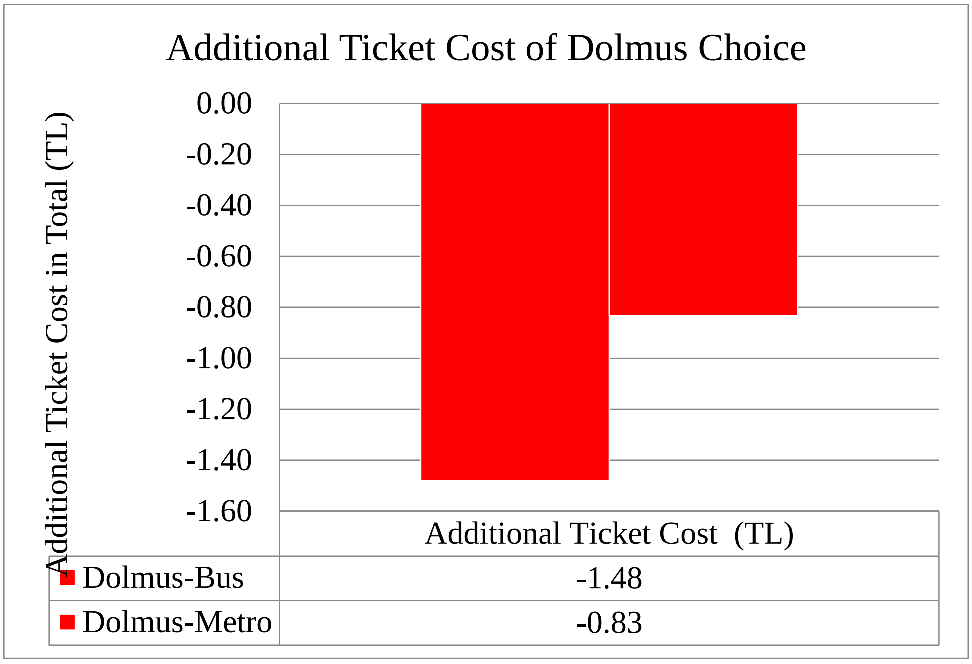

Figure 20. Additional Ticket Cost of Dolmus Choice

As can be seen from the charts above disadvantageous situation of dolmuş against bus choice and advantageous situation of dolmus against metro choice continues in total km calculations too. However, value of 1 minute travel time value differentiates in significant manners. If the competition between “Dolmus” and “Bus” are compared, “Dolmus” users are losing both time and money (See Table 23). In per km calculations value of 1 minute travel time was equal to -0.33 TL. In here the value decreases to -0.34 TL in total. Nevertheless still, if “Dolmus” and “Bus” users are compared depending on the zones, in which competition takes place in real life, the choice of dolmus is not rationale. That is why, it would not be wrong to say that sample is unable to explain the competition between these two patterns, or that comfort, convenience and other perceptions (stop frequency, distance to stops, waiting times at bus stops, reliability of service etc.) also play a role.

Table 23. Value of 1 Minute Travel Time According to the User Perception (Dolmus-Bus)

DOLMUS-BUS COMPARISON	
Total Time Loss (Min)	-4.29
Additional Ticket Cost in Total (TL)	1.48
Value of 1 Minute Travel Time (TL)	-0.34

Coming to Dolmus-Metro comparison, the value of 1 minute is equal to 0.66 TL in zones with real competition (See Table 18). When per km results are checked, the value of 1 minute travel time was found to be equal to 0.70 TL. Even though total km is much more reasonable compared with previously calculated one, it is still unable to explain the logic behind "Dolmus" choice against "Metro". Maybe comfort and convenience measurements are significantly important for dolmuş preferences or exclusion of in-campus travel time resulted this high value.

Table 24. Value of 1 Minute Travel Time According to the User Perception (Dolmus-Metro)

DOLMUS-METRO COMPARISON	
Total Time Saving (Min)	1.26
Additional Ticket Cost in Total (TL)	0.83
Value of 1 Minute Travel Time (TL)	0.66

6.3. Multimodal Patterns Comparison

6.3.1. Per km Comparison

Second comparison will be made between multimodal patterns. As the focal point is dolmuş in the whole study, in this part also the basis perspective will be based upon dolmuş users' travel times and ticket costs. There are again two different comparisons here; “Dolmus + Bus” and “Bus + Bus” comparison will be the first one. “Dolmus + Metro” and “Bus + Metro” comparison will be the second one. It is much more important than the previous comparison because, the literature shows that dolmuş like paratransit vehicles are much more successful as supporters (or feeders) of conventional modes.

To start with “Dolmus + Bus”- Bus + Bus” comparison, dolmuş transferred bus choice has 0.54 minute time saving against bus transferred bus choice (See Figure 21). In the meantime, these users pay 0.03 TL per km for this time saving value (See Figure 22). On the other hand, the other comparison is between “Dolmus + Metro”- “Bus + Metro”. In this second multimodal comparison dolmuş transferred metro choice provides its user 1.14 minute saving on time per km (See Figure 21) and creates 0.16 TL additional ticket cost for that time saving (See Figure 22). The important point in here, which should be emphasized again is that, these results are standardized to the entrances of METU campus and the values are calculated depending on mean km, mean ticket cost and mean travel time. However, different from single mode comparisons, in multimodal comparisons dolmuş transferred choices are definitely advantageous for its users. Fully conventional travel patterns’ conventional feeder buses (as represented in the literature) are not as good as paratransit modes in operating feeder systems of main transportation axes according to the results of survey.

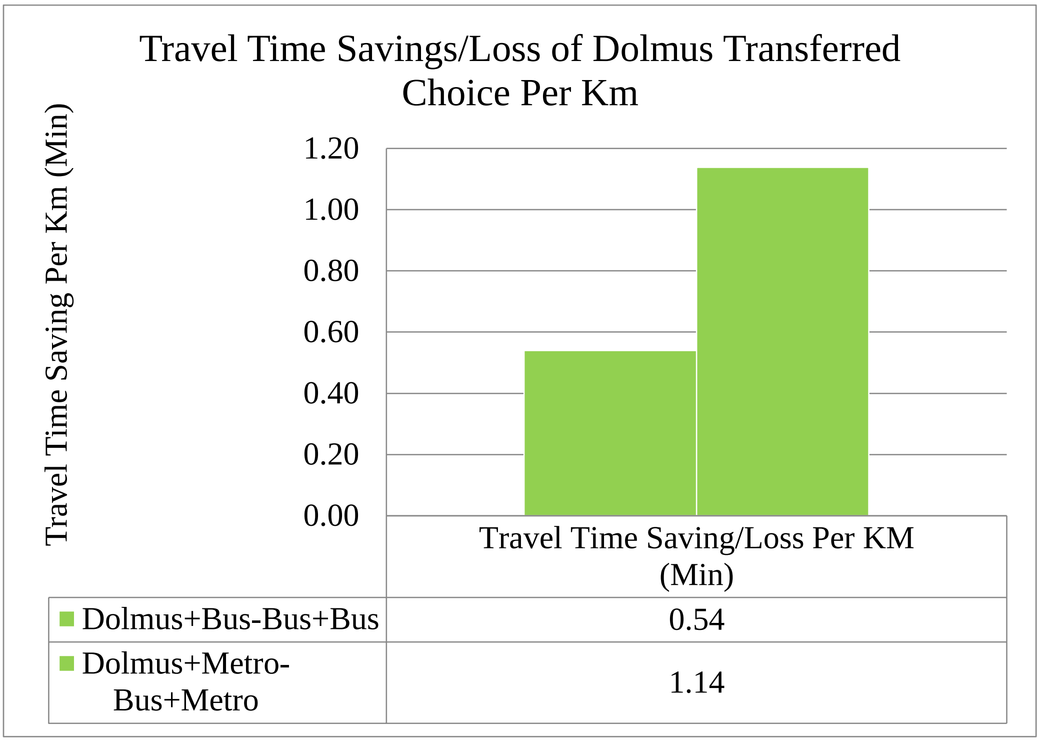

Figure 21. Travel Time Savings/Loss of Dolmus Transferred Choice Per km

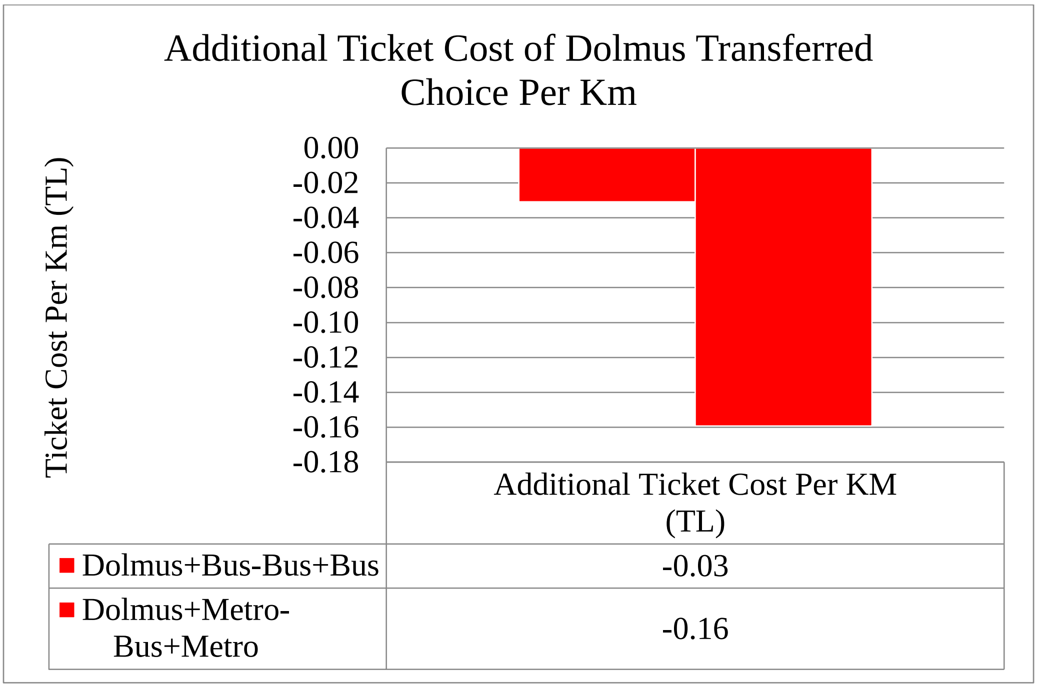

Figure 22. Additional Ticket Cost of Dolmus Transferred Choice Per km

To start with rubber wheel modes, “Dolmus + Bus”-“Bus + Bus” comparison is the first one that will be evaluated. For dolmuş transferred rubber tired multimodal comparison, the value of 1 minute travel time is equal to 0.06 TL per km (See Table 25). The value is positive and compared with the expectations it is quite reasonable value for time saving. Even it would not be wrong to state that, up to that part of the study, it is the most reasonable value of 1 minute travel time. Besides, it is important to point out that dolmuş is a better feeder system even for the bus network on the main axes. It is important to find out that result because, as it is stated previously, transportation network of Ankara is actually a rubber tired modes dominated. That is why, this finding could lead the experts to a new integration policy for the dolmuş feeders to not only for metro but also for bus services. However, before passing the judgment on that result, total km comparison could provide better insight for the evaluation. Therefore, in multimodal comparison too, total km results should be evaluated as well.

Table 25. Value of 1 Minute Travel Time According to the User Perception (Dolmus+Bus-Bus+Bus)

DOLMUS+BUS-BUS+BUS COMPARISON	
Time Saving Per Km (Min)	0.54
Additional Ticket Cost Per Km (TL)	0.03
Value of 1 Minute Travel Time (TL)	0.06

If the results of metro related multimodal trips are investigated, “Dolmus + Metro” is advantageous against “Bus + Metro” with 1.1 minute time saving per km. According to the aggregate results dolmuş transferred users are paying 0.16 TL for 1.14 minutes time saving per km. Depending on these two results, value of 1 minute travel time is calculated as 0.14 TL per km (See Table 26). This result shows that dolmuş is a better feeder for metro than bus. Nevertheless, total km comparison again could provide better insight for the evaluation. Furthermore, as “Dolmus + Metro”-“Bus + Metro” comparison cover Dolmus + Metro/Metro + Dolmus and Bus + Metro/Metro + Bus, there are trips, which are actually ending on the departments (trip ends of these trips too are standardized for campus entrances). It should not be forgotten that, because of the deduction of in campus travel times of each individual, real time saving value is actually higher because of entrance standardized results.

Table 26. Value of 1 Minute Travel Time According to the User Perception (Dolmus+Metro-Bus+Metro)

DOLMUS+METRO/BUS+METRO COMPARISON	
Time Saving Per Km (Min)	1.14
Additional Ticket Cost Per Km (TL)	0.16
Value of 1 Minute Travel Time (TL)	0.14

6.3.2. Total km Comparison

To continue with mean travel times and mean ticket cost comparisons in here, as total km travelled advantageous situation of dolmuş remains the same. However, in the last part total time savings and additional ticket costs of dolmus users could possibly give an idea about the mean value of 1 minute time saving. This average value is not a directly paid value again, as explained in the previous sections. For example, according to the Chart 12 below; “Dolmus + Metro” users are paying 2.00 TL more than “Bus + Metro” users. Surely, they are not actually paying that amount but it shows a standardized value (standardization depending on mean km and mean ticket cost calculations) about the monetary differences. The important thing in here is the fact that, there are significant ticket payment differences between the partially conventional and fully conventional public transport users. From the charts below it could be deducted that, there is remarkable time savings for each dolmuş transferred pattern, which means that there is a rationale between total time savings and money costs.

To start with the “Dolmus + Bus”-“Bus + Bus” users’ comparison, there is 7.56 minutes (Mean km Travelled * Mean Travel Time Per km) time saving of dolmuş transferred users in total (See Figure 23). These users pay 0.43 TL for this time saving (Please see Figure 24). The advantage they gained against fully conventional pattern users has a reasonable price. As in per km values, dolmus transferred bus choice provides a significant advantage to its users. On the other side "Dolmus + Metro"-"Bus + Metro" users have a much more remarkable difference between them. Dolmus transferred choice provides 14.37 minutes difference to its users (See Figure 23) and the amount of payment for this time saving is 2.01 TL on average (See Figure 24). For developing a better understanding a detailed analysis is needed.

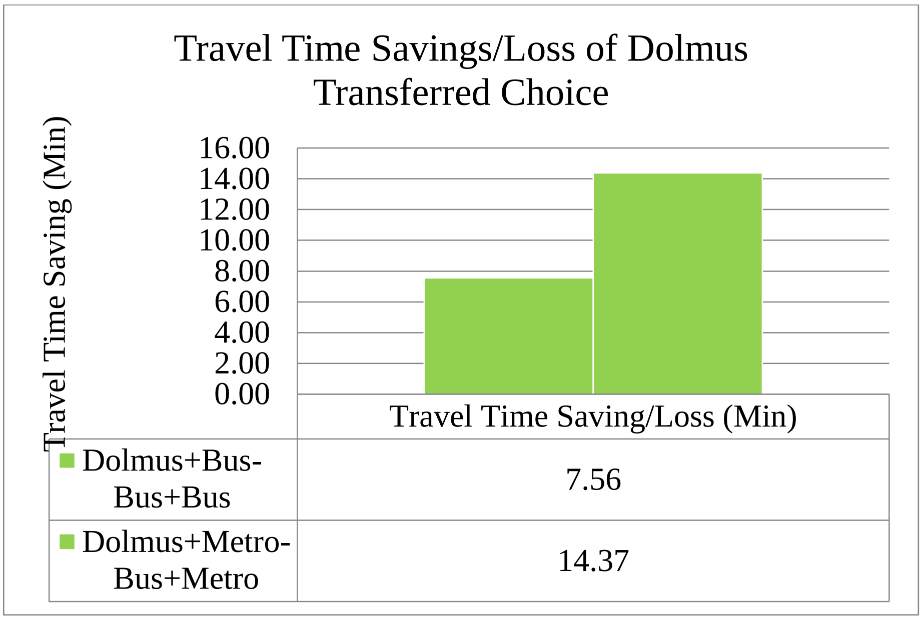

Figure 23. Travel Time Savings/Loss of Dolmus Transferred Choice

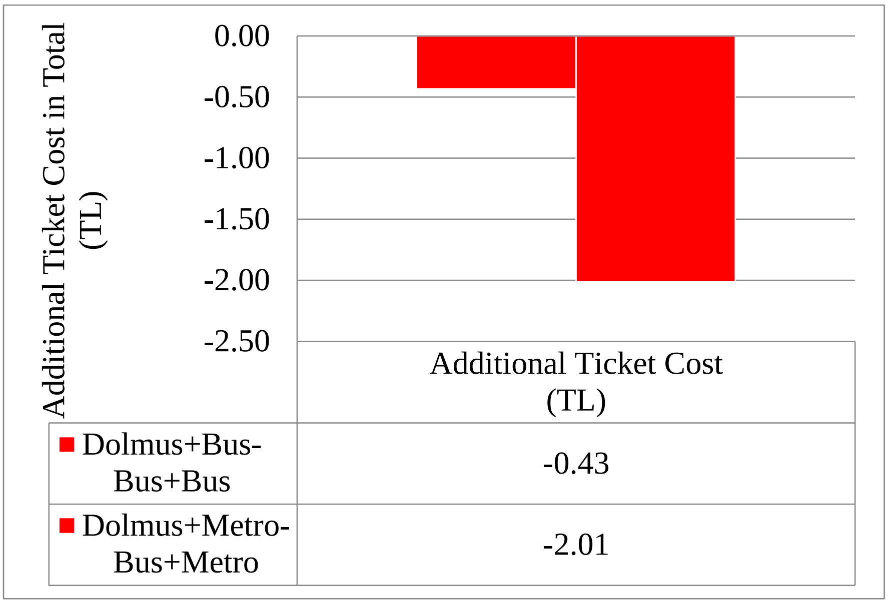

Figure 24. Additional Ticket Cost of Dolmus Transferred Choice

In detail evaluation of two rubber tired multimodal pattern comparison “Dolmus + Bus”-“Bus + Bus”, the results show that, the value of 1 minute travel time saving provided by dolmuş could be bought with 0.06 TL (See Table 27). It was 0.06 TL for “Dolmus + Bus”-“Bus + Bus” per km calculations. It is important to emphasize that, total km value of 1 minute time saving is equal to the per km value of the same comparison. It would not be wrong to say that it is the closest value to the calculated 1 minute time saving values. Consequently, it is obvious that, an integration between dolmuş and buses is possible unexpectedly.

Table 27. Value of 1 Minute Travel Time According to the User Perception (Dolmus+Bus-Bus+Bus)

DOLMUS+BUS/BUS+BUS COMPARISON	
Total Time Saving (Min)	7.56
Additional Ticket Cost in Total (TL)	0.43
Value of 1 Minute Travel Time (TL)	0.06

Continuing with the “Dolmus + Metro” and “Bus + Metro” comparison the value of 1 minute travel time is calculated as 0.14 TL (See Table 28). As the table below shows, it is same with the per km value, which is 0.14 TL. It is again higher than rubber tired multimodal comparison value of 1 minute results; however, it should not be forgotten that both the exclusion of comfort and convenience or higher willingness to pay could be the reason of this. Especially for the metro, comfort value because of the inflexibility in routing, is a crucial input of the decision making.

Table 28. Value of 1 Minute Travel Time According to the User Perception (Dolmus+Metro-Bus+Metro)

DOLMUS+METRO/BUS+METRO COMPARISON	
Total Time Saving (Min)	14.37
Additional Ticket Cost in Total (TL)	2.01
Value of 1 Minute Travel Time (TL)	0.14

With this aggregate comparison it has been possible to see the advantages and disadvantages of “Dolmus” and dolmus related two modes compared here namely; “Dolmus + Bus”, “Dolmus + Metro” against conventional competitors (benchmarks of the system namely “Bus + Bus”, “Bus + Metro”. As the calculation is made for the zones, in which the compared zones are really competing, it is important to see the differentiation of travel time and ticket cost changes. As the main aim of this analysis is to merge the values of different zones to get perceived value of 1 minute travel time, aggregate calculations are meaningful. These values in the upcoming part will be compared with the previously calculated (depending on urban economics literature) 1 minute travel time values which were 0.045 TL and 0.030 TL. With that comparison integration option will be evaluated for the re-formulation of dolmuş operations in Ankara.

6.4. Monetary Gains/Losses of Dolmus Users and Dolmus Operators

6.4.1. Monetary Gains/Losses of Dolmus Users

Previously, the results of time savings for each comparison have been explained in detail. The difference of travel times and ticket costs between compared modes have been shown and discussed. Additionally by dividing ticket costs to perceived travel time differences between dolmuş users and non-dolmuş users, value of 1 minute travel time is calculated for each comparison type. It was mentioned that perceived value of 1 minute travel time and literature based calculated value of 1 minute travel times (Half Wage 0.045 TL and One Third Wage 0.030 TL) would be compared later on. The lowest value of 1 minute travel time value was calculated as 0.06 TL per km and 0.05 TL total km for "Dolmus + Bus" and "Bus + Bus" comparison. Even the lowest perceived value of 1 minute travel time, which is 0.05 TL (which was found in "Dolmus + Bus"-"Bus + Bus" total km comparison) is higher than calculated two travel time values respectively 0.045 TL and 0.030 TL. That means, without any exception, there is welfare loss of dolmus users against non-dolmus users. It was mentioned that, according to Quandt (1970) and Mills (1972) value of 1 minute travel time should be between half of the 1 minute value of minimum wage and one third of the 1 minute value of minimum wage. The values higher than this value range (0.030-0.045) means that time saving is unable to compensate additional ticket cost.

Surely, willingness to pay of students could be higher than calculated (because they are not spending their own money from their wage; contrary they are spending the pocket money they get from their family) or comfort-convenience measures could be the reason of that relatively high additional ticket cost values; however, that discussion is the research focus of another study. As in this study, the aim is to explain travel time ticket cost relationship with the existing data, and the main finds demonstrates that, there is a welfare loss of dolmuş users. That explanation can be better represented in a comprehensive table of findings in per km and total km (See Table 29 and Table 30).

Table 29. Dolmus User Welfare Loss With Respect to Compared Mode (Per km)

Compared Modes	Per km Time Saving with Respect to Compared Mode (Min)	Value of 1 Minute Time Saving According To Minimum Wage*		Per KM Value of 1 Minute Time Saving According to Additional Ticket Cost With Respect to Compared Mode (TL)	Per km Additional Ticket Cost With Respect to Compared Mode (TL)	User Welfare Loss Per km** (TL)	
		Half Wage (0.045 TL)	One Third Wage (0.030 TL)			Half Wage (0.045 TL)	One Third Wage (0.030 TL)
Dolmus - Bus	-0,45	***-0,0203***	***-0,0135***	-0,444	***0,2000***	0,220	0,214
Dolmus - Metro	0,10	***0,0045***	***0,0030***	1,000	***0,1000***	0,096	0,097
(Dolmus + Bus) - (Bus + Bus)	0,50	***0,0225***	***0,0150***	0,060	***0,0300***	0,008	0,015
(Dolmus + Metro) - (Bus + Metro)	1,10	***0,0495***	***0,0330***	0,182	***0,2000***	0,151	0,167

*** Value of 1 Minute Time Saving According To Minimum Wage = Per km Time Saving With Respect to Compared Mode * Minute Value of Wage Rate**

**** User Welfare Loss Per km = Per km Additional Ticket Cost - Value of 1 Minute Time Saving With Respect to Compared Mode**

Table 30. Dolmus User Welfare Loss With Respect to Compared Mode (Total km)

Compared Modes	Total km Time Saving with Respect to Compared Mode (Min)	Value of 1 Minute Time Saving According To Minimum Wage*		Total km Value of 1 Minute Time Saving According to Additional Ticket Cost With Respect to Compared Mode (TL)	Total km Additional Ticket Cost With Respect to Compared Mode (TL)	User Welfare Loss Total km** (TL)	
		Half Wage (0.045 TL)	One Third Wage (0.030 TL)			Half Wage (0.045 TL)	One Third Wage (0.030 TL)
Dolmus - Bus	-4,3	***-0,1935***	***-0,1290***	-0,349	***1,5000***	1,694	1,629
Dolmus - Metro	1,3	***0,0585***	***0,0390***	0,615	***0,8000***	0,742	0,761
(Dolmus + Bus) - (Bus + Bus)	7,6	***0,3420***	***0,2280***	0,053	***0,4000***	0,058	0,172
(Dolmus + Metro) - (Bus + Metro)	14,4	***0,6480***	***0,4320***	0,139	***2,0000***	1,352	1,568

*** Value of 1 Minute Time Saving According To Minimum Wage = Total km Time Saving With Respect to Compared Mode * Minute Value of Wage Rate**

**** Total km User Welfare Loss = Total km Additional Ticket Cost - Value of 1 Minute Time Saving With Respect to Compared Mode**

These two tables demonstrate the definite welfare loss of dolmuş users in terms of travel time-ticket cost relationship. It should not be forgotten that these results are per km calculations based. That is why; as can be seen in the further studies per km values could be a better substitute but it will be evaluated later on.

6.4.2. Monetary Gains/Losses of Dolmus Operators

As a final step before policy proposal on ticket and route integration an expenditure analysis from operators' side is needed too. The amounts of users' time savings and value of time saving for each user's give a clue about the user profit. A public transport integration proposal is only possible –as stated before- with the consensus of each stakeholder respectively local decision maker, operator and user. Then, what about the gains/losses of dolmuş operators? As it is a privately operated public transport service, it definitely has a profit from the operations. For that calculation first of all, expenditure of dolmuş should be calculated. For that calculation, on 7th of May, 2016 an in-depth interview was realized with a dolmuş license plate owner/dolmuş operator. Depending on this interview an average cost calculation has been made. In the explanations below, these calculations are explained systematically.

Expenditure calculation of dolmuş operators is depending on both the expressions of the interviewee and survey results. Calculation could be made with the formula below;

Average Cost of Dolmuş Operations=Capital Cost+Operational Cost (11)

In this equation two variables could be represented as;

$$\text{Capital Cost} = \text{License Plate Cost} + \text{Vehicle Cost} \qquad (12)$$

$$\text{Operational Cost} = \text{Maintenance Cost}+\text{Fuel Cost}+\text{Driver's Wage} \qquad (13)$$

These five variables namely license plate cost, vehicle cost, maintenance cost, fuel cost and driver's wage will be calculated step by step in this section. According to these variables, it would be possible to calculate expenditure of dolmuş operator per day. With this per day expenditure calculation, it is possible to calculate per passenger per km expenditures of each dolmuş operation.

1) License Plate cost is the major input of the study. It was explained before in detail those license plates are quite expensive. For this reason, their daily profit to the operator is the dominant variable about the expenditure. As it is a capital cost, the calculation of its daily equivalent is possible only with the annual interest yield of the money. That is why; first of all net interest rate should be calculated. Net interest rate could be shown basically with the formula below;

$$\text{Net Interest Rate} = \text{Nominal Interest Rate-Inflation Rate} \quad (14)$$

According to the data of Turkish Central Bank (2015), for the period, during which the surveys are made, Nominal Interest Rate was about 13.20% and inflation rate was about 8.20% on average. That makes the result of the equation as;

$$\text{Net Interest Rate} = 13.20\text{-}8.20$$

$$\text{Net Interest Rate} = 5\%$$

Annual Return of License Plate Cost could be calculated with this net interest rate value. Both interviewee and license plate on sale on web shows that, average license plate amount is about 1,800,000 TL. With that total amount, annual return is;

$$\text{Annual Return of License Plate Cost} = \text{License Plate Cost*Net Interest Rate}$$

$$\text{Annual Return of License Plate Cost} = 1{,}800{,}000*0.05$$

$$\text{Annual Return of License Plate Cost} = 90{,}000 \text{ TL/year}$$

However this value is annual. As the calculation will be made on daily expenditures, it should be turned into daily equivalent.

$$\text{Daily Return of License Plate Cost} = \frac{\text{Annual Return of License Plate Cost}}{\text{Number of Days in a Year}} \quad (15)$$

$$\text{Daily Return of License Plate Cost} = \frac{90{,}000}{365}$$

Daily Return of License Plate Cost = 246,57 TL/day

2) Vehicle cost is another capital cost of dolmuş operator. Vehicle prices are both checked from the interviewee's answers and from the websites of mostly used models (Mercedes Sprinter and Iveco Daily). On average new minibus cost is 120,000 TL. Depending on UKOME decisions of İstanbul and Ankara Municipality economic life of the minibus is up to 10 years. However, interviewee stated that, the oldest vehicles on operation are at most 8 years old. That is why; this value has been taken as the basis.

$$\text{Annual Cost of Purchasing a Minibus} = \frac{\text{Vehicle Cost}}{\text{Economic Life of the Vehicle}} \quad (16)$$

$$\text{Annual Cost of Purchasing a Minibus} = \frac{120{,}000}{8}$$

Annual Cost of Purchasing a Minibus = 15,000 TL/year

However, this value is annual. As the calculation will be made on daily expenditures, it should be turned into daily equivalent.

$$\text{Daily Cost of Purchasing a Minibus} = \frac{\text{Annual Cost of Purchasing a Minibus}}{\text{Number of Days in a Year}} \quad (17)$$

$$\text{Daily Cost of Purchasing a Minibus} = \frac{15000}{365}$$

Daily Cost of Purchasing a Minibus = 41.09 TL/day

3) Maintenance cost covers the sum of the costs of mechanical impairments, renewal costs, general maintenance costs etc. From internet sources, it could be deducted that annual mechanical control of the mostly used minibus

models is between 200 TL – 760 TL in different firms. These mechanical controls are made for each 15000 km travelled. According to the interviewee's responses, dolmuş operators are making 60,000 km each year on average. That means there are four mechanical control payments for these vehicles. Mechanical control payment could be taken as the average of minimum and maximum values. In that case, the calculation of daily equivalent of maintenance cost of minibus is;

$$\text{Annual Maintenance Cost of Minibus} = \frac{\text{(Lowest Cost+Highest Cost)}}{2} \qquad (18)$$

$$\text{Annual Maintenance Cost of Minibus} = \frac{(200+760)}{2}$$

$$\text{Annual Maintenance Cost of Minibus} = 480 \text{ TL/each } 15{,}000 \text{ km}$$

However, this value is annual. As the calculation will be made on daily expenditures, it should be turned into daily equivalent. It should not be forgotten that there will be 4 mechanical control payments each year.

$$\text{Daily Equivalent of Maintenance} = \frac{\text{Annual Maintenance Cost of Minibus*4}}{\text{Number of Days in a Year}} \qquad (19)$$

$$\text{Daily Equivalent of Maintenance} = \frac{480*4}{365}$$

Daily Equivalent of Maintenance of Minibus = 5,26 TL/day

4) Fuel cost will be calculated with the mean km value of dolmuş operations. With that mean value, it is meant that; there were four types of operations which were compared with the conventional competitors, namely "Dolmus" (Against Bus), "Dolmus" (Against Metro), "Dolmus + Bus", "Dolmus + Metro" and their mean km values are respectively 9.6 km (Against Bus), 12.8 km (Against Metro), 14.0 km, 12.6 km. For the mean calculation all of these

four will be used. The distance of single "Dolmus" could be directly used however, dolmuş transferred last two are unable to be used directly because according to survey there is no such data, which is showing the km travelled for each trip per user. Consequently, it is not possible to divide mean km travelled before and after transferred the best way possible would be to divide the value of km travelled of transferred choices (Dolmus + Bus, Dolmus + Metro) into two (as in the previous chapter). In calculation the formula is;

$$\text{Mean km Travelled Per Direction} = \frac{9.6+12.8+\left(\frac{14.0}{2}\right)+\left(\frac{12.6}{2}\right)}{4}$$

$$\text{Mean km Travelled Per Direction} = 8{,}9 \text{ km/headway}$$

However, that is the per round result. Like other public transport operations dolmuş operations too, realized as round trips. That is why; before next step, daily km travelled is needed for an average dolmuş operation. Interviewee declared that the number of rounds reaches at most 14-15 a day. Then the total km travelled per day formula is;

$$\text{Total km Travelled} = \text{No of Headways} * \text{Mean km Travelled Per Direction} \quad (20)$$

$$\text{Total km Travelled} = 15 * 8{,}9$$

$$\text{Total km Travelled} = 133.5 \text{ km/day}$$

After the calculation of total km travelled per day, now it is possible to calculate fuel cost of dolmuş operator on average. Both Alternative Fuels Data Center (AFDC) of the US (2015) and interviewee responses show that per liter diesel fuel enables 10 km travel for each minibus in urban traffic. That makes daily fuel consumption as;

$$\text{Fuel Consumption of Minibus} = \text{Total km Travelled} * \text{Km travelled per L} \quad (21)$$

$$\text{Fuel Consumption of Minibus} = \frac{133.5}{10}$$

Fuel Consumption of Minibus=13.35 L/day

However this value is liter based. As the calculation will be made on with monetary equivalent of each variable, it should be turned into monetary value. It is checked from Energy Market Regulatory Authority (2015) data, for the period in which survey is made the average diesel fuel price per liter is 3.86 TL. In that case daily fuel cost is;

Daily Fuel Cost of Minibus = Fuel Consumption* Fuel Price per L (22)

Daily Fuel Cost of Minibus = 13.5*3.86

Daily Fuel Cost of Minibus = 52.11 TL/day

5) Last input of daily costs is the wage of drivers. As there is high exploitation – represented in the literature part- in paratransit sector it is quite problematic to get information about wages. However, according to the interviewee's answers it could be deducted indirectly that -visible- wage of drivers is 120 TL. Interviewee (license plate owner) stated that drivers are allowed to take the payment of standing passengers ticket cost directly. Interviewee's indicated that, because of that problem in peak hours –in which passenger number is high- operators or vehicle owners themselves use the vehicle (rather than give it to a driver) to reduce the number of those uncontrolled earnings.

Daily Equivalent of Driver's Wage = 120 TL/day

6) In the pre-final part of this calculation average cost of dolmuş operations according to mean values can be deducted. Capital cost and operational cost

is two main inputs of total cost. Firstly, capital cost at the end can be calculated as;

Capital Cost = License Plate Cost + Vehicle Cost

Capital Cost = 246.57+41.09

Capital Cost = 287.66 TL/day

And the second one operational cost can be calculated as;

Operational Cost = Maintenance Cost+Fuel Cost+Driver's Wage

Operational Cost = 5.26+52.11+120

Operational Cost = 177.37 TL/day

As all of the calculations are represented in daily monetary value, the result will be in that unit too. The result of the calculation of the average cost of dolmuş operations per day is;

Average Cost of Dolmuş Operations = Capital Cost+Operational Cost

Average Cost of Dolmuş Operations = 287.66+177.37

Average Cost of Dolmuş Operations per day = 465.03 TL/day

7) As represented before cost of dolmuş operations should be turned into per passenger per km expenditures for the comparison of the value with the survey value. For that comparison daily cost of dolmuş should be turned into per passenger earnings. It was stated before that, on average one dolmuş vehicle makes 15 rounds a day. According to interviewee's answers, on average 20 passengers/pax (14 passengers sitting+6 passengers standing) are carried each headway on average.

Pax Carried per day = No of Headways*No of Pax Carried per headway (23)

Pax Carried per day = 15*20

Pax Carried per day = 300 passenger/day

At the end, there are two important findings of this calculation. One of these findings of that part is “cost of each passenger to operator”. The second one is “cost of per passenger per km to dolmuş operator”. It should not be forgotten that; “cost of per passenger per km to dolmuş operator” and “cost of per passenger to dolmuş operator” includes all expenditures including normal profits from the capital costs. In other words, these two formulas already include capital huge capital investments for the inclusion of all money losses because of dolmuş operations and even in this cost too, their huge capital investments are taking into account. That is a valuable deduction that should be considered for the policy proposals’ negotiations between decision makers and dolmuş operators.

Cost of each passenger to operator is possible to calculate according to the number of passenger carried per day (calculated above);

$$\text{Cost of Each Passenger to Operator} = \frac{\text{Average Cost of Dolmuş Operations per day}}{\text{Pax Carried per day}} \quad (24)$$

$$\text{Cost of Each Passenger to Operator} = \frac{465.03}{300}$$

Cost of Each Passenger to Dolmuş Operator = 1.5501 TL per passenger

The second one of the most important findings of this calculation set is cost of per passenger per km to dolmuş operator. With that last explanation the equation is;

$$\text{Cost of per passenger per km} = \frac{\text{Cost of Per Passenger to Operator}}{\text{Total km Travelled}} \quad (25)$$

$$\text{Cost of per passenger per km} = \frac{1.5501}{8.9}$$

Cost of per passenger per km = 0.174 TL per passenger per km

These calculations show that even if no profit is added there is 1.5501 TL per passenger expenditure of dolmuş in total km travelled (which is the mean km of the zones served by dolmuş) and 0.174 TL per passenger per km expenditure of dolmuş per km travelled is constant. The meaning of this is the fact that, without compensating these costs it is impossible for dolmuş operator to continue its operations. As total km value is calculated by mean km travelled, for shorter and longer distances, the value would be changed. However, per km calculation represents true per km cost of dolmuş operator. That is one important deduction of these calculations. The second important finding is that; these values give per passenger per km expenditure of dolmuş operators. Per passenger per km welfare losses were calculated before. With that final calculation from the operator's side, it is possible to compare these two values. Additionally, this provides an opportunity to check whether it is possible to integrate dolmuş with existing smart card ticketing system with a lower price than 2.25 TL standard ticket price. Additionally, post-integration ticket price of dolmuş operations could be found if there is any excess profit and it could be compared with the existing welfare losses of dolmuş users. If excess profit is found, then to minimize the welfare loss of users or maybe even to compensate user's welfare loss could be possible. Final part of this chapter will show whether is it possible to provide a feeder dolmuş service to main conventional lines with a price lower than 2.25 TL standard ticket price or not.

6.5. Ticket Integration for Paratransit-Public Transport Operations

The results of section 6.3 showed that dolmuş users pay more ticket cost than time saving they gained. There is a definite welfare loss. On the other hand, section 5.2.4 showed that dolmuş or dolmuş-transferred choices are advantageous in all zones in terms of travel time. In other words, dolmuş (especially as a feeder system) operates better than any conventional mode. The historical development of Ankara urban form resulted with a rubber tired –specifically private car- based urban form development. Private car oriented development of the Ankara results in urban sprawl even around the main two axes with metro corridors. All transportation investments in the fringe of the city center provide a better and faster travel opportunity to on-surface transportation options. As the fastest mode on-surface with its door-to-door transport opportunity, private cars and their users benefit from that kind of urban development. At that point, intentionally or unintentionally, because of its characteristics, dolmuş accommodates itself to that development better than any other public transport option. In other words, they adapt better than any other mode to the development of private car based urban environment as stated by Tekeli and Okyay (1981). That characteristic of dolmuş, statistical results of the surveys and literature basis of the study demonstrate that dolmuş plays a significant role in urban transport, that it meets mobility demands and are preferred by many users although in its current operational structure, it results in its users paying extra costs due to lack of ticket integration. Furthermore, due to the lack of any physical (route) integration regarding dolmuş and the rest of public transport systems, it competes with metro systems and contributes to traffic congestion since it results in many trips being made in these small capacity vehicles along corridors of high demand. Carrying high numbers of passengers in small dolmuş vehicles, as opposed to large capacity systems, such as the metro, inevitably results in inefficient and irrational use of the existing infrastructure and more congestion. Consequently, there is a need to reorganize dolmuş operations with a view to integrate them into the rest of public transport systems in both route and ticketing. As shown in the above analysis, dolmuş becomes advantageous to its users in terms of time savings in shorter distances. Hence using this system as a feeder to the metro could be a viable approach. However, for this to work, the fares on dolmuş and other systems including the metro should be integrated.

Consequently, there is a ticket integration policy requirement between dolmuş and conventional modes for an optimum solution. Surely, a ticket integration policy comes parallel with a price regulation between separately operated public transport options. For private operators it is not easy to find out a ticket price, which is acceptable for them. In here, the calculations about the expenditures of dolmuş (Section 6.2.4) are made for the reasoning of new price level by reducing all costs even including license plate cost of dolmuş. By showing excess profit in here, it is possible to find out an average value for the integration especially in transferred trips. It is important to reduce existing ticket prices after ticket integration because it is a loss, which directly paid by dolmuş user but no one else. That is why; it makes sense to emphasize it from user's perspective with a basis on dolmuş and other modes comparison.

6.5.1. Dolmus Operator Excess and Net Profit With Respect to Compared Mode for per km and total km

In the previous section cost of each passenger to dolmuş has been calculated for per km and total km values. By subtracting these values from ticket price of dolmuş the excess profit of dolmuş operator could be found. In here, as there are two different calculations made namely per km and total km, excess profit calculations will be made for the same two titles also. However, it is important to remember one more time that there are two different comparisons of dolmuş and dolmuş related modes. First one was single mode comparison (Dolmus-Bus and Dolmus-Metro) and the second one was multimodal comparison (Dolmus+Bus-Bus+Bus and Dolmus+Metro-Bus+Metro). In excess and net profit calculations, the mean value, which is 8.9 km for dolmuş operations, could be used directly for single "Dolmus" however; dolmuş transferred choices excess profit calculations should be made in a different way. As it is not possible to divide mean km travelled before and after transfers, similar to what is made before, the best way possible would be to divide the values of transferred choices into two.

6.5.1.1. Per km Calculations

In calculation of the formula for single mode comparison excess profit is;

$$\text{Dolmuş Operator's Excess Profit Per km} = \frac{\text{Ticket Price-(Mean km*Cost Per Pax Per km)}}{\text{Mean km}} \quad (26)$$

$$\text{Dolmuş Operator's Excess Profit Per km} = \frac{2.25\text{-}(8.9*0.174)}{8.9}$$

Dolmuş Operator's Excess Profit Per km = 0.0786 TL per km (Single Mode)

In calculation of the formula for multimodal mode comparison excess profit is;

$$\text{Dolmus Operator's Excess Profit Per km} = \frac{\text{Ticket Price-(Half of Mean km*Cost Per Pax Per km)}}{\text{Half of Mean km}} \quad (27)$$

$$\text{Dolmus Operator's Excess Profit Per km} = \frac{2.25\text{-}(4.45*0.174)}{4.45}$$

Dolmus Operator's Excess Profit Per km = 0.3316 TL per km (Multimodal)

The important point is that the dolmuş might expect that these costs are compensated and therefore, this issue may become important during a negotiation process between the dolmuş operators and the transit authority (in integrating dolmuş fares to the city's integrated ticket system). However, there is another input, which should be included before the calculation of net profit of dolmuş operators. This input is the value of time saving that dolmuş operator provides. The question in here is, why it is so important to include travel time savings of dolmuş users? Rationally, if any public transport service provides a better, faster, reliable service compared with its competitors, it is not acceptable to charge it with the same price with the competitors. It is contrary with the basic principle of the economics. Better-qualified supply should be priced with a price determined according to the advantage it provides. That is why; this travel time advantage of the dolmuş users should be added to the excess profit for the calculation of net profit. In that approach, net profit of dolmuş operator could give an idea about the possible ticket prices of dolmuş per km after ticket integration. In other words, a value between 0 profit and Net profit could be reduced from the existing ticket price of the survey period, which was 2.25 TL. Depending on the zone it operates, dolmuş price could be possibly re-arranged by UKOME, the transport coordination center of the Greater Municipality. It is obvious from the table below especially for transferred trips that the net profit of dolmuş is as high as 0.30 TL per km (See Table 31).

Table 31. Dolmus Operator's Net Profit With Respect to Compared Mode (Per km)

Compared Modes	Value of 1 Minute Time Saving According To Minimum Wage*		Dolmus Operator's Excess Profit Per KM (TL)	Dolmus Operator's Net Profit Per KM *** (TL)	
	Half Wage (0.045 TL)	One Third Wage (0.030 TL)		Half Wage (0.045 TL)	One Third Wage (0.030 TL)
Dolmus - Bus	***-0,0180***	***-0,0120***	0,0786	0,0966	0,0906
Dolmus - Metro	***0,0045***	***0,0030***	0,0786	0,0741	0,0756
(Dolmus + Bus) - (Bus + Bus)	***0,0225***	***0,0150***	0,3316	0,3091	0,3166
(Dolmus + Metro) - (Bus + Metro)	***0,0495***	***0,0330***	0,3316	0,2821	0,2986

***** Dolmus Operator's Net Profit Per KM = Dolmus Operator's Excess Profit Per KM - Time Saving Dolmus Service Provides Per KM with Respect to Compared Mode**

These net profit values shown in the table above demonstrates that especially for the transferred choice a reasonable average price is possible for both dolmuş user and dolmuş operator. To give an example about how to decide the price of new ticketing after integration; a zone within Ankara can be chose. For example, this can be done for dolmuş users of *Cayyolu, Umitkoy (12 km)* zone with a view to determine a new ticket fare. This zone is chosen because, it is one of the most suitable lines for dolmuş feeder as it is on the same metro route like METU.

$$\text{New Ticket Price=Old Ticket Price-}\frac{\text{(Net Profit per km*Half of Distance Travelled)+0 Profit}}{2} \quad (28)$$

$$\text{New Ticket Price=2.25-}\frac{\text{(0.2986*6)+0 Profit}}{2}$$

New Ticket Price=1.35 TL per headway

For the explanation of the formula, as it is a transferred choice the half of the distance is used for the calculation of net profit for the whole trip. About the addition of net profit and 0 profit values; not reducing all net profit per km value is because if new ticket is determined by reducing all of the net profit of dolmuş operator then it would not be possible for the operators to get any profit and a negotiation may not be possible with that zero profit. Rather than cancelling out all net profit for the negotiation, a reasonable new price could be charged. Additionally, it should not be forgotten that new public transport service distribution will change the whole carrying capacity of public transport. Possibly, some private car users' would start to feel that public transport is a good option for commuting trips and finally passenger capacity in zones especially around the metro corridors will increase in significant amounts. Definitely, this passenger increase will reflect to the passenger number of feeder mode dolmuş. Additionally, it is important to indicate one more time that this is a pilot study and with a greater sample and much more aim specific survey design more significant and reliable results could be found.

6.5.1.2. Total km Calculations

In total km calculation the formula for single mode comparison excess profit is;

Dolmus Operator's Excess Profit Total km=Ticket Price-(Mean km*Cost Per Pax Per km) (29)

Dolmus Operator's Excess Profit Total km=2.25-(8.9*0.174)

Dolmus Operator's Excess Profit Total km=0.70 TL total km (Single Mode)

In calculation the formula for multimodal mode comparison excess profit is;

Dolmus Operator's Excess Profit Total km = Ticket Price-(Half of Total km*Cost Per Pax Per km (30)

Dolmus Operator's Excess Profit Total km=2.25-(4.45*0.174)

Dolmus Operator's Excess Profit Total km=1.4757 TL Total km (Multimodal)

In total km calculations too, excess profit calculations do not include the value of time saving that dolmuş operator provided. If again, net profit calculations is made the results could be seen below (See Table 32);

Table 32. Dolmus Operator's Net Profit With Respect to Compared Mode (Total km)

Compared Modes	Value of 1 Minute Time Saving According To Minimum Wage*		Dolmus Operator's Excess Profit Total KM (TL)	Dolmus Operator's Net Profit Total KM *** (TL)	
	Half Wage (0.045 TL)	One Third Wage (0.030 TL)		Half Wage (0.045 TL)	One Third Wage (0.030 TL)
Dolmus - Bus	***-0,1935***	***-0,1290***	0,7000	0,8935	0,8290
Dolmus - Metro	***0,0585***	***0,0390***	0,7000	0,6415	0,6610
(Dolmus + Bus) - (Bus + Bus)	***0,3420***	***0,2280***	1,4757	1,1337	1,2477
(Dolmus + Metro) - (Bus + Metro)	***0,6480***	***0,4320***	1,4757	0,8277	1,0437

***** Dolmus Operator's Net Profit Total KM = Dolmus Operator's Excess Profit Total KM - Time Saving Dolmus Service Provides Total KM with Respect to Compared Mode**

These net profit values in the table above demonstrates an average value for excess profit. Differnet than per km values, as they are standardized according to mean km values, they are not as suitable as per km calculations. It could give an average price that could be used for all dolmuş integrations however, as can be seen from the table above, using the half of net profit from that deduction will not be beneficial because it creates a reduction equal to 0.50 TL, which is not acceptable for the users. Besides, negative results of fixed ticketing is mentioned and explained in detail in the previous chapters. That is why, it is better to use per km values for distance based pricing rather than proposing a fixed reduced price for all dolmuş operations.

6.6. Summary: Ticket Integration Proposal for Feeder Dolmuş Operations to the Existing Conventional Public Transport Services

At the end of the previous chapter distance based differentiation of travel time and ticket cost for eight travel patterns have been shown in detail. As it was explained in the summary and findings section of the fifth chapter, with the help of their advantageous characteristics (emphasized in the third chapter), dolmuş and dolmuş related travel patterns transcend the fully conventional modes almost in all zones. That was a major finding, which was showing that to remove the dolmuş operations is not realistic, because it would create an enormous lack of supply currently. Based on that finding, it has been proposed in the beginning of this chapter that, a detailed analysis is needed to ensure the integration of dolmuş operations with the conventional modes is possible. That is why a detailed analysis has been made at first in this chapter on the joint evaluation of travel time and ticket costs with aggregate totals. Aggregate totals of each of the seven travel patterns have been compared with each other for per km and total km values. That comparison showed that, dolmuş operation could create significant time savings only for the transferred choices. In other words, time savings of single mode "Dolmus" is negligible compared with the additional ticket costs that users pay. Although dolmuş transferred choices could create a significant time saving compared with the fully conventional competitors, even for these choices the calculated value of 1 minute travel time was lower than perceived 1 minute travel time value. That demonstrated that, there is welfare loss of users. In other words, users of dolmuş were paying more than they would according to saved times for each travel.

On the other hand, for dolmuş operators another calculation was made. It was proved that there was user welfare loss but there was also a need for the gains/losses of operators. As stated in the very beginning of the whole study, an integration project is only possible with the agreement of all stakeholders. That is why it was a necessity to calculate if there is an excess profit or not. With the help of an in-depth interview with a dolmuş license plate owner, a detailed calculation of per passenger per km cost of dolmuş operator has been estimated. After calculating per passenger per km cost of dolmuş operator, the existence of excess profit of dolmuş operator was investigated. The results showed that dolmuş operators were getting quite high excess profits. Even if their time saving provision to their users are added to their costs, still 2.25 TL ticket cost is quite high for dolmuş operators especially in the shorter distances. With that understanding, a new ticket price proposal is made for a particular zone. The results of that final calculation demonstrated that even though it is not possible to provide a free transfer opportunity for users; to integrate dolmuş operations especially on the subzones around metro corridors is possible with much more reasonable prices. For example, it is possible to integrate dolmuş operations to Çayyolu, Umitkoy (12 km) zone as a feeder line of Çayyolu Metro (M2) with 1.35

TL ticket price. It is not difficult to foresee that, with the help of time saving advantage and lower ticket costs, efficiency of public transport (specifically metro operations) could be increased significantly. As in many successful developing country examples, metro operations could be preferable for the users by the help of paratransit mode dolmuş.

From the very beginning of the study, the question was “What will be the future of dolmuş operations in Turkish metropolitan areas?” The conducted study has shown that, to integrate dolmuş into the rest of public transport, rather than to dismiss their operations entirely, is much more realistic and much more beneficial for Turkish urbanization pattern. As a developing country in Turkey, rapidly increasing car ownership rates and related to that urban environment developing for the benefit of private car users are not suitable for the operations of conventional modes. Urban sprawl takes place, resident pattern re-organizes according to increasing car usage with high numbers of car parks. The duty of transportation planners in an environment like this, is to find ways to increase the competitiveness of public transport options against private car usage. The survey study conducted showed that, integration of dolmuş operations could increase the efficiency of public transport in terms of travel time saving with relatively lower ticket costs. Furthermore, with the re-organization of routing of paratransit operations, buses operating as feeder systems around the metro stations could be re-organized for the corridors that do not have metro service. That definitely will result in the increase of the efficiency of both metro and public bus operations in different sub-zones in Ankara network.

CHAPTER 7

7. CONCLUSION

7.1. Comprehensive Summary of Research

The aim of this research was to investigate the role of paratransit in public transport and accessibility with a particular view of user's perspective in Ankara transportation network, and to investigate the opportunities for integrating paratransit systems into the rest of public transport modes. These evaluations provided valuable insights on the characteristics of paratransit that are valued positively by transit users and with the help of this information, it has been possible to look for possible strategies, which would increase the efficiency of public transport against the private cars.

In a detailed explanation of the whole study, firstly, in the introduction of the research, four main titles namely context, problem definition, aim of research and the structure of the thesis have been formulated. In the second and third chapters of the research, literature review has been presented. In literature review chapters, it has been emphasized that, private car usage should be balanced with efficient public transport options and that re-structuring of a variety of public transport options is necessary. Transport system integration has been referred as one of the best options for cities with a variety, and sometimes a fragmentation of, public transport opportunities namely metro, bus, minibus, ferry, commuter rail etc. The variety of examples on transport system integration showed that, rather than cancellation of some privately operated public transport, to create a diverse and direct travel opportunity with a single ticket with the inclusion of all possible public transport options is the key to increase the competitiveness of public transport against the private car usage. Detailed definition, explanation and analysis of paratransit services showed that the presence of paratransit services in cities are the natural results of the lack of transportation services in meeting the mobility demand. Even though it is difficult to make research on paratransit due to its informal and flexible organizational characteristics, an analysis of paratransit systems in detail is a necessity in order to be able to make sound proposals on the complete integration of all public transport services. Detailed literature research demonstrated that, the dominance of paratransit modes in networks, which they exist, is not a coincidence. To make it more clear, paratransit systems' positive characteristics namely flexibility-adaptability, convenience, affordability, convenience and comfort makes their operations as effective substitutes to conventional modes like bus or metro. However, on the other hand, the challenging characteristics showed that it is not logical for city authorities to allow existing paratransit operations as they are in the future for if an effective and attractive public transport service is to be created. It is seen that, especially two of the negative characteristics, ownership pattern and issues of integration, make paratransit modes difficult to integrate into the existing network. As paratransit operators are horizontally organized in many different geographies in the world and their operational characteristics, which often make them a better alternative than conventional modes in populated, congested as well as sprawling cities, are difficult to re-formulate without diminishing their appeal for the users, the integration of these modes are necessary on the one hand but challenging on the other hand. Actually, the real problem is that these consolidated groups are very difficult to negotiate with because it is not possible to compensate a loss on one line with the surplus gathered from another line. That is why, only if their expectations are met by the local authorities, it would be possible to create an effective policy package. However, it should also be indicated that, traffic safety issues, unreliability of the operations and congestion effect of low capacity paratransit vehicles are the other three negative characteristics of paratransit vehicles, necessitating the integration –or maybe the removal for some cases- of paratransit systems in terms of sustainability measures. At the end of the literature review part, the findings demonstrated that, the solution of paratransit issue cannot be addressed successfully without involving the three stakeholders, namely public transport users, operators and city authorities that run public transport services. As each locality has its own characteristics, the study then focused on Turkey and Ankara cases for a detailed analysis of the network and the stakeholders.

In the fourth chapter, Turkish paratransit mode “dolmuş” has been analyzed in detail and in a historical context. Previous findings about paratransit have been reviewed with the dolmuş reality in Turkey. Early period, rising period and recent period of dolmuş have been analyzed in detail and five breaking points for the consolidation of dolmuş operations in transportation operations have been deducted. These findings showed that, the dominance of dolmuş in Turkish urban traffic is not a coincidence and dolmuş also encompasses the characteristic common to most paratransit systems in the world, which make their services appealing to certain users. Following the general overview on dolmuş operators, the case study Ankara’s transportation history has been presented. Historical representation was vital for the evaluation of dolmuş operations, because theoretical characteristics, which have been explained in detail in the chapter on paratransit, could be observed from the historical context easily. Furthermore, evaluating different periods enabled to see the different approaches of city authorities in different periods and made it possible to see the modal split change in Ankara from the 1930s to 2015. Other interesting findings of the transportation history section were the arguments it provided, which actually support the necessity of transport system integration. Synthesis modal split table, from the 1930s to present, at the end of the study showed the gradual increase in private cars and the dramatically decreasing efficiency of publicly operated public transport options in terms of modal share. At the end of the fourth chapter, the future of dolmuş operations have been discussed in the light of the literature review and historical development of Ankara transportation network. As stated by Kılınçaslan (2012, 36) when dolmuş vehicles started operating in 1929, it would not be possible to foresee that they would reach 20% share in modal split in the future (and this share is even higher for the Ankara case). Because of this unexpected continuity of dolmuş operations it is necessary to develop strategies and proposals for dealing with them. However, rather than terminating these services altogether, Dimitriou (1990) defends that innovative solutions for the future of paratransit operations are possible, nevertheless, the real progress it to be made by addressing the local needs. For the systematic analysis of dolmuş in the current situation, particularly in relation to other modes and with reference to users' perceptions, a survey study has been carried out as presented in the fifth chapter of the research.

In the fifth chapter, specifically to examine dolmuş operations a detailed transportation network analysis have been made based on a survey named "METU Campus and Transportation Survey" conducted in Middle East Technical University (METU). As the survey covered many different dimensions of transportation preferences of METU students, questions regarding dolmuş were only a section of this comprehensive survey. Descriptive analyses within this chapter provided important findings about the mode choices of the students coming from different neighborhoods in Ankara. According to the survey results, dolmuş was the firstly preferred mode of the students in their commuting travels with 41.6% share after leaving their homes. In addition, respondents' answers about metro usage showed that, even though almost all of the students used metro at least once in their lifetime, their overall satisfaction was not very high. Especially regarding the safety and price measures most of them are not satisfied from the metro operations. That was not surprising because these answers were supporting the 7.1% share of the metro usage. As a result of users' dissatisfaction, in the next section possible improvement strategies, which can be implemented by the public authority have been enquired. The most important findings of that possible transportation improvements section was that the proposal for "Cheaper/Free Transfer Opportunity from Dolmuş to Metro" received the highest share. Furthermore, the answers of the participants showed that to increase of the efficiency of metro operations was possible with the integration of metro with other options.

These findings were quite important for the contemporary comparison of paratransit modes and conventional modes because, that showed even in a highly accessible location like METU Campus, students' first preference was dolmuş and policies related with dolmuş operations were highly demanded. Findings also demonstrated that, there is a need for transport system integration demanded by the users. Especially, the integration of, and reduced/transfer fares between metro and dolmuş were highly demanded by the students. Besides, from the findings showed that due to their high modal share, the removal of dolmuş services would possibly create vulnerability in terms of accessibility of users, students in this case.

However, fragmented operations of private and public transit are an issue that needs to be addressed, and integration is urgently needed. In order to provide a better understanding of the reasons behind the high share of dolmuş usage, an in-depth and more detailed analysis has been made in the next section of the chapter. As it was not possible to evaluate the comfort and convenience measures (since these were not included in the METU transportation survey), an evaluation has been made based on travel time and ticket cost measures. For the evaluation of those two inputs of travel, a standardaziation has been made based on 20 different zones. After that standardization of the survey data, the evaluation of the comparison results showed that, in terms of travel time dolmuş operations are extremely advantageous against conventional modes in many of the zones. The users, who travel with dolmuş even in one trip during their travel, are advantageous against the users who prefer conventional modes. Especially after 8 km distance dolmuş was fully dominating the network with its high speed/low travel time. That was considered as the suitability of the dolmuş operations to Ankara traffic flow and urban environment (road widths, congestion, driving characteristics etc.). However, in terms of ticket cost, the lack of ticket integration and high ticket cost of dolmuş operations were easily visible. On the contrary to travel time advantage in many zones, almost in all of the zones, dolmuş operations have higher ticket costs. An interesting finding here was that, the less the distance was, the more the dolmuş user was paying per km. The lack of distance based pricing showed its negative externalities on travel cost of the users obviously. According to the findings of this chapter, it was seen that, dolmuş and dolmuş related travel patterns dominate the trips due to the time saving this mode provides. On the other hand, ticket prices of dolmuş operations are quite high, when compared with the conventional modes. That showed the need for a further study on the joint evaluation of travel times and ticket costs in detail because, time saving and additional ticket price should be reasonable in order to explain the reasons behind the dolmuş choice of the users.

In the sixth chapter of the research, firstly 1 minute travel time value has been calculated according to the techniques in transport economics literature. For these calculations 1 minute value of minimum wage rates for the November 2014-May 2015 period has been calculated. Then an interval has been determined between half of this 1 minute value of wage and one third of this 1 minute value of wage, again following the methods suggested in related literature. The aim was to find out whether the value of 1 minute according to the students is higher or lower than this value. For that calculation, aggregate totals of the seven travel patterns namely "Dolmus–Bus", "Dolmus–Metro", "Dolmus+Bus–Bus+Bus", "Dolmus+Metro–Bus+Metro" has been compared in terms of travel time and ticket cost relationship. In detail, additional ticket costs arising as a result of chosing dolmuş related patterns has been divided to the travel time saving that emerged again as a result of chosing dolmuş related pattern. Each of these comparisons has been made for per km and total km values and for four comparisons. The reason behind the comparison of aggregate totals was to investigate whether it was possible to integrate dolmuş operations with the conventional modes with acceptable prices. The measurement of the acceptable pricing was the value of 1 minute travel time. If perceived 1 minute travel time (division of additional ticket cost to time saving) is between or lower than the value of 1 minute travel time calculations (half wage-one third wage), then the users are paying reasonable additional ticket costs to compensate that time saving. However, if the value is higher, that means there is welfare loss of the users.

After the analysis, it has been seen that, dolmuş operations were more expensive compared with the conventional competitors than it should be from the users perspective. Based on that evaluation, it has been seen that except "Dolmus-Bus" comparison, in all other comparisons dolmuş related travel patterns provided a better service to its users with shorter travel times against the conventional public transport operations. Especially, for the patterns that included a transfer to or from dolmuş, there was significant time saving of dolmuş users. Even as a bus feeder system, dolmuş operations were better alternatives than bus feeders. However, there was also definite welfare loss of the users because this time saving was not compensating the additional ticket cost paid.

From those findings it was obvious that there was a need for the ticket price reduction in the case of transfers. Nevertheless, as stated many times in the previous chapters, that reduction should be made with a negotiation process with the operators. For the investigation of possible negotiation methods for the reduction of dolmuş ticket prices an additional study has been made. An in-depth interview has been conducted with a dolmuş license plate owner/operator on the all inputs of average dolmuş costs. This additional study provided valuable information on per passenger per km costs of a dolmuş operation. At the end, per passenger per km costs of operators and time savings of users has been merged with each other and a final calculation has been made to figure out if there was high excess profit of operators from 2.25 TL standard ticket cost or not. To find out this excess profit was important, because it would be a basis for the negotiation between city authority and operators for the reduction of the ticket price. The results were extraordinary because, almost in all of the comparisons, there was quite high excess profit of dolmuş operators. At the final stage three main findings from the first four sections of the chapter were:

1- There is significant time savings and parallel to that, significant additional ticket costs of dolmuş passengers against the public transport users

2- The amount of time saved is not compensating the additional ticket cost according to economically acceptable calculations

3- While users were suffering from welfare loss, operators on the other hand are getting excess profit from the ticket costs even if their faster service value and their costs are reduced from 2.25 TL ticket price

That is why; at the end of the chapter, a new pricing mechanism has been proposed. According to these new calculations (an example has been given for a zone along the metro route), it has been demonstrated that the re-structuring of dolmuş operations in terms of routing and ticketing is possible. The results showed that, as a feeder mode before/after the main arterial transfer mode, dolmuş operations can be reformulated with lower ticket prices. That proposals would either decrease the total ticket cost for dolmuş related transfer or reduce the travel time per trip in significant amounts. Besides, it is expected that, this reformulation would help to increase the efficiency of main arterials with metro and bus service on the one hand, and provide an opportunity to re-distribute the currently operating feeder buses around the metro corridors to other routes on the other hand..

7.2. Main Findings and Recommendations

Throughout the study, it has been emphasized that there is no consensus on the future of paratransit. The complete removal of the operations as one option, and the introduction/reformulation of paratransit vehicles where needed as the other option are the two extremes among the transportation experts and decision makers (Cervero; 2000; Dimitriou, 2011; Grava, 2003; Kılınçaslan, 2012). The results of both literature review and the survey analysis are supporting the argument for the reformulation of paratransit services as a better option for the Ankara case, which is a developing country capital.

As stated in the sixth chapter, time saving measure is the most dominant one in mode choice decisions of public transport users. That is why, significant time saving advantage of dolmuş users is vital for the re-structuring the paratransit mode dolmuş in Ankara. It is obvious that, dolmuş provides its users with enormous time advantages per travel against the completely conventional modes, even though the METU Campus is a relatively accessible zone, which is on the M2 (Çayyolu) metro line. Lee et al. (2003) note that a 10% increase in speeds could attract 5% of car drivers to the bus and subway. Cities, which invest in Bus Rapid Transit (BRT) projects, like Bogota and Curitiba, have managed to increase the average commercial speed of buses to between 18-28 km/h and 17.5 km/h, carrying 1.6 million and 2.26 million passengers per day respectively (Yüce and Babalık-Sutcliffe, 2012). That is why, if time savings stated in the sixth chapter could be provided with a new formulation of Ankara transportation network, it would be possible to change the carrying capacity of the network significantly.

It should be noted that in industrialized countries; revitalization of paratransit services has actually emerged as a result of system efficiency development and minimizing the operation costs. Nevertheless, as could be seen from the statistics it is a necessity for Ankara case. Currently the share of dolmuş is significant in passenger trips in this city and as seen in the survey presented in the study, many passengers prefer using dolmuş, either as their sole mode of transport or as a mode they transfer to or from in combination with other modes, such as metro or bus.

Based on these findings, this study proposed that dolmuş is restructured in Ankara in a way that it provides short feeder services to the metro system rather than operate along routes that compete with the metro. This is possible particularly for the case of Çayyolu M2 Metro line since it serves sprawled urban areas, that the literature showed as potential places for operating paratransit systems. Such a proposal is also supported by the findings of the survey since an extremely high share of students indicated that they would like to see free or low-fare transfer opportunities between dolmuş and the metro. As a result, the integration of dolmuş into the public transport network can be formulated in such a way that the dolmuş routes are reorganized as short lines that feed the metro stations. Such short lines are also profitable from the operators' point of view although an understanding of operator perspective is also necessary.

It has therefore been emphasized in the study that, the realization of that kind of integration project is quite difficult because of the lobbying activities of the dolmuş operators. However, these lobbying activities could be eliminated by making policies which substantiates the losses of these groups, prepared with a participatory process of all stakeholders and creative negotiation ways.

Dolmuş was an entrepreneurial mode for Turkey and emerged unintentionally in transportation network. It has helped both low-income citizens and public authorities to deal with the urbanization related problems of Turkey in the last 60 years. As it was a provision, which was directly demanded by the society, it also helped the configuration of the individual behaviors. In the current situation, as survey data supported, it could again be the key for reaching an efficient metro and bus network in a city, in which urban sprawl takes place.

7.3. Future Research

This study conceptualizes a new framework for the evaluation of transportation modes that emerged as a result of societal needs. As explained in detail above, the support of theoretical knowledge with mathematical calculations is quite important however, this approach should not diminish the social aspects of transportation because transportation decisions are directly related with the societal preferences, in other words social aspects affecting the embodiment of the society. Besides, the result of this study cannot be a benchmark for the studies of different geographies. It is important to understand that each locality has its own perceptions and decision making criteria. Consequently, this study can be used as a basis for carrying out similar analysis in different localities with a view to propose context-specific solutions to mobility demands, and the role of paratransit in public transport services.

In this study, as a result of time and budget constraints, it was not possible to reach a larger sample for the evaluation of city transportation network. It is important to enlarge the sample size; because, increasing the sample size and also the variety of survey participants (including full ticket users from different occupations and different income levels) would give much better results in terms of reliability and applicability. Besides, following the evaluation of the existing ticket prices and current public transport service routes; the determination of a new ticket price and re-designing the routes of different modes for integration is possible only and only if, with an analysis covering all three stakeholders of the system; dolmuş operators, local decision makers and users. An in-depth understanding, which puts an emphasis on different concerns and expectations would provide beneficial tools for transport system integration in a real implementation project. On the other hand, to evaluate the values of peak hour and off-peak hour separately can contribute further to transport mode choice calculations and policy making-planning processes. Based on a survey in California, Small (1997) found that commuters have a strong aversion to unpredictable travel times under congested conditions, so that a minute of time savings under congested conditions is valued at 2.5 times that of an uncongested minute of travel time savings. An earlier study by Waters (1992) concluded that a 1.3 to 2.0 mark-up factor is appropriate, depending on the level of congestion. In addition, separate studies of toll roads also show that peak period commuters make trade-offs between time and cost, in which they value their time at 1.4 to 1.8 times the normal value of time (Sullivan, 2000). The importance of even the period for the calculation can be seen from these findings easily. That is why further research including more inputs regarding users' behavior in peak and off-peak can contribute to the arguments regarding the restructuring of paratransit operations.

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APPENDICES

APPENDIX A

METU CAMPUS AND TRANSPORTATION SURVEY FILE

ODTÜ YERLEŞKE VE ULAŞIM ANKETİ - ÖĞRENCİ		
Anket No:	Yer/Tarih:	Anketör:

A. KATILIMCI BİLGİLERİ
A1. Cinsiyetiniz: ( ) Kadın ( ) Erkek
A2. ODTÜ'de kayıtlı olduğunuz, **Bölüm:** **A3. Sınıf : ( )** Hazırlık **( )** 1. Sınıf **( )** 2. Sınıf **( )** 3. Sınıf **( )** 4. Sınıf **( )** Yüksek Lisans **( )** Doktora
A4. Yaşınız: ( ) 16-25 ( ) 26-35 ( ) 36-50 ( ) 51-60 ( ) 61-64 ( ) >65
A5. Medeni Durumunuz: ( ) Evli ( ) Bekar
A6. Aylık Ortalama Geliriniz: ( ) <500 TL ( ) 500-1000 TL ( ) 1000-2000 TL ( ) 2000-3500 TL ( ) 3500-5000 TL ( ) >5000 TL

C KAMPÜSE ERİŞİM

C1. Ankara'da yaşadığınız yer:

( ) ODTÜ Kampüsü YURT:.................. **(C5'e atlayınız)**

( ) Şehir Merkezi Semtiniz:............................

C2. Haftada ortalama kaç gün kampüse geliyorsunuz?

( ) 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7

C7. (Anketör Eşliğinde Doldurunuz) Kampüse gelişte kullandığınız ulaşım türlerinin tercihinize sıranıza göre belirtiniz. Kullandığınız türler için ortalama haftalık kullanım sıklığınızı, evden-bölüme ortalama erişim sürenizi ve aktarma zorunluluğunuzu belirtiniz.

Tercih Sırası	**Kullandığı gün sayısı**	**Tür**	**Ortalama erişim süresi (dakika)**	**Öncesi/Sonrası Aktarma Türü**
		EGO Belediye Otobüsü		
		Özel Halk Otobüsü		
		Metro (Diğer hatlar)		
		Metro (Çayyolu hattı)		
		Dolmuş		
		Servis Aracı		
		Özel Araç		
		Motorsiklet		
		Bisiklet		
		Yürüme		
		Diğer (Belirtiniz)...........		

C8. İlk tercihiniz olan ulaşım türünde aşağıdaki özelliklerden hangileri sizin için önemlidir? (..........................)

a)Hız/süre

b)Maliyet/Ücret

c)Sefer sıklığı

d)Rahatlık-konfor

e)Sık duraklama/indirme olanağı

f)Kişiye özel olma

g)Çevresel duyarlılık

h)Güvenilirlik (geç kalmama, sabit güzergah, vb)

i)Güvenlik (kaza riski, kişisel güvenlik, vb)

Çayyolu-Kızılay METRO hattı tecrübeniz hakkında,

C9. Hiç kullandınız mı? **( )** Evet **( )** Hayır **(Hayırsa C11'e atlayınız)**

C10. Memnuniyetinizi aşağıdaki faktörler açısında değerlendirebilir misiniz?

	Memnun Değilim	**Memnunum**
a) Hız/süre		
b) Ücreti		
c) Sefer sıklığı		
d) EGO ring servisleri		
e) Diğer aktarma olanakları (minibüs)		
f) Rahatlık-konfor		
g) Güvenlik (kaza riski, kişisel güvenlik, vb)		
h) Güvenilirlik (geç kalmama, arıza yapmama, vb)		
i) Genel memnuniyet		

C11. Aşağıdaki iyileştirmelerden hangisi/hangileri sizin bu hattı daha fazla tercih etmenize katkıda bulunur? (Birden fazla seçebilirsiniz)

Katkısı olan	İyileştirmeler
	a) Metro seferlerinin sıklaştırılması
	b) Vagon sayısının arttırılması
	c) Daha güvenilir hizmet sunulması (Dakiklik vb)
	d) Metro Ring servis sıklığının artılması
	e) Metro Ring servisinin kampüs içinde güzergahının genişletilmesi
	f) EGO otobüslerine daha ucuza/bedava aktarma imkanı sağlanması
	g) Metro duraklarında araç/bisiklet için park imkanı sağlanması
	h) Dolmuşlardan metroya ucuz/bedava aktarma imkanı sağlanması

C12. Genel olarak, ODTÜ'ye erişim koşullarının iyileştirilmesi için aşağıdakilerin hangisi ne derece önemlidir?

	Hiç önemli değil	Biraz önemli	Oldukça önemli	Çok önemli
a) EGO Semt servisi sağlanması				
b) Minibüs/dolmuş seferi konması/artırılması				
c) EGO otobüs-raylı sistemleri arasında ücretsiz transfer olması				
d) ODTÜ semt servisi imkanının sağlanması/arttırılması				
e) Çayyolu Metro Hattı hizmetlerinin iyileştirilmesi				
f) Kampüs içi yaya ve bisiklet erişiminin geliştirilmesi				
g) Kampüs içi ring hizmetlerinin geliştirilmesi				
h) Carpooling/ortak araç kullanım sistemlerinin geliştirilmesi				

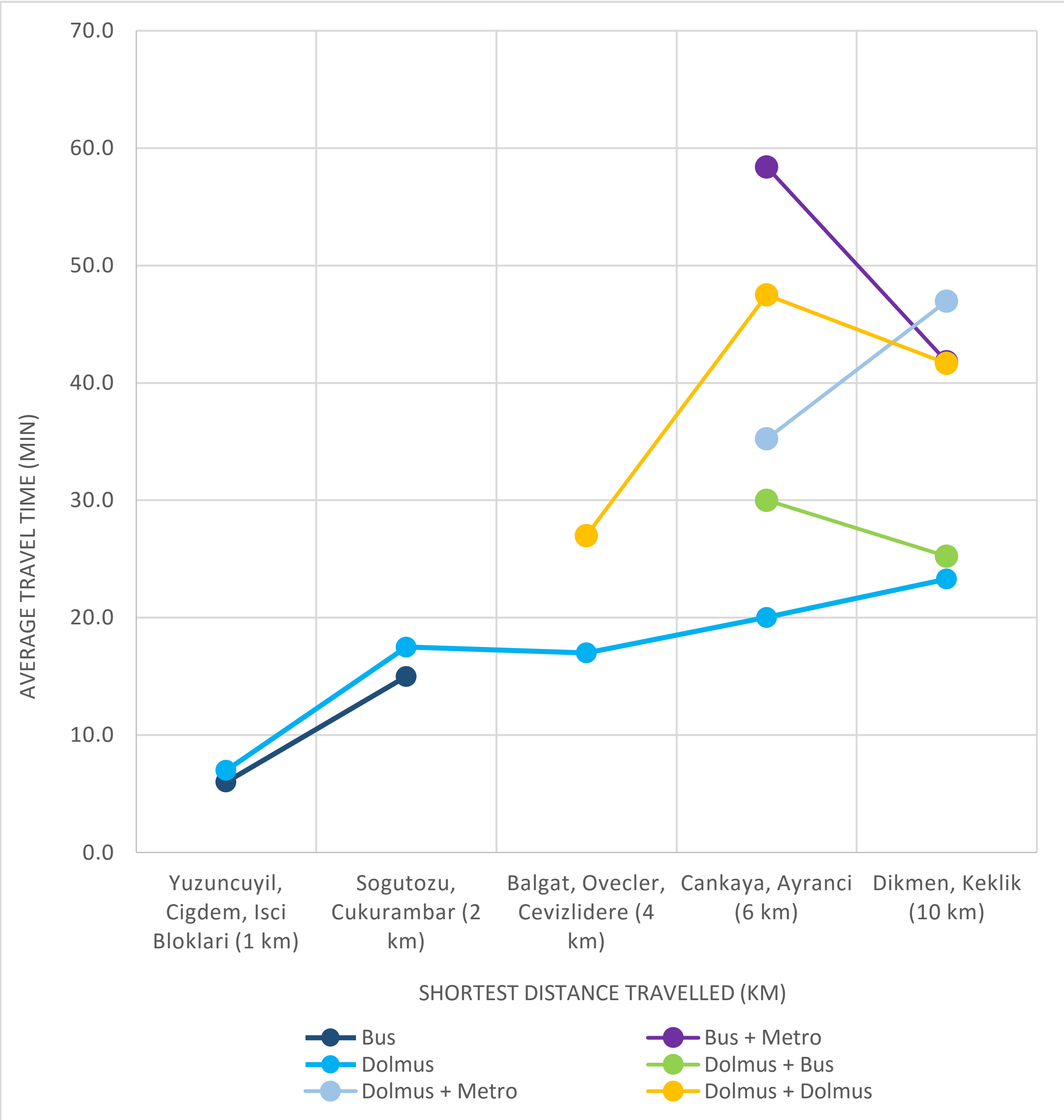
C12. Genel olarak, ODTÜ'ye erişim koşullarının iyileştirilmesi için aşağıdakilerin hangisi ne derece önemlidir? (Continues)

i) Dolmuşların Ankara-Kart sistemine dahil edilmesi				
j) Diğer (Lüften belirtiniz)				

APPENDIX B

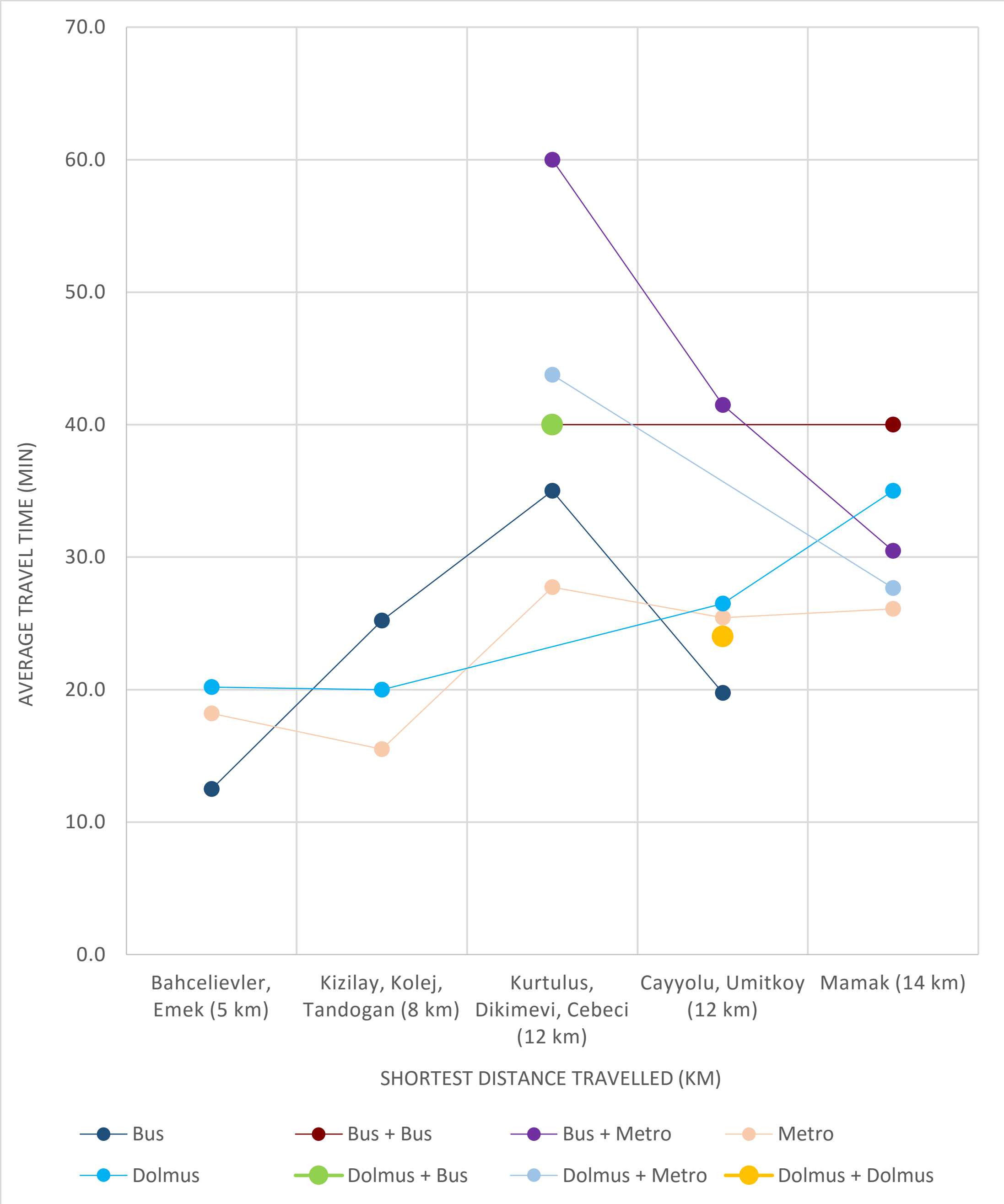
DETAILS OF TRAVEL TIME-DISTANCE ANALYSIS

ZONE GROUP 1 (Direct Dolmus Service Corridor)



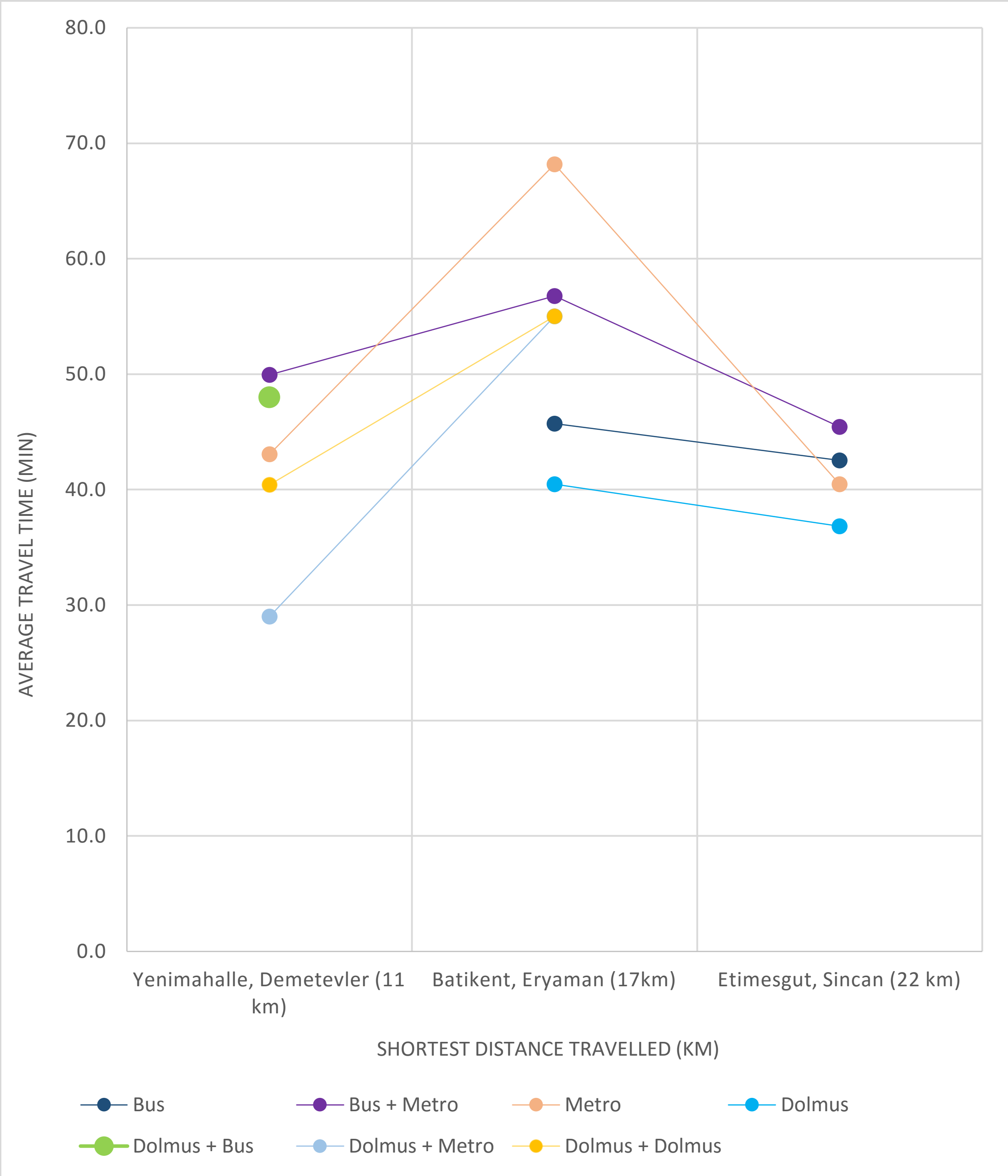
ZONE GROUP 1 (Direct Dolmus Service Corridor) Average Travel Time (Min)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
Yuzuncuyil, Cigdem, Isci Bloklari (1 km)	1	6.0	-	-	-	7.0	-	-	-
Sogutozu, Cukurambar (2 km)	2	15.0	-	-	-	17.5	-	-	-
Balgat, Ovecler, Cevizlidere (4 km)	4	-	-	-	-	17.0	-	-	27.0
Cankaya, Ayranci (6 km)	6	-	-	58.4		20.0	30.0	35.2	47.5
Dikmen, Keklik (10 km)	10	-	-	41.8		23.3	25.2	47.0	41.7

ZONE GROUP 2 (Direct Metro Service Corridor 1 / Ankaray+Koru Metro)



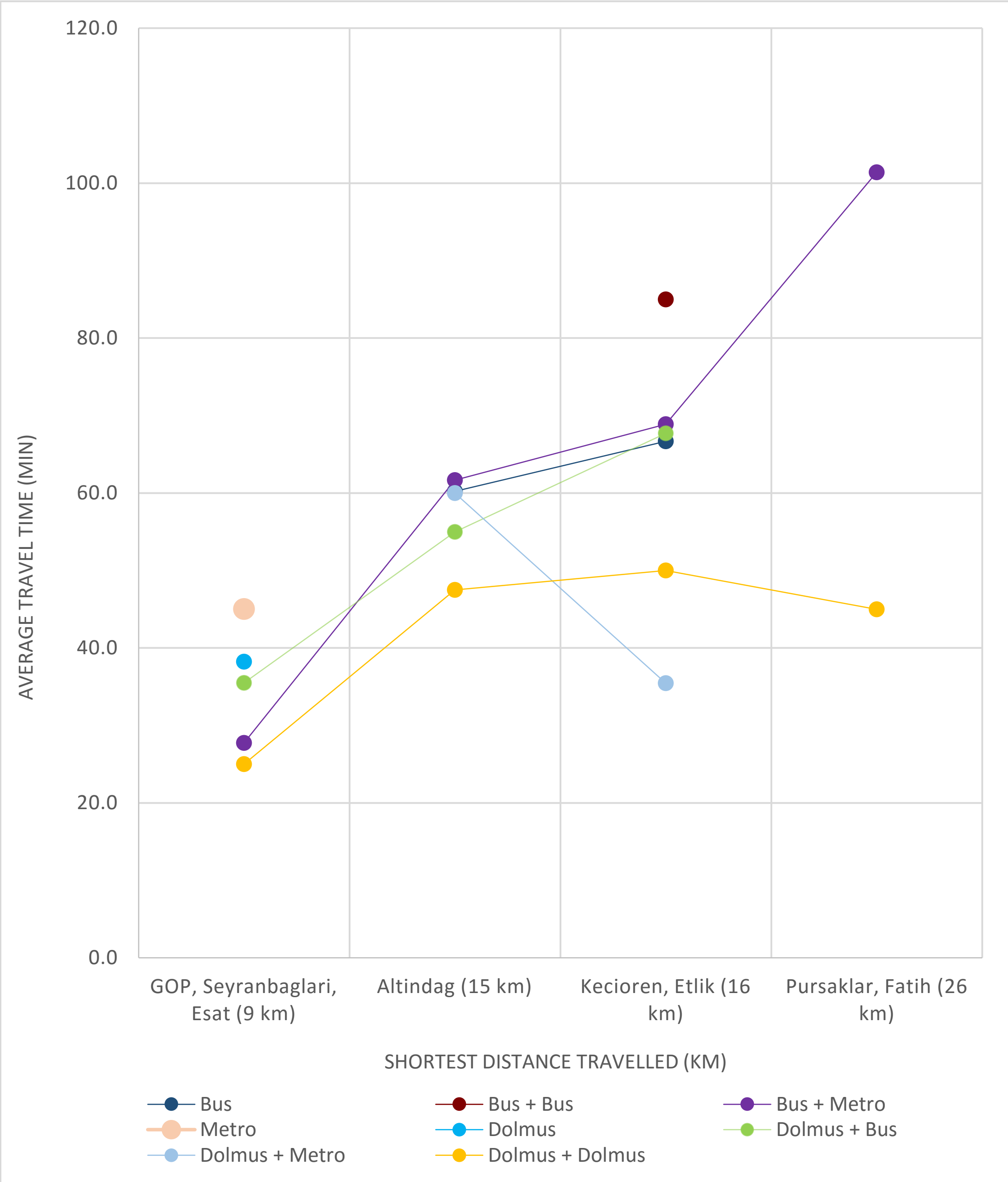
ZONE GROUP 2 (Direct Metro Service Corridor 1 / Ankaray+Koru Metro) Average Travel Time (Min)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
Bahcelievler, Emek (5 km)	5	12.5	-	-	18.2	20.2	-	-	-
Kizilay, Kolej, Tandogan (8 km)	8	25.2	-	-	15.5	20.0	-	-	-
Kurtulus, Dikimevi, Cebeci (12 km)	12	35.0	40.0	60.0	27.7		40.0	43.8	
Cayyolu, Umitkoy (12 km)	12	19.7		41.5	25.4	26.5	-	-	24.0
Mamak (14 km)	14		40.0	30.5	26.1	35.0	-	27.7	

ZONE GROUP 3 (Direct Metro Service Corridor 2 / Batıkent+Koru Metro)



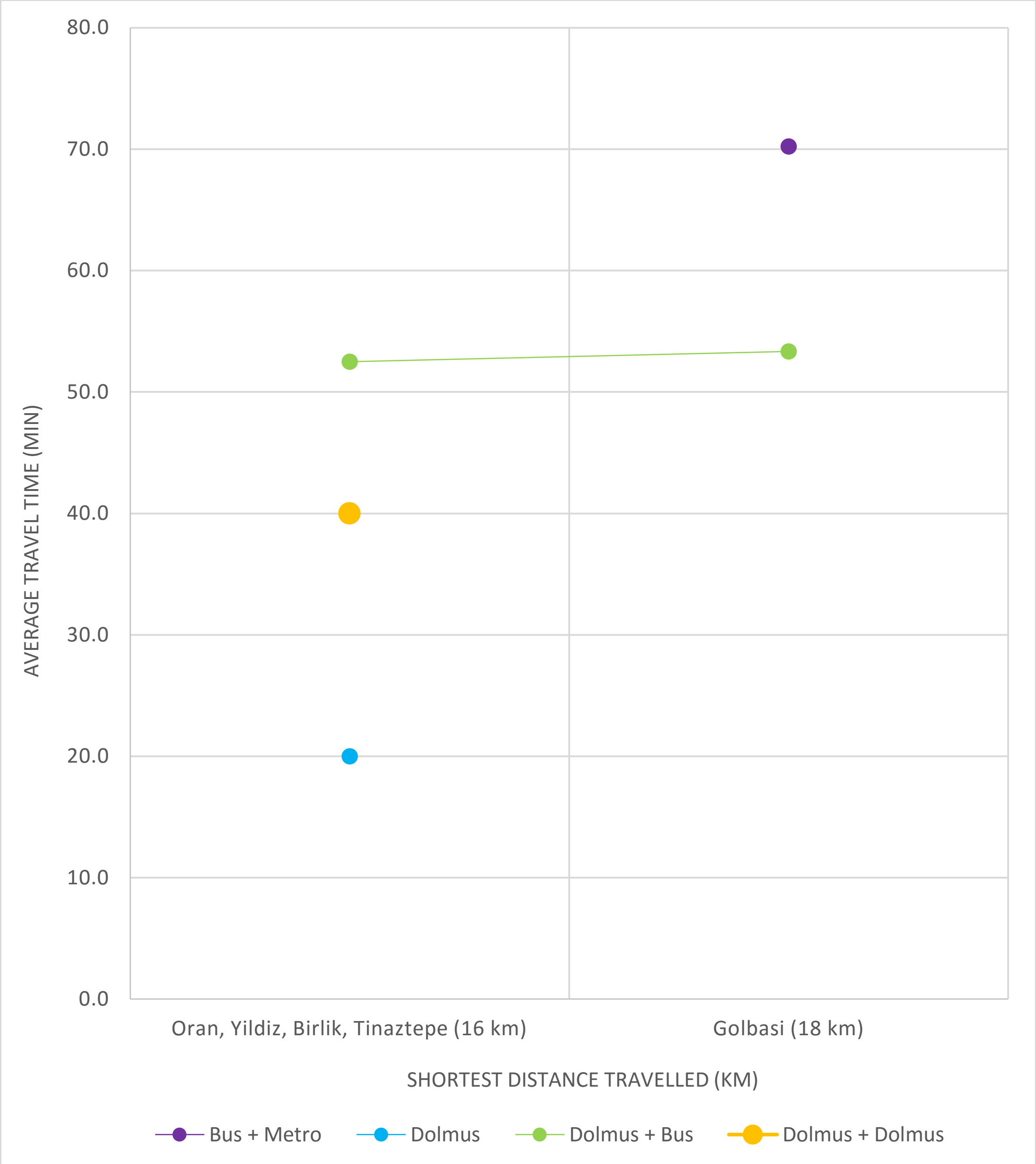
ZONE GROUP 3 (Direct Metro Service Corridor 2 / Batıkent+Koru Metro) Average Travel Time (Min)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
Yenimahalle, Demetevler (11 km)	11	-	-	50.0	43.1	-	48.0	29.0	40.4
Batikent, Eryaman (17km)	17	45.7	-	56.8	68.2	40.5	-	55	55.0
Etimesgut, Sincan (22 km)	22	42.5	-	45.4	40.5	36.8	-	-	-

ZONE GROUP 4 (Transferred Patterns Territory)



ZONE GROUP 4 (Transferred Patterns Territory) Average Travel Time (Min)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
GOP, Seyranbaglari, Esat (9 km)	**9**	-	-	27.7	45.0	38.2	35.5	-	25.0
Altindag (15 km)	15	60.2	-	61.7	-	-	55.0	60.0	47.5
Kecioren, Etlik (16 km)	16	66.7	85.0	68.9	-	-	67.7	35.5	50.0
Pursaklar, Fatih (26 km)	26		-	101.4	-	-	-	-	45.0

ZONE GROUP 5 (Other Zones)

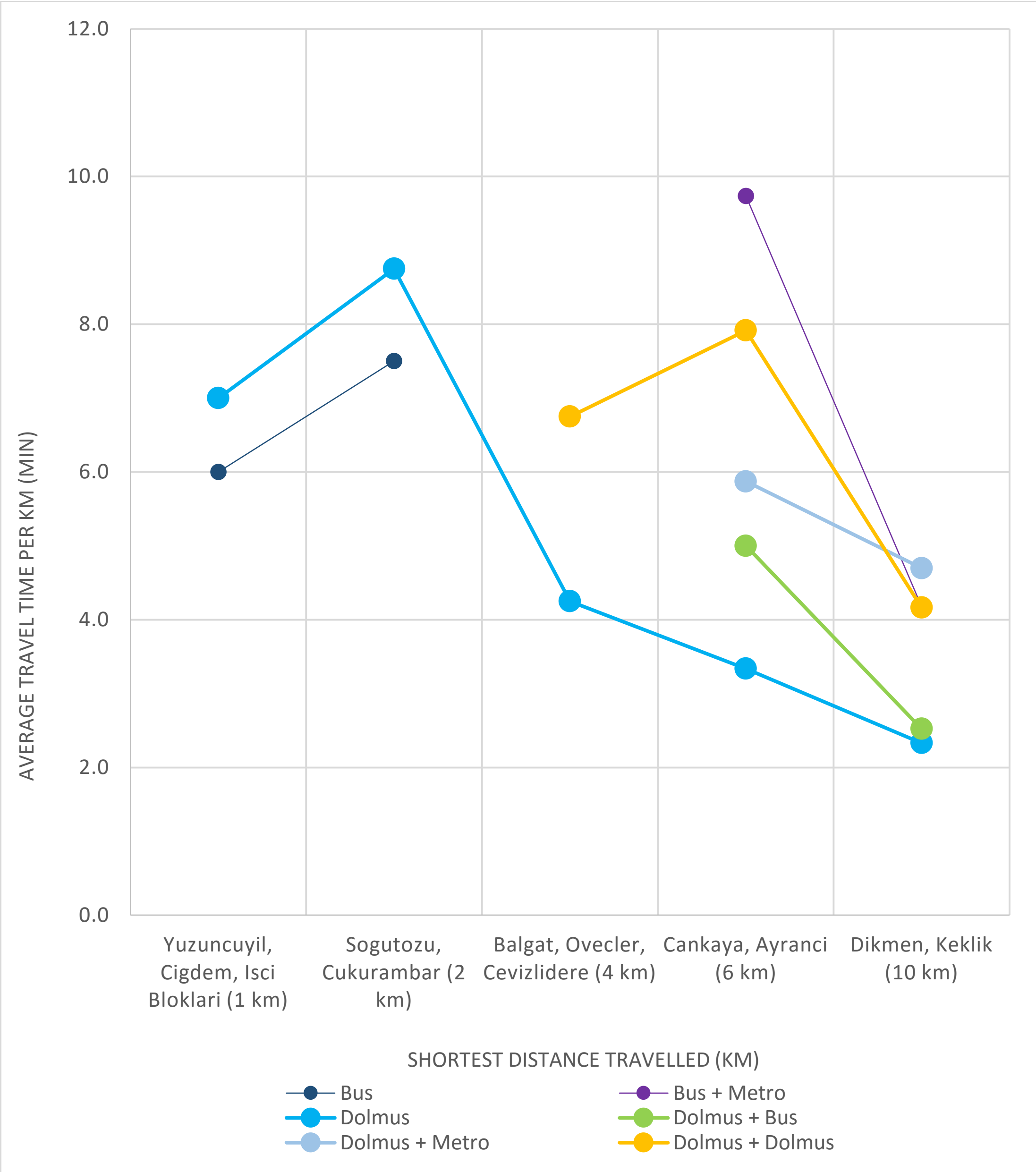


ZONE GROUP 5 (Other Zones) Average Travel Time (Min)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
Oran, Yildiz, Birlik, Tinaztepe (16 km)	16	-	-	-	-	20.0	52.5	-	40.0
Golbasi (18 km)	18	-	-	70.2	-	-	53.3	-	-

APPENDIX C

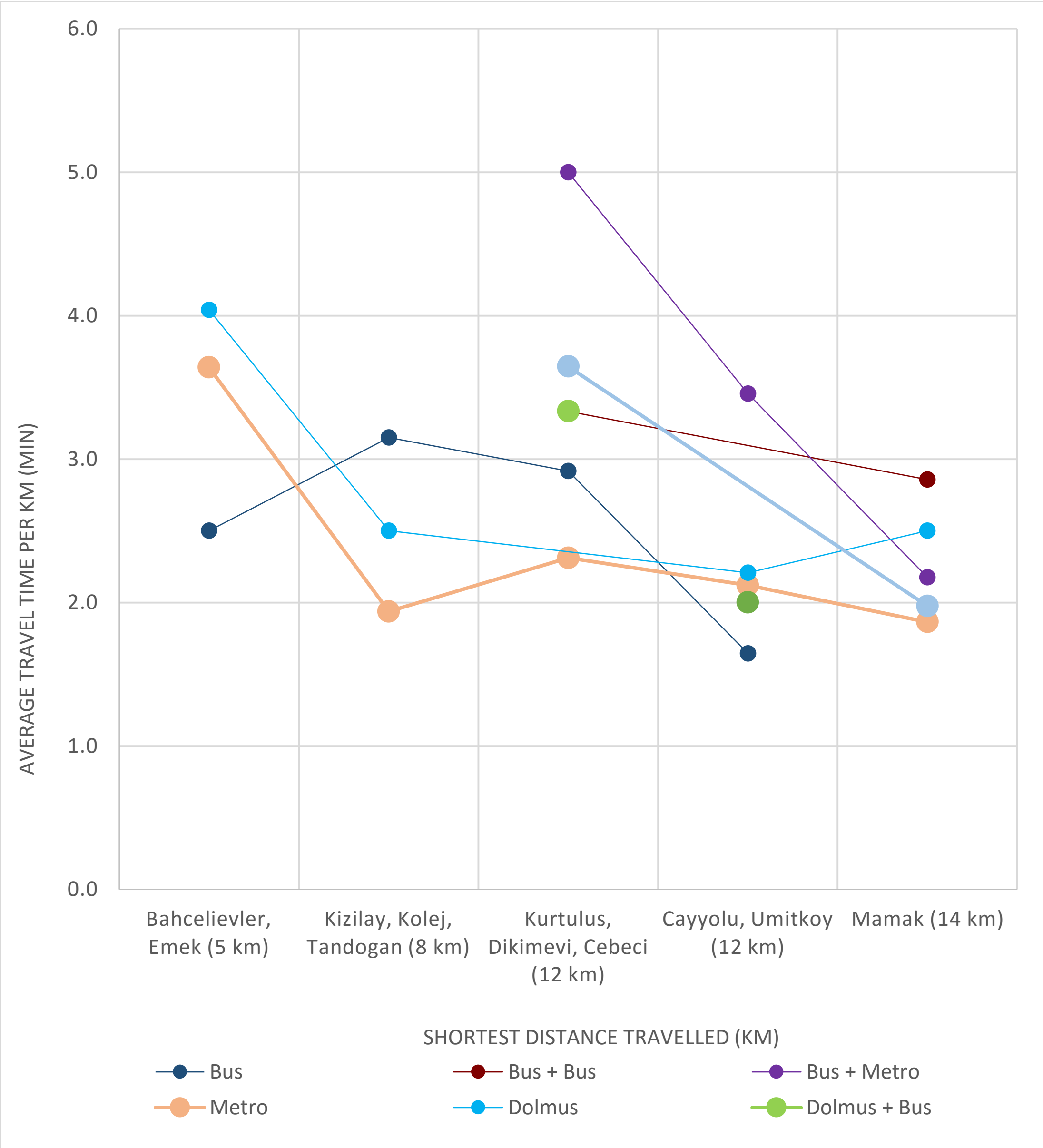
DETAILS OF TRAVEL TIME PER KM-DISTANCE ANALYSIS

ZONE GROUP 1 (Direct Dolmus Service Corridor)



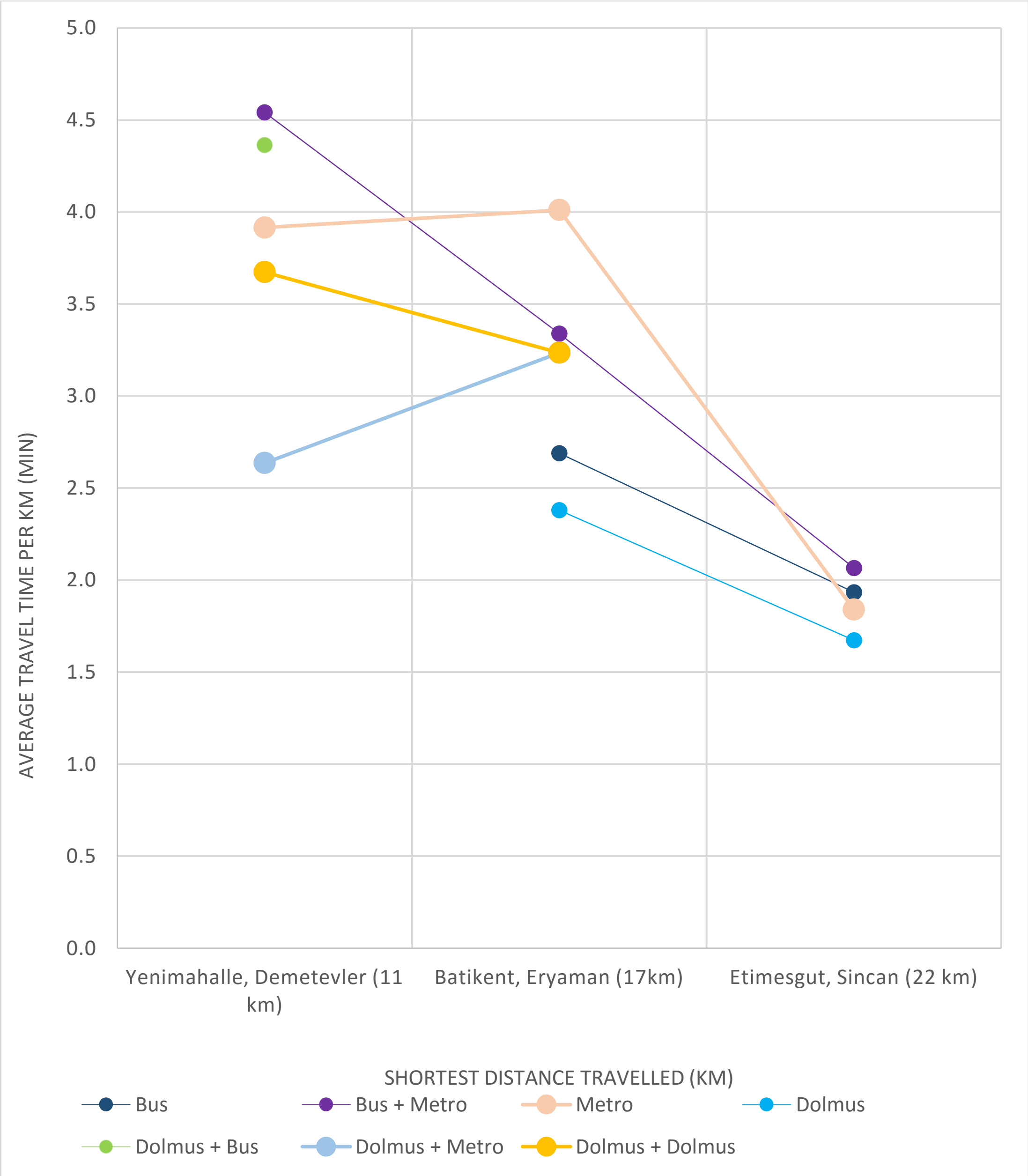
ZONE GROUP 1 (Direct Dolmus Service Corridor) Average Travel Time Per km (Min)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
Yuzuncuyil, Cigdem, Isci Bloklari (1 km)	1	6.0	-	-	-	7.0	-	-	-
Sogutozu, Cukurambar (2 km)	2	7.5	-	-	-	8.75	-	-	-
Balgat, Ovecler, Cevizlidere (4 km)	4	-	-	-	-	4.3	-	-	6.8
Cankaya, Ayranci (6 km)	6	-	-	9.7	-	3.3	5.0	5.9	7.9
Dikmen, Keklik (10 km)	10	-	-	4.2	-	2.3	2.5	4.7	4.2

ZONE GROUP 2 (Direct Metro Service Corridor 1 / Ankaray+Koru Metro)



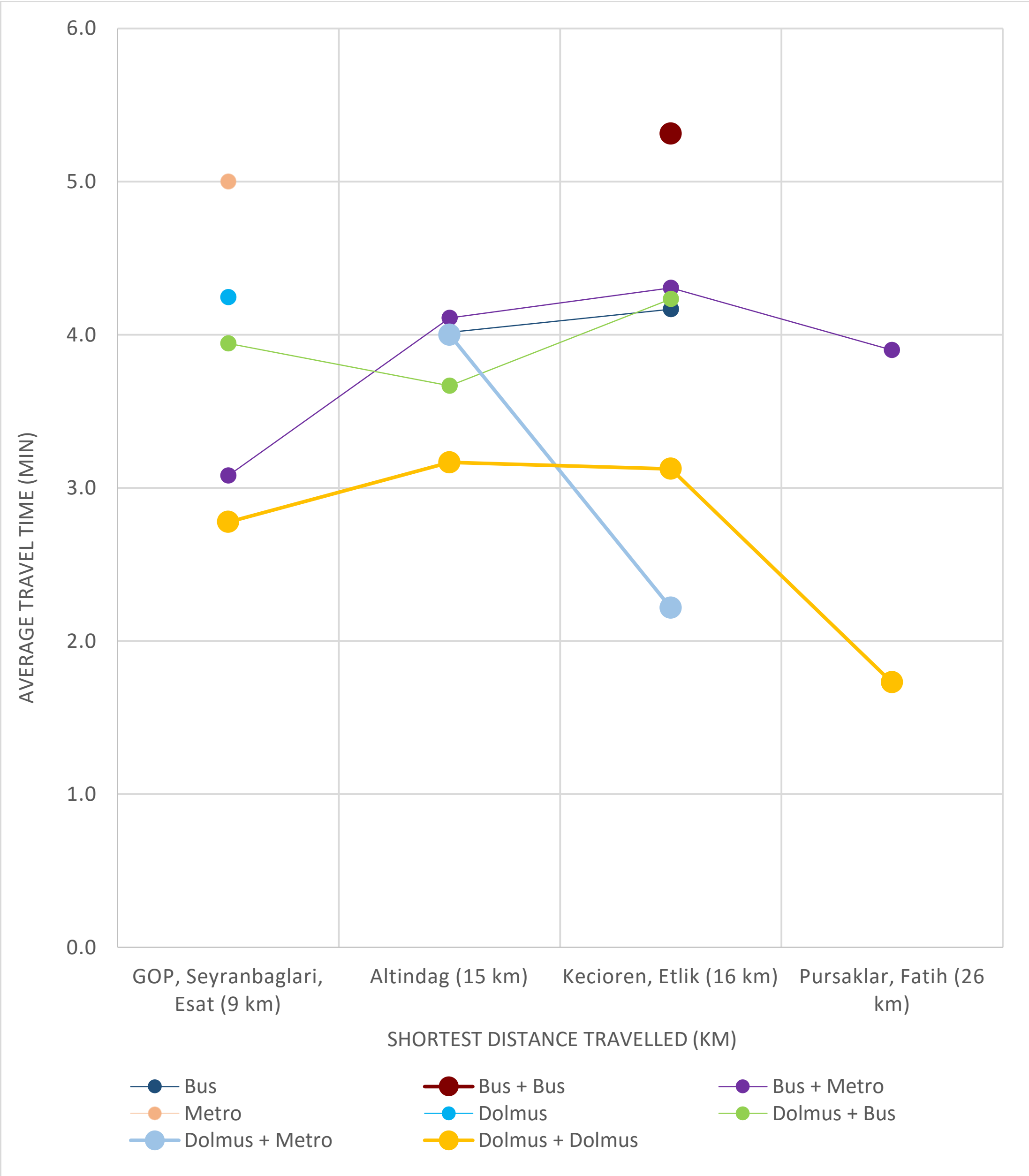
ZONE GROUP 2 (Direct Metro Service Corridor 1 / Ankaray+Koru Metro) Average Travel Time Per km (Min)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
Bahcelievler, Emek (5 km)	5	2.5	-	-	3.6	4.0	-	-	-
Kizilay, Kolej, Tandogan (8 km)	8	3.15	-	-	1.9	2.5	-	-	-
Kurtulus, Dikimevi, Cebeci (12 km)	12	2.9	3.3	5.0	2.3	-	3.3	3.6	-
Cayyolu, Umitkoy (12 km)	12	1.6	-	3.5	2.1	2.2	-	-	2.0
Mamak (14 km)	14	-	2.9	2.2	1.9	2.5	-	2.0	-

ZONE GROUP 3 (Direct Metro Service Corridor 2 / Batıkent+Koru Metro)



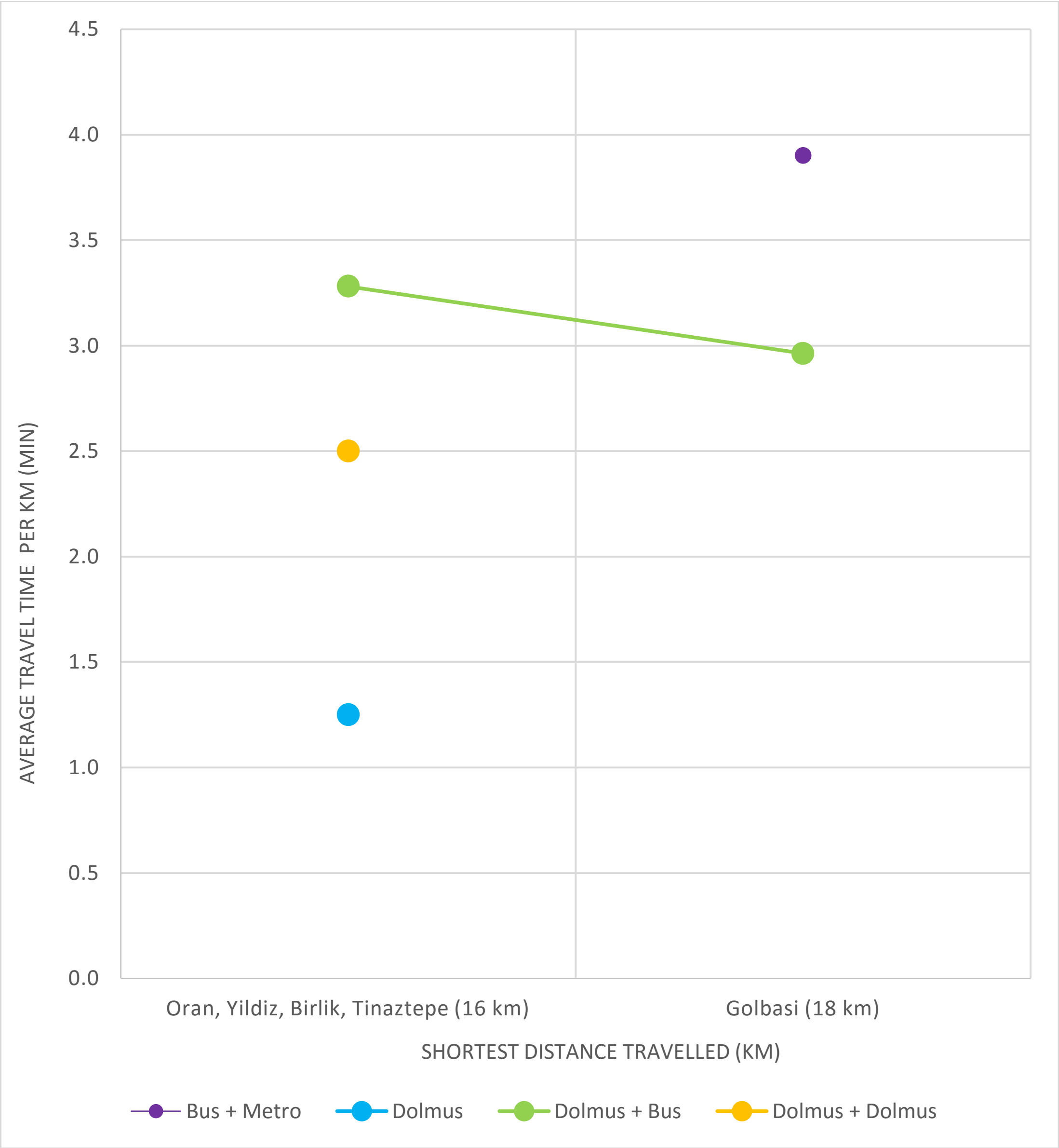
ZONE GROUP 3 (Direct Metro Service Corridor 2 / Batıkent+Koru Metro) Average Travel Time Per km (Min)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
Yenimahalle, Demetevler (11 km)	11	-	-	4.5	3.9	-	4.4	2.6	3.7
Batikent, Eryaman (17km)	17	2.7	-	3.3	4.0	2.4	-	3.2	3.2
Etimesgut, Sincan (22 km)	22	1.9	-	2.1	1.8	1.7	-	-	-

ZONE GROUP 4 (Transferred Patterns Territory)



ZONE GROUP 4 (Transferred Patterns Territory) Average Travel Time Per km (Min)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
GOP, Seyranbaglari, Esat (9 km)	**9**	-	-	3.1	5.0	4.2	3.9	-	2.8
Altindag (15 km)	15	4.0	-	4.1	-	-	3.7	4.0	3.2
Kecioren, Etlik (16 km)	16	4.2	5.3	4.3	-	-	4.2	2.2	3.1
Pursaklar, Fatih (26 km)	26	-	-	3.9	-	-	-	-	1.7

ZONE GROUP 5 (Other Zones)

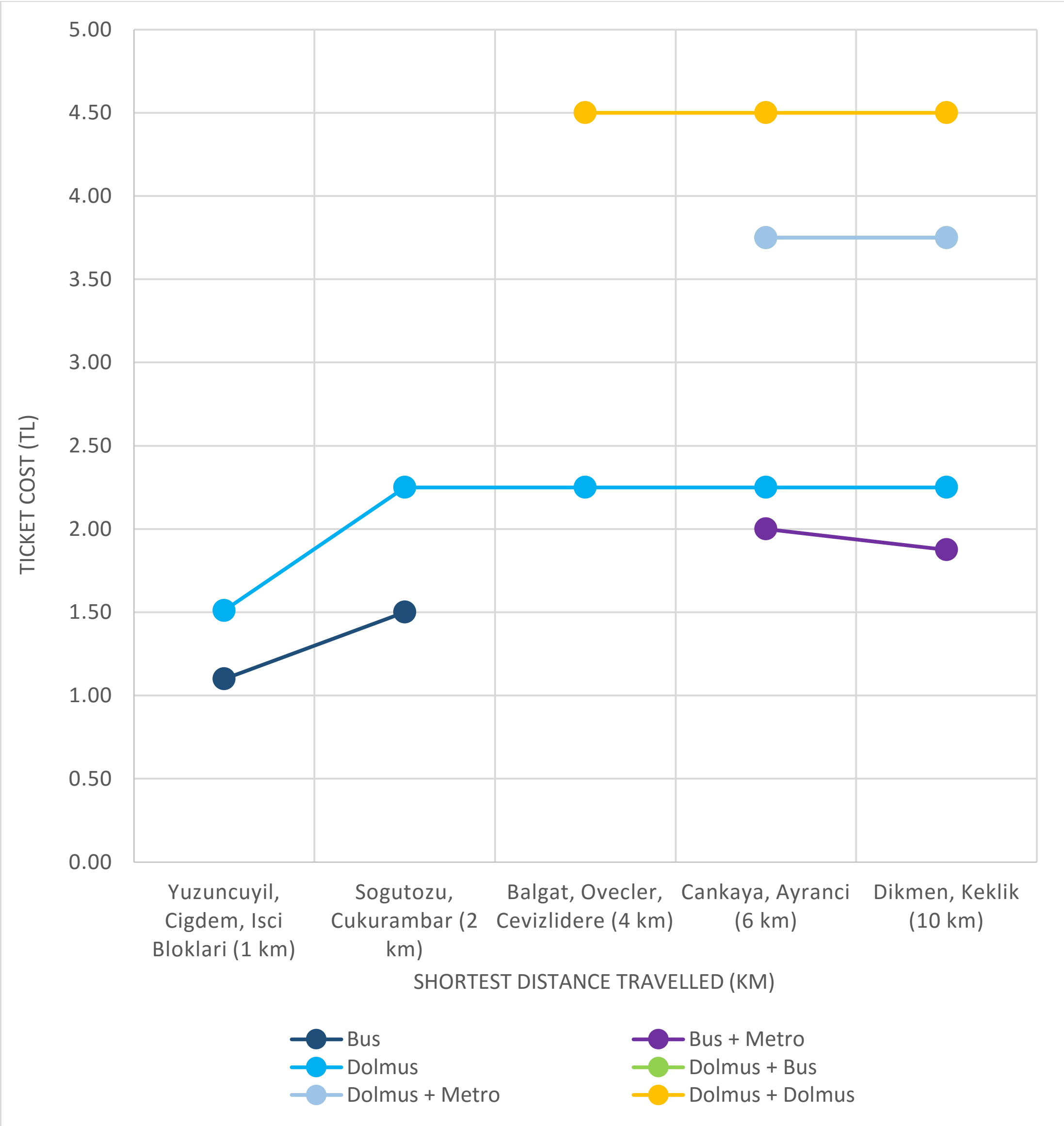


ZONE GROUP 5 (Other Zones) Average Travel Time Per km (Min)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
Oran, Yildiz, Birlik, Tinaztepe (16 km)	16	-	-	-	-	1.3	3.3	-	2.5
Golbasi (18 km)	18	-	-	3.9	-	-	3.0	-	-

APPENDIX D

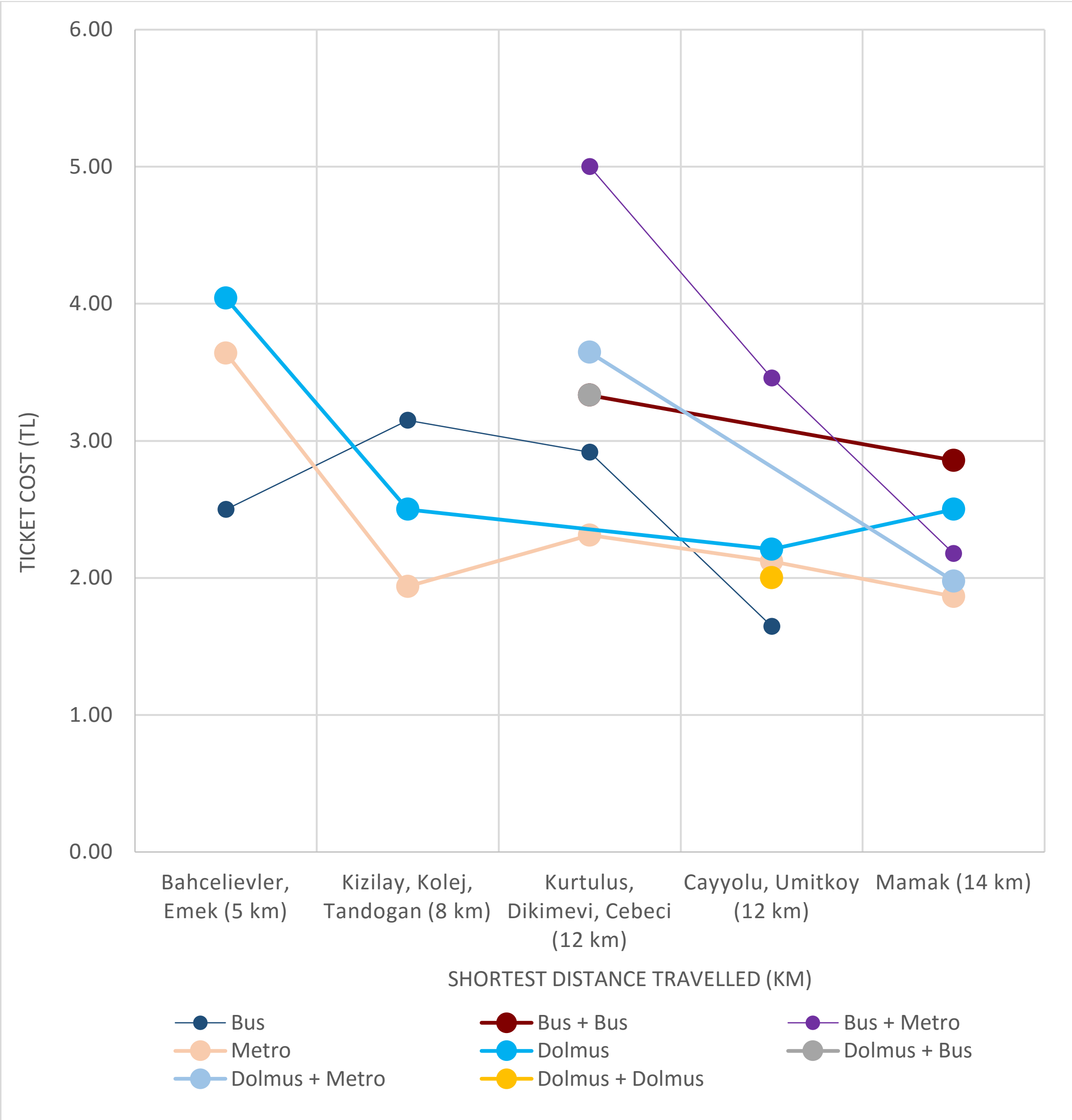
DETAILS OF TICKET COST -DISTANCE ANALYSIS

ZONE GROUP 1 (Direct Dolmus Service Corridor)



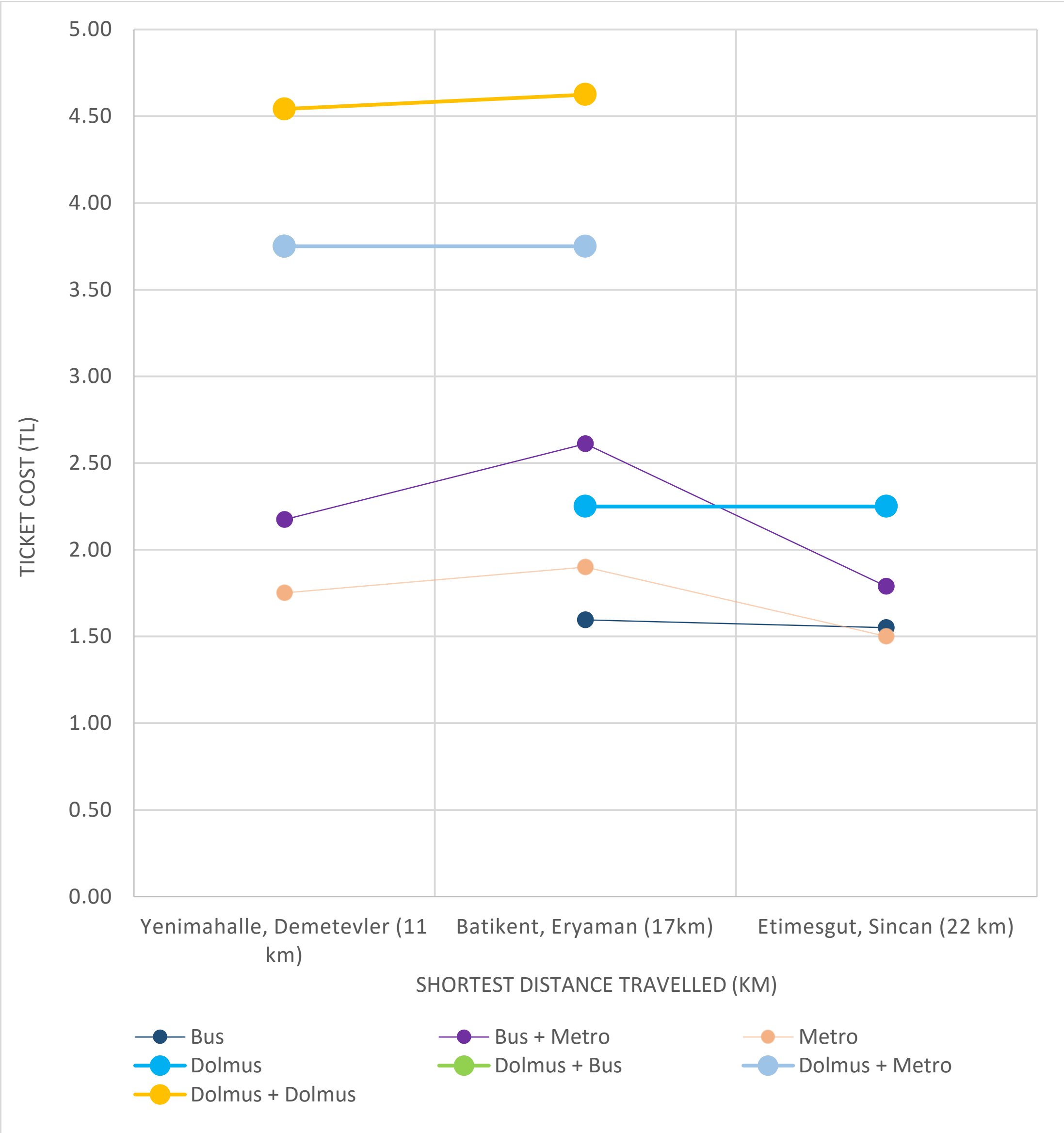
ZONE GROUP 1 (Direct Dolmus Service Corridor) Ticket Cost (TL)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
Yuzuncuyil, Cigdem, Isci Bloklari (1 km)	1	1.10	-	-	-	1.51	-	-	-
Sogutozu, Cukurambar (2 km)	2	1.50	-	-	-	2.25	-	-	-
Balgat, Ovecler, Cevizlidere (4 km)	4	-	-	-	-	2.25	-	-	4.50
Cankaya, Ayranci (6 km)	6	-	-	2.00	-	2.25	3.75	3.75	4.50
Dikmen, Keklik (10 km)	10	-	-	1.88	-	2.25	3.75	3.75	4.50

ZONE GROUP 2 (Direct Metro Service Corridor 1 / Ankaray+Koru Metro)



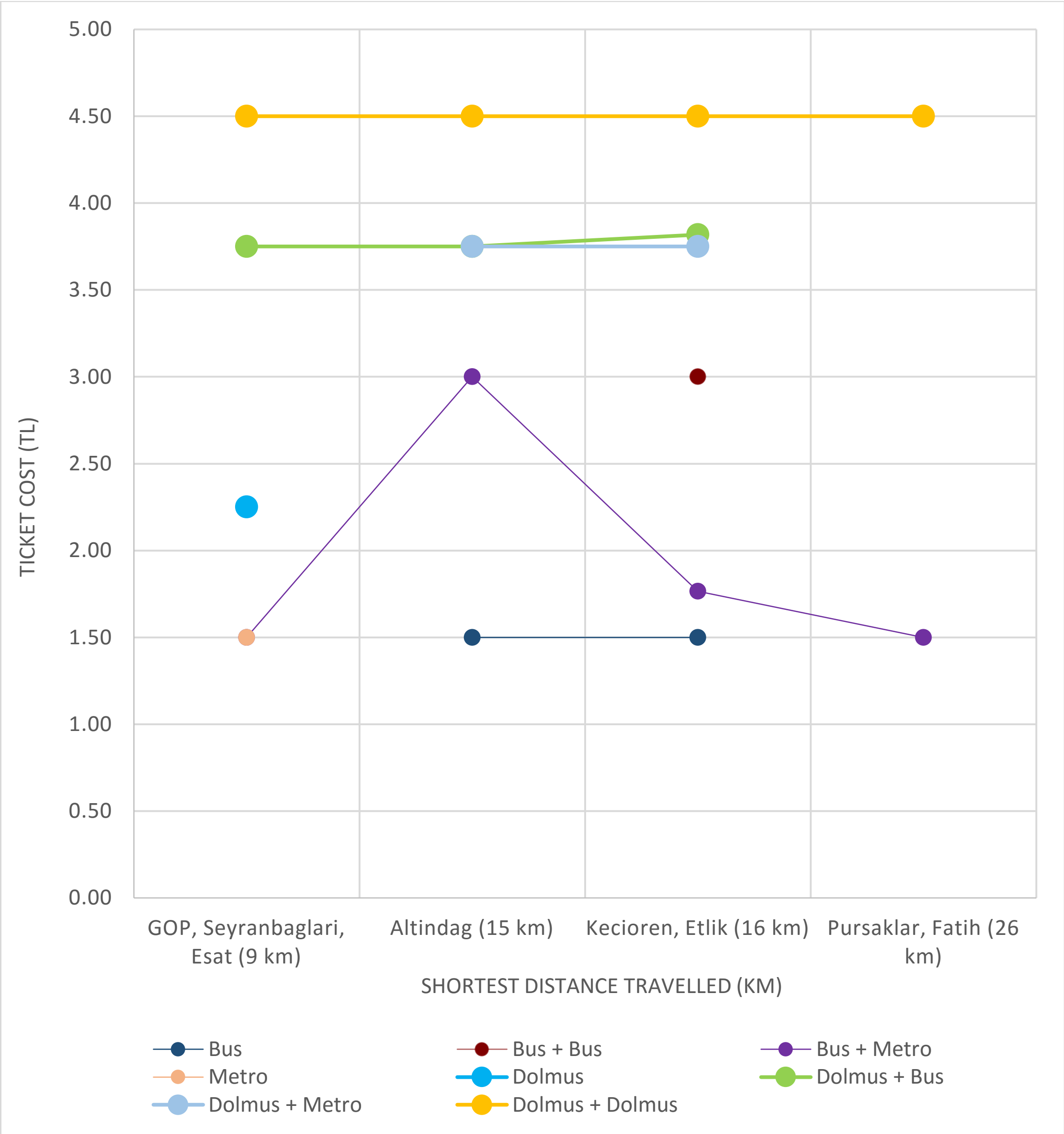
ZONE GROUP 2 (Direct Metro Service Corridor 1 / Ankaray+Koru Metro) Ticket Cost (TL)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
Bahcelievler, Emek (5 km)	5	2.50	-	-	3.64	4.04	-	-	-
Kizilay, Kolej, Tandogan (8 km)	8	3.15	-	-	1.94	2.50	-	-	-
Kurtulus, Dikimevi, Cebeci (12 km)	12	2.92	3.33	5.00	2.31	-	3.33	3.65	-
Cayyolu, Umitkoy (12 km)	12	1.64	-	3.46	2.12	2.21	-	-	2.00
Mamak (14 km)	14	-	2.86	2.18	1.86	2.50	-	1.98	-

ZONE GROUP 3 (Direct Metro Service Corridor 2 / Batıkent+Koru Metro)



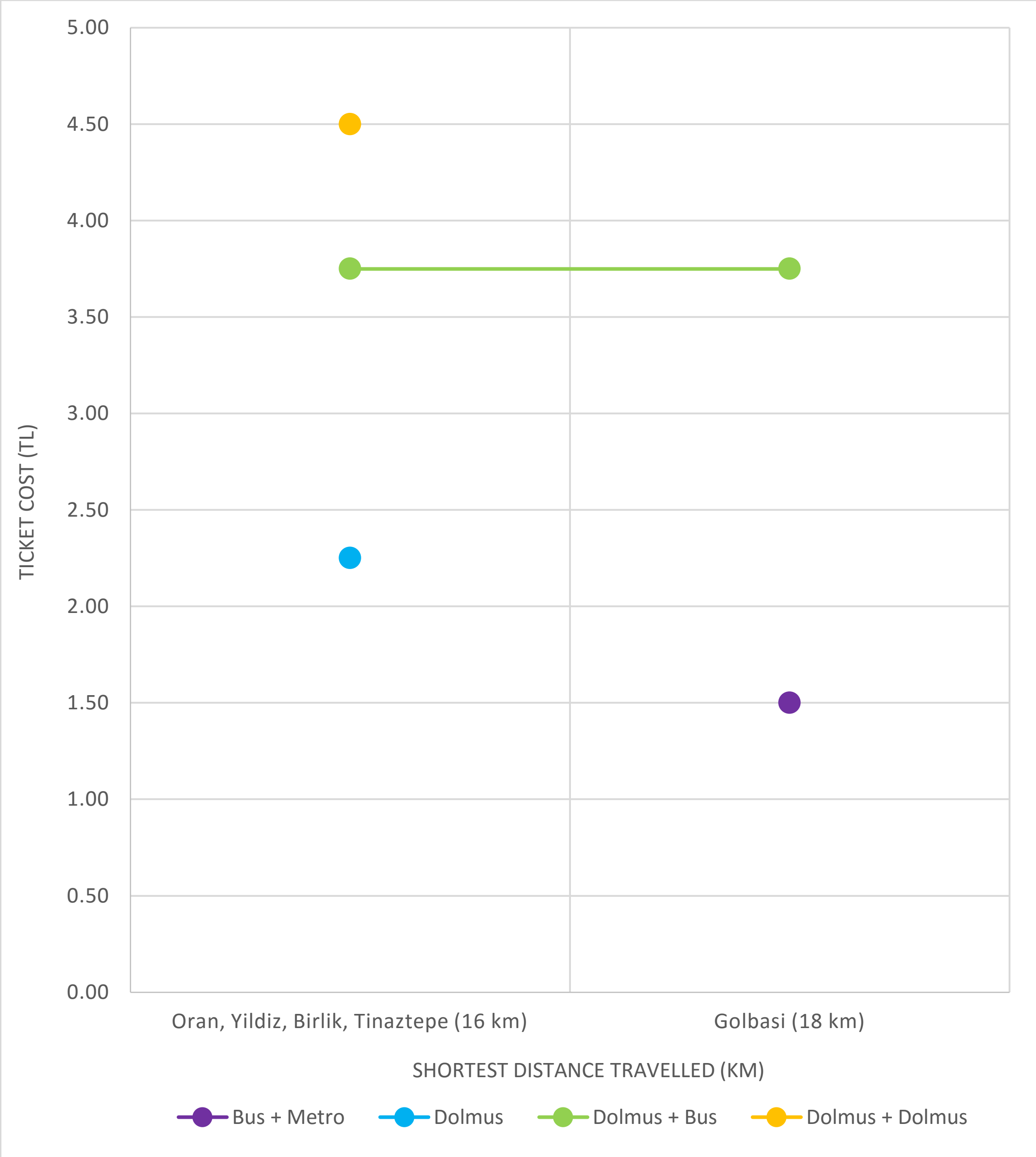
ZONE GROUP 3 (Direct Metro Service Corridor 2 / Batıkent+Koru Metro) Ticket Cost (TL)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
Yenimahalle, Demetevler (11 km)	11	-	-	2.17	1.75	-	3.75	3.75	4.54
Batikent, Eryaman (17km)	17	1.60	-	2.61	1.90	2.25	-	3.75	4.63
Etimesgut, Sincan (22 km)	22	1.55	-	1.79	1.50	2.25	-	-	-

ZONE GROUP 4 (Transferred Patterns Territory)



ZONE GROUP 4 (Transferred Patterns Territory) Ticket Cost (TL)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
GOP, Seyranbaglari, Esat (9 km)	**9**	-	-	1.50	1.50	2.25	3.75	-	4.50
Altindag (15 km)	15	1.50	-	3.00	-	-	3.75	3.75	4.50
Kecioren, Etlik (16 km)	16	1.50	3.00	1.76	-	-	3.82	3.75	4.50
Pursaklar, Fatih (26 km)	26	-	-	1.50	-	-	-	-	4.50

ZONE GROUP 5 (Other Zones)

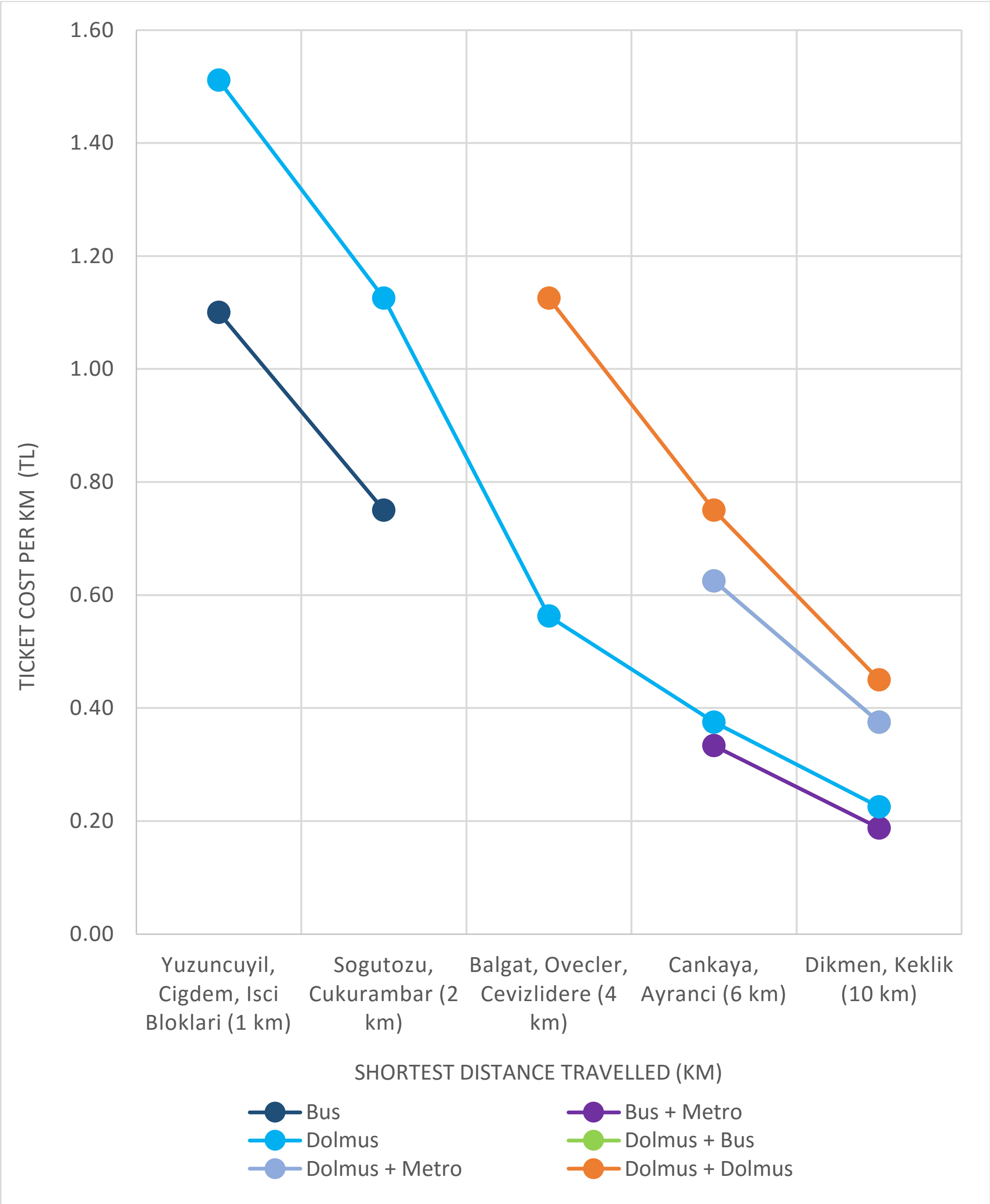


ZONE GROUP 5 (Other Zones) Ticket Cost (TL)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
Oran, Yildiz, Birlik, Tinaztepe (16 km)	16	-	-	-	-	2.25	3.75	-	4.50
Golbasi (18 km)	18	-	-	1.50	-	-	3.75	-	-

APPENDIX E

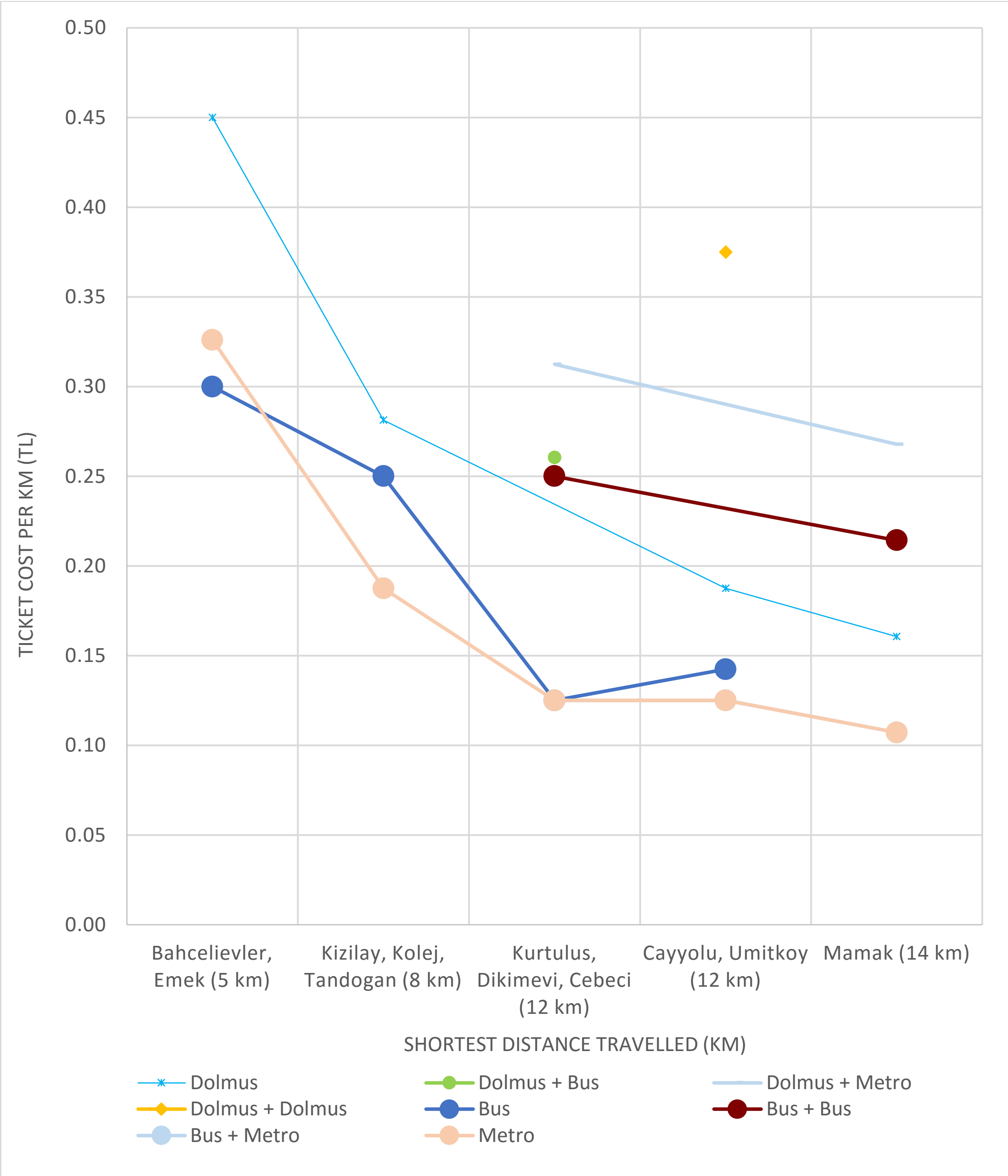
DETAILS OF TICKET COST PER KM-DISTANCE ANALYSIS

ZONE GROUP 1 (Direct Dolmus Service Corridor)



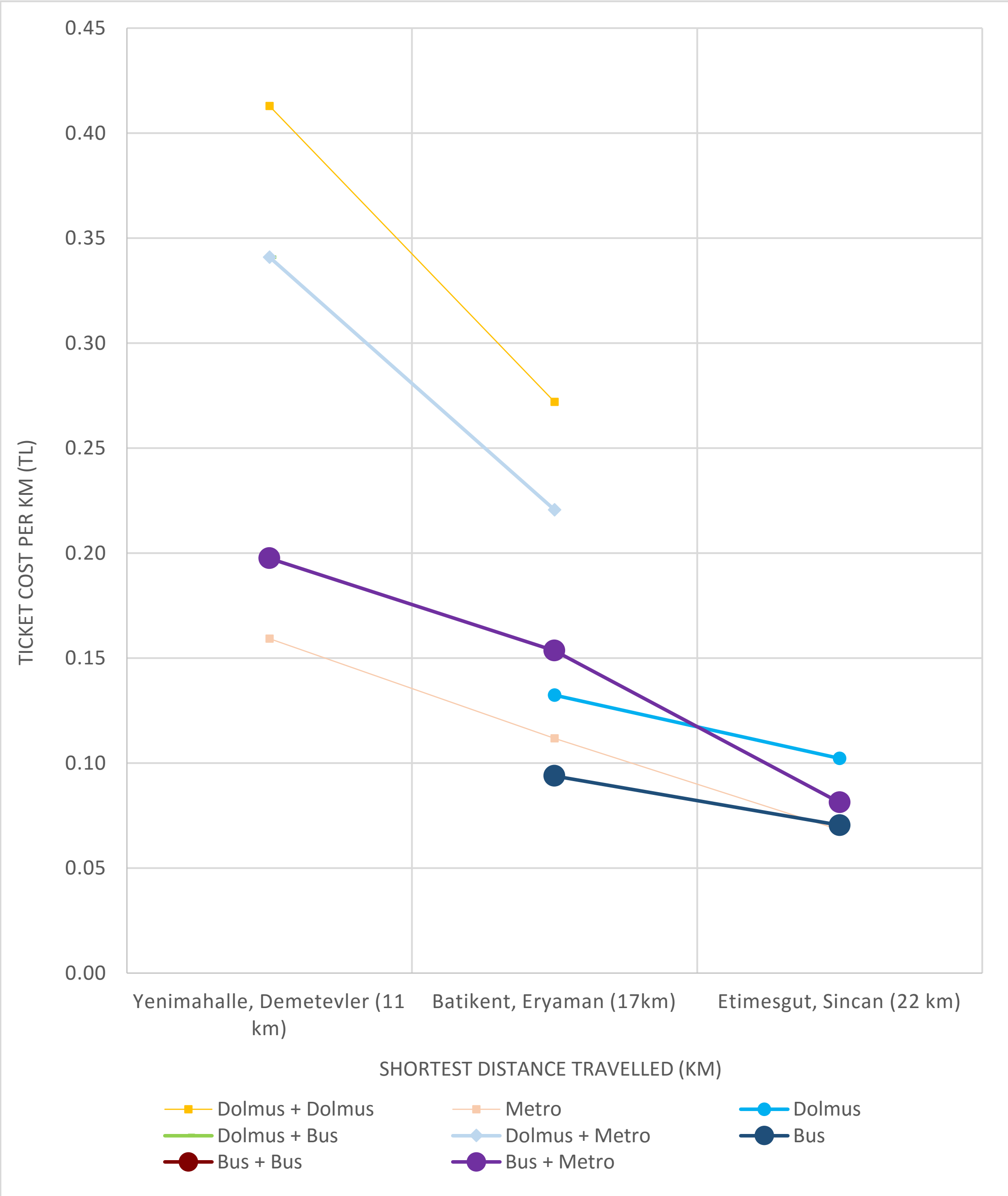
ZONE GROUP 1 (Direct Dolmus Service Corridor) Ticket Cost Per km (TL)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
Yuzuncuyil, Cigdem, Isci Bloklari (1 km)	1	1.10	-	-	-	1.51	-	-	-
Sogutozu, Cukurambar (2 km)	2	0.75	-	-	-	1.13	-	-	-
Balgat, Ovecler, Cevizlidere (4 km)	4	-	-	-	-	0.56	-	-	1.13
Cankaya, Ayranci (6 km)	6	-	-	0.33	-	0.38	0.63	0.63	0.75
Dikmen, Keklik (10 km)	10	-	-	0.19	-	0.23	0.38	0.38	0.45

ZONE GROUP 2 (Direct Metro Service Corridor 1 / Ankaray + Koru Metro)



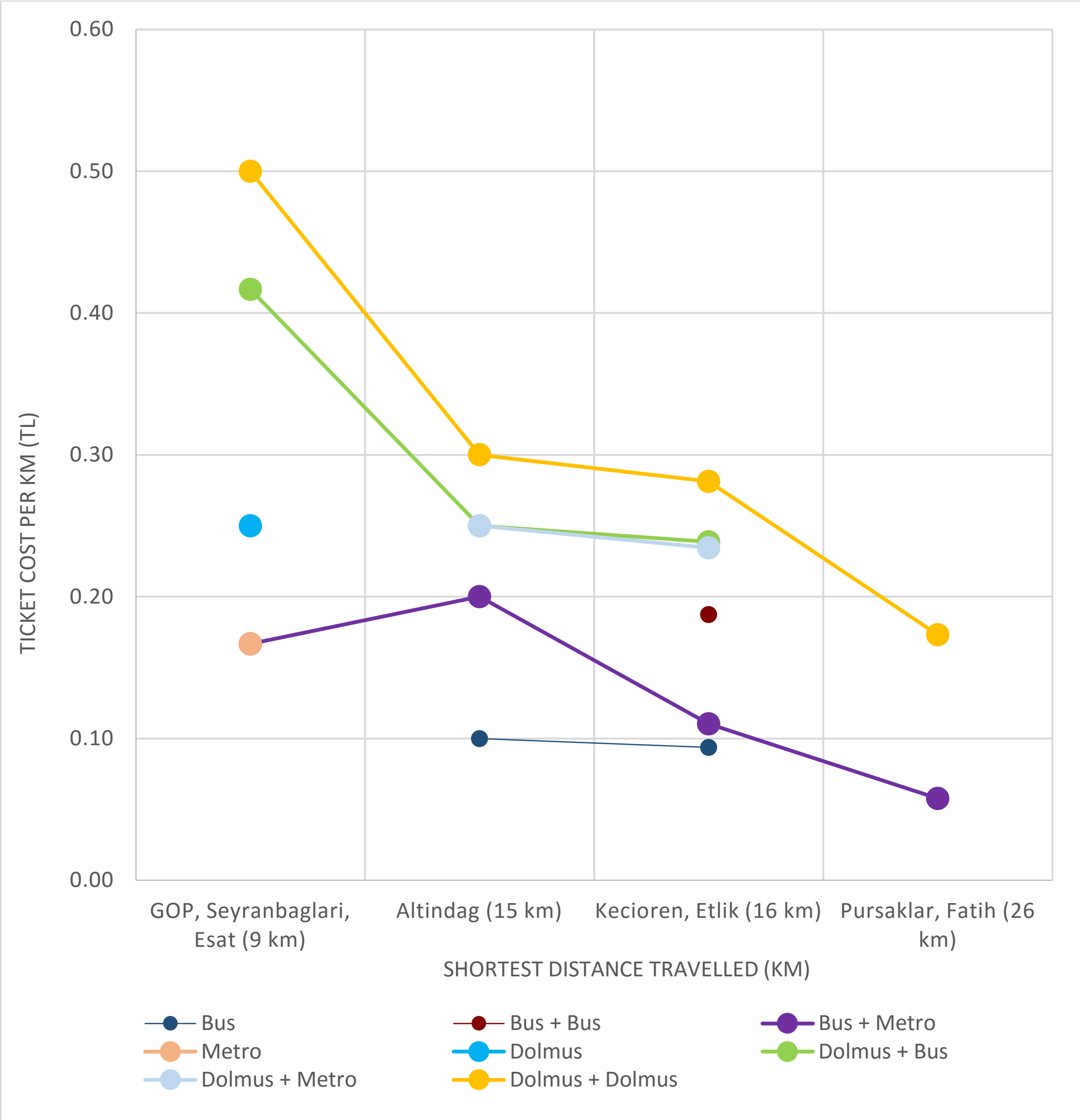
ZONE GROUP 2 (Direct Metro Service Corridor 1 / Ankaray+Koru Metro) Ticket Cost Per km (TL)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
Bahcelievler, Emek (5 km)	5	0.30	-	-	0.33	0.45	-	-	-
Kizilay, Kolej, Tandogan (8 km)	8	0.25	-	-	0.19	0.28	-	-	-
Kurtulus, Dikimevi, Cebeci (12 km)	12	0.13	0.25	0.13	0.13	-	0.26	0.31	-
Cayyolu, Umitkoy (12 km)	12	0.14	-	0.13	0.13	0.19	-	-	0.38
Mamak (14 km)	14	-	0.21	0.11	0.11	0.16	-	0.27	-

ZONE GROUP 3 (Direct Metro Service Corridor 2 / Batıkent+Koru Metro)



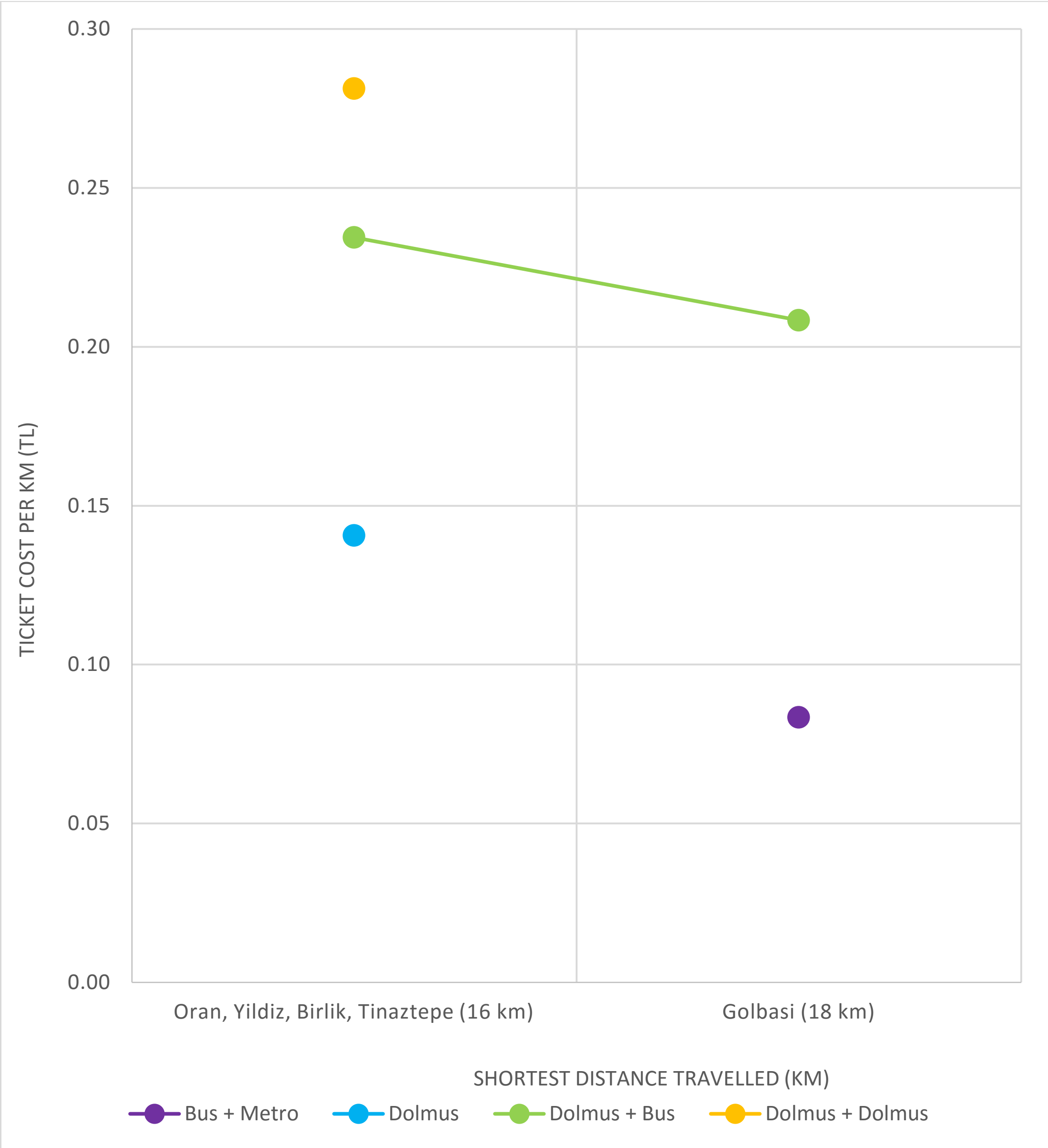
ZONE GROUP 3 (Direct Metro Service Corridor 2 / Batıkent+Koru Metro) Ticket Cost Per km (TL)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
Yenimahalle, Demetevler (11 km)	11	-	-	0.20	0.16	-	0.34	0.34	0.41
Batikent, Eryaman (17km)	17	0.09	-	0.15	0.11	0.13	-	0.22	0.27
Etimesgut, Sincan (22 km)	22	0.07	-	0.08	0.07	0.10	-	-	-

ZONE GROUP 4 (Transferred Patterns Territory)



ZONE GROUP 4 (Transferred Patterns Territory) Ticket Cost Per km (TL)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
GOP, Seyranbaglari, Esat (9 km)	**9**	-	-	0.17	0.17	0.25	0.42	-	0.50
Altindag (15 km)	15	0.10	-	0.20	-	-	0.25	0.25	0.30
Kecioren, Etlik (16 km)	16	0.09	0.19	0.11	-	-	0.24	0.23	0.28
Pursaklar, Fatih (26 km)	26	-	-	0.06	-	-	-	-	0.17

ZONE GROUP 5 (Other Zones)



ZONE GROUP 5 (Other Zones) Ticket Cost Per km (TL)									
Zone Distance From Campus / Travel Pattern	**Shortest Distance (km)**	**Bus**	**Bus + Bus**	**Bus + Metro**	**Metro**	**Dolmus**	**Dolmus + Bus**	**Dolmus + Metro**	**Dolmus + Dolmus**
Oran, Yildiz, Birlik, Tinaztepe (16 km)	16	-	-	-	-	0.14	0.23	-	0.28
Golbasi (18 km)	18	-	-	0.08	-	-	0.21	-	-