TRUCK FREIGHT TRANSPORTATION CHARACTERISTICS IN TURKEY

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Submission for track: B: Freight Transport and Logistics Systems

ABSTRACT

Today, freight transportation is growing even more rapidly than passenger transportation. Furthermore, it is continuing to shift towards road, and trucking dominates the freight transportation in many countries, including Turkey. Trucking captures almost 90% of the freight transportation in Turkey. Therefore, it is very important to investigate characteristics and efficiency of these movements before developing any policies to decrease dominance of road freight. Unfortunately, road freight transportation has not been studied in detail in Turkey, due to lack of disaggregate commodity flow data. Consequently, this study aims to present general characteristics of road freight movements using roadside axle survey data.

Keywords: Truck freight in Turkey, network assignment principle, shortest path, roadside axle surveys.

1. INTRODUCTION

Today, freight transportation demand is growing even more rapidly than passenger transportation demand and it is expected to continue in the future (Kahn Ribeiro et al., 2007). Furthermore, freight transportation is continuing to shift towards road, and trucking dominates the freight transportation in many countries, including Turkey (Steenhof et al., 2006; Kamakate and Schipper, 2009). Trucking also captures almost 90% of the freight transportation in Turkey (TurkStat, 2012a). Therefore, it is very important to investigate characteristics and efficiency of these movements before developing any policies to dominance of road freight. Unfortunately, road freight transportation has not been studied in detail in Turkey, due to lack of disaggregate commodity flow data. Unal (2009) provided the only national level forecasts for the trip generation and distribution of road freight for the

period of 1996-2004. Consequently, this study aims to present general characteristics of road freight movements using roadside axle survey data. The structure of the paper is as follows: after a brief review of literature on aggregate freight transportation statistics, detailed analysis of roadside axle surveys were presented in Section 3. Network assignment principle of the road freight movements was discussed in Section 4. Conclusions were presented in Section 5.

2. AGGREGATE FREIGHT TRANSPORTATION STATISTICS

Table 1 presents aggregate statistics on freight volumes for different transportation modes in Turkey during the period 2001 to 2009. Road freight accounted for almost 90% of the freight transportation in the last decade. The remaining demand was shared between maritime and railway modes. Air transportation have almost negligible freight transportation share in Turkey. These statistics prove the predominance of trucking in the freight transportation.

Table 1 - Freight transportation ton-km for different modes in Turkey, 2001-2009 (in billion) (TurkStat, 2012a)

	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Road	151.4	150.9	152.2	156.9	166.8	177.4	181.3	181.9	176.5
(%)	(86.9)	(89.3)	(88.9)	(90.2)	(91.3)	(91.4)	(90.3)	(89.3)	(89.0)
Maritime	15.0	10.6	10.0	7.3	6.4	7.1	9.6	11.1	11.4
(%)	(8.6)	(6.3)	(5.8)	(4.2)	(3.5)	(3.6)	(4.8)	(5.5)	(5.8)
Railway	7.6	7.2	8.7	9.4	9.2	9.7	9.9	10.7	10.3
(%)	(4.3)	(4.3)	(5.1)	(5.4)	(5.0)	(5.0)	(4.9)	(5.3)	(5.2)
Air	0.3	0.3	0.3	0.4	*	*	*	*	*
(%)	(0.2)	(0.2)	(0.2)	(0.2)					
Total	174.3	169. 0	171. 1	173. 9	182. 8	194. 1	200. 9	203. 8	198. 2

* There is no published data for this year.

Table 2 presents annual road freight transportation activity in the period 2001 to 2009 in detail. It is seen that, although an overall growth of 17% was observed in terms of ton-km transported, truck vehicle-km demand increased less than 5%. Analysis of the annual aggregate values based on truck types showed that the market share of articulated trucks have been increasing with the decreasing share of rigid trucks in the road freight movements in Turkey. This situation might be the reason behind the increasing overall ton-km values despite the constant vehicle-km values, as articulated trucks have higher load carrying capacity.

Table 2 - Road freight transportation ton-km and vehicle-km in Turkey, 2000-2009 (in billion) (TGDH, 2011)

Year	Ton-Km				Vehicle-Km				Total	
	Rigid Trucks	(%)	Articulated Trucks	(%)	Rigid Trucks	(%)	Articulated Trucks	(%)	Ton-Km	Vehicle-Km
2001	129.9	(85.8)	21.5	(14.2)	14.4	(91.4)	1.3	(8.6)	151.4	15.7
2002	128.2	(85.0)	22.7	(15.0)	14.2	(91.2)	1.4	(8.8)	150.9	15.6
2003	128.8	(84.6)	23.4	(15.4)	14.3	(91.0)	1.4	(9.0)	152.2	15.7
2004	122.0	(77.7)	34.9	(22.3)	11.2	(84.6)	2.1	(15.4)	156.9	13.3
2005	127.3	(76.3)	39.5	(23.7)	12.0	(83.3)	2.4	(16.7)	166.8	14.4
2006	130.9	(73.8)	46.5	(26.2)	12.4	(81.4)	2.8	(18.6)	177.4	15.2
2007	128.8	(71.0)	52.6	(29.0)	12.7	(79.2)	3.3	(20.8)	181.3	16.1
2008	124.2	(68.3)	57.7	(31.7)	12.3	(77.0)	3.7	(23.0)	181.9	16.0
2009	107.5	(60.3)	68.8	(39.7)	11.3	(69.1)	5.1	(30.9)	176.5	16.4

Turkish General Directorate of Highways (TGDH) annually publishes statistics on freight transportation volumes on different road categories (See Table 3). In 2009, 72% of the freight transportation occurred on state roads. The total freight volume on motorways was 23%. Provincial roads which are generally in urban sections, accounted for only 5% of the freight demand in Turkey (TGDH, 2012).

Table 3 - Road freight transportation volumes on different road segments, 2005-2009 (in billion) (TGDH, 2012)

Year	Vehicle-Km				Ton-Km			
	State Roads	Motorways	Provincial Roads	Total	State Roads	Motorways	Provincial Roads	Total
2005	10.6	2.9	0.9	14.4	128.3	28.5	10.0	166.8
(%)	(74.0)	(19.8)	(6.2)	(100)	(76.9)	(17.1)	(6.0)	(100)
2006	11.0	3.3	0.9	15.2	134.4	32.9	10.1	177.4
(%)	(72.5)	(21.7)	(5.9)	(100)	(75.7)	(18.6)	(5.7)	(100)
2007	11.7	3.5	0.8	16.1	137.0	34.5	9.9	181.3
(%)	(72.6)	(21.6)	(5.7)	(100)	(75.5)	(19.0)	(5.5)	(100)
2008	11.5	3.6	0.9	16.0	135.4	36.9	9.4	181.9
(%)	(72.0)	(22.5)	(5.5)	(100)	(74.5)	(20.3)	(5.2)	(100)
2009	11.7	3.8	0.9	16.4	127.2	40.5	8.7	176.5
(%)	(71.5)	(23.1)	(5.3)	(100)	(72.1)	(23.0)	(4.9)	(100)

3. ROADSIDE AXLE SURVEYS

While local authorities are responsible on provincial roads, TGDH is the only responsible authority to collect data on intercity roads (state roads and motorways) in Turkey. Their regularly performed roadside axle surveys provides only source of disaggregate data sample for national freight transportation in Turkey, as there is no commodity flow data available. TGDH has 17 regional divisions and each regional division performs axle load surveys at minimum two or three locations every year. Figure 1 shows the location of the roadside axle surveys between 2007 and 2009 (TGDH, 2011). On average 10,000 trucks are surveyed at a total of more than 40 survey locations each year, which covers the almost every region of the country. As the winter conditions do not allow performing these surveys, surveys are not conducted in the winter. During these surveys, randomly selected trucks are stopped at the roadside according to predetermined sampling ratio, and then they are weighted and interviewed. For each surveyed truck, a set of data is collected, including locational information (e.g. date, time, direction and hourly traffic volumes); vehicular information (e.g. license number, truck type, axle type, maximum gross weight); trip information (e.g. origin-destination county and city of the trip); and commodity type.

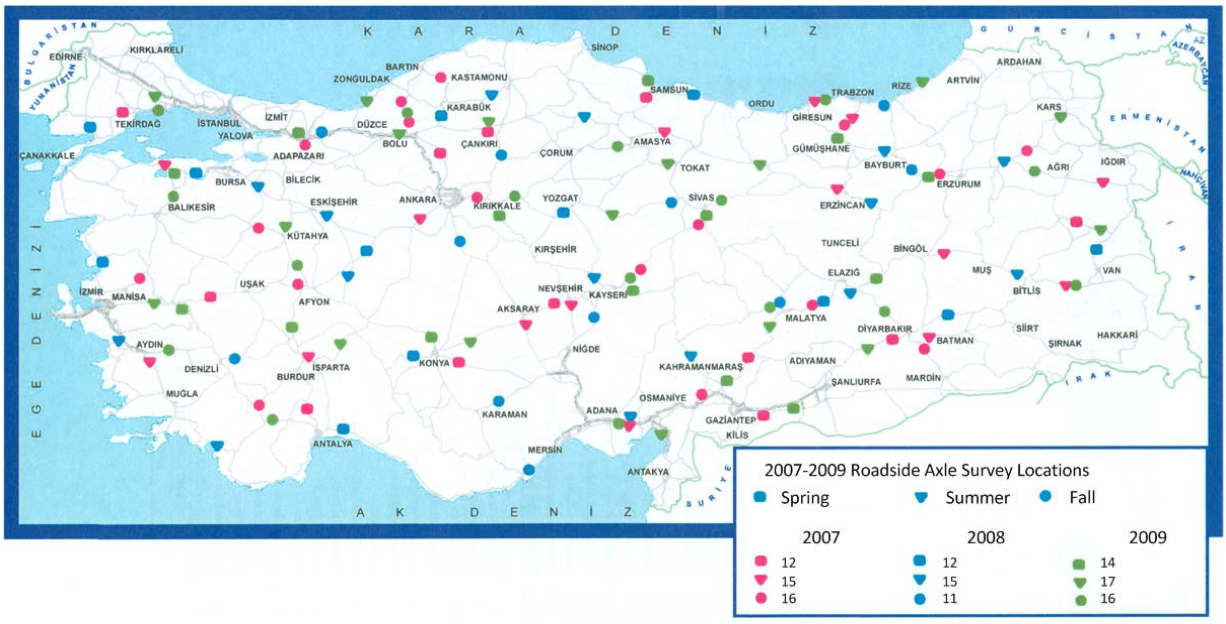

Figure 1 - Roadside axle survey locations, 2007-2009 (TGDH, 2011)

It should be noted here that, roadside axle surveys are capable of capturing mostly inter-city truck movements as they are performed on intercity roads, and do not provide any insight on

the intra-city movements, which are excluded from scope of this study. Further details of the roadside axle surveying methodology were discussed by Ozen and Tuydes-Yaman (2012). During surveys automatic traffic counting and classification are also performed at the survey section to ensure sampling ratio. The further details of sampling methodology are presented by TGDH (2011). The following subsections provide roadside axle survey statistics based on truck types, emission legislations and commodity types and trip distances.

3.1 Truck Type Statistics

Table 4 presents number of surveyed trucks for different gross vehicle weight sizes of rigid and articulated trucks, and their corresponding average trip distances. As it is seen, only certain sizes of trucks are used in road freight movements in Turkey. Truck movements are mostly performed by rigid trucks with maximum gross vehicle weight of 20-26 ton, and 28-32 ton; and articulated trucks of 28-34 ton, 34-40 ton and 40-50 ton.

Table 4 - Truck type statistics on roadside axle surveys

Truck Type	2007		2008		2009	
	No. of Trucks	Avg. Trip Distance (Km)	No. of Trucks	Avg. Trip Distance (Km)	No. of Trucks	Avg. Trip Distance (Km)
R. < 7.5 t	548	281	341	331	459	288
R. 7.5 – 12 t	286	307	233	346	342	290
R. 12 – 14 t	66	330	74	343	93	355
R. 14 – 20 t	313	398	251	386	397	393
R. 20 – 26 t	**4638**	515	**2642**	500	**3966**	474
R. 26 – 28 t	31	339	147	470	23	522
R. 28 – 32 t	**2208**	486	**1490**	475	**2521**	452
R. > 32 t	12	495	275	514	16	534
Rigid Trucks	**8102**	**477**	**5453**	**468**	**7817**	**443**
A. 14 – 20 t	---	---	---	---	18	424
A. 20 – 28 t	18	484	17	438	107	443
A. 28 – 34 t	131	678	85	557	**599**	513
A. 34 – 40 t	**708**	751	**485**	627	**877**	642
A. 40 – 50 t	**2613**	683	**2004**	648	**2666**	585

Truck Type	2007		2008		2009	
	No. of Trucks	Avg. Trip Distance (Km)	No. of Trucks	Avg. Trip Distance (Km)	No. of Trucks	Avg. Trip Distance (Km)
A. 50 – 60 t	---	---	60	542	2	1045
Articulated Trucks	**3470**	**696**	**2651**	**638**	**4269**	**583**
All Trucks	**11572**	**543**	**8104**	**524**	**12086**	**492**

It should be noted that, there might be some bias in the sampling of the roadside axle surveys against very heavily loaded trucks. It was mentioned by Unal (2009) that such trucks were not stopped during these surveys, as it is not safe to stop and measure them on the roadside. However, the percentage of such truck movements was expected to be small, and not endangering the sampling capacity of the surveys. There is a slightly decreasing trend in the average trip distance of the truck movements. The average trips distance of the all movements decreased from 543 km to 492 km between 2007 and 2009. There is also a strong correlation between maximum gross vehicle weight and average trip distance (r_{rigid} = 0.79 and $r_{articulated}$ = 0.73). Besides, articulated trucks were preferred longer distance than rigid trucks (i.e. average trip distances of the articulated trucks were higher than those of rigid trucks).

3.2 Emission Legislation Statistics

Freight transportation is responsible about one-quarter of the transportation sector emissions in Turkey (Ozen and Tuydes-Yaman, 2012). As a European Union Candidate State, Turkey signed Kyoto Protocol in 2009. This requires reducing emissions from every sector, including transportation. Therefore, it is also important to know European emission legislations of the trucks in the freight market. However, there is no published statistics on the matter for Turkey. Besides, heavy truck emission legislations have not been followed in a timely manner in Turkey. Truck diesel engine emissions were first regulated with Euro I legislation in 2001. Thus, diesel vehicles of pre-Euro I can be all grouped together under the Conventional legislation. Euro II and Euro III legislations were not introduced in Turkey. Then, Euro IV legislation was introduced in 2008. Euro V legislation which was introduced in 2008 in the European Union, still has not been introduced for diesel engines in Turkey, yet. If the data by published by Turkish Statistical Institute (TurkStat, 2012b) for production year of the trucks is used to estimate emission legislations, it is possible to construct the shares of

European emission legislations in truck vehicle fleet in Turkey (see Table 5). According to this estimation, two thirds of the trucks produced before 2001 and had Conventional legislation in 2009. Penetration of the Euro I and Euro IV trucks were 27% and 8%, respectively. As similar, emission legislations of the survey trucks can be estimated using production year data. Even though Conventional trucks still captured the highest share with 65.3% in the truck vehicle fleet in 2009, they accounted for only 29.8% of the survey sample. Euro I trucks were observed more frequently in the surveys, despite their relatively slow penetration into the vehicle park. The share of Euro IV trucks were around 15% in 2009, which is almost twice their percentage in the vehicle park (see Table 5). The average trip distance (calculated by dividing the total vehicle-km by total number of trucks) was 520 km for Euro I trucks. The average trip distances of Euro IV and Conventional trucks were 482 km and 447 km, respectively. These might be an indication of a trend of using the new and cleaner trucks in longer distances in road freight movements. In addition, it shows the employment of more efficient technologies in the longer hauls as a natural evolution of commercial freight sector.

Table 5 - Estimated shares of European emission legislations

Year	Vehicle Park (%)			Road Side Axle Surveys (%)		
	Conventional	Euro I	Euro IV	Conventional	Euro I	Euro IV
2007	70.8	29.2	---	37.2	62.1	0.7
2008	67.5	27.8	4.6	30.8	59.8	9.4
2009	65.3	26.9	7.8	29.8	55.2	15.1

3.3 Loading Factor Statistics

Besides the fleet characteristics, it is important to study the loading factors of the truck freight to get an idea of the efficiency in the sector. Table 6 summarizes general overview of the empty running, average loading and payload of the surveyed trucks in Turkey. “Empty run” can be defined as the movements with less than 5% loading condition. Table 8 also presents average trip distance of empty movements (e.g. Type 0 movements are empty). Share of empty surveyed trucks was more than 25.0% in all survey years. Furthermore, they were accounted more than 30% of the surveyed trucks and 22.3% of the vehicle km in 2009 (see Table 6 and Table 8). These values are in the range of 25% average empty running in EU countries (McKinnon and Edwards, 2010). Assuming this sample percentage as an estimator for the national market, it can be estimated that 3,645 million-km of the road freight

movements was driven empty in 2009. The empty running percentage of articulated trucks was higher than rigid trucks. The average trip distance of all empty movements was 370 km between 2007 and 2009, which was less than average trip distance of the all commodity types. Even though, empty movements are partly unavoidable as nature of in freight transportation, if the share of empty movements is reduced, the efficiency of freight transportation can be greatly increased (McKinnon and Edwards, 2010).

Table 6 - Empty run vehicle-km, average loading factor, and average payload in the roadside axle surveys

Year	Empty Run Vehicle-Km (%)			Average Loading Factor (%)*			Average Payload (Ton)		
	Rigid	Articulated	Total	Rigid	Articulated	Total	Rigid	Articulated	Total
2007	17.4	22.5	19.3	74.1	77.1	75.0	10.8	15.5	12.6
2008	18.6	21.2	19.5	72.6	71.7	72.3	10.4	14.7	12.1
2009	19.8	25.8	22.3	73.1	78.7	75.0	10.4	14.0	11.9

* Does not include empty movements.

Average loading factor and payload are closely related factors and depend on the composition of vehicles in the freight market. The average loading factor of the laden trips was 75% in 2009. Besides, average payload per truck was 12 ton which is within the average pay load range of 7 ton to 16 ton in the EU countries (Piecyk and McKinnon, 2010). Figure 2 compares average trip distance of the empty and laden movements. Trip distance of the 68% of the empty movements and 40% of the laden movements were less than 500 km which can be considered as short haul in the Turkish highway network. Only for 10% of the empty and 22.8% of the laden trucks, average trip distance was longer than 1000 km.

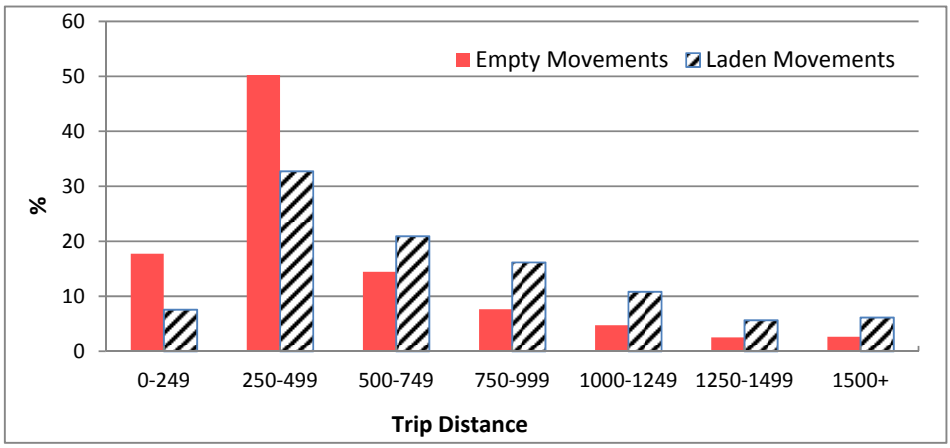

Figure 2 – Trip distance distribution of the empty movements

3.4 Commodity Type Analysis

TGDH adopted NST 2007 commodity classification system (ECE, 2008), which has twenty commodity type categories and the empty movement (see Table 7). The empty runs are also analysed under the loading factor statistics. To analyse the freight statistics of the Commodity types 1 to 20, a summary table is prepared for the three consecutive years (see Table 8). The important points of the commodity type analyses can be summarized as follows:

Table 7 - NST 2000 commodity type classification (ECE, 2008)

Type	Commodity Types	Type	Commodity Types
0	Empty	11	Machinery and equipment n.e.c.
1	Products of agriculture, hunting, and forestry	12	Transport equipment
2	Coal and lignite; peat; crude petroleum	13	Furniture; other manufactured goods n.e.c.
3	Metal ores and other mining products	14	Secondary raw materials
4	Food products, beverages and tobacco	15	Mail, parcels
5	Textiles and textile products	16	Equip. and mat. utilized in the transport of goods
6	Wood and products of wood and cork	17	Goods moved in the course of household
7	Coke, refined petroleum products	18	Grouped goods
8	Chemicals, chemical products	19	Unidentifiable goods
9	Other non-metallic mineral products	20	Other goods n.e.c.
10	Basic metals; fabricated metal products		

- Food products (Type 4) were the main commodity types in terms of average number of surveyed vehicles with 11% share between 2007 and 2009.
- Product of agriculture (Type 1) and other non-metallic mineral products (Type 9) were the second and third major observed commodity types with the 11% and 8% shares, respectively.
- Metal ores (Type 3) and coal and lignite (Type 2) accounted for the maximum average payload per truck (i.e. more than 20 ton/vehicle). They accounted for overloaded cases in 2008 and 2009 in terms of loading factor. But, average trip distances of these commodities were almost lower than all other commodity types.
- Textile products (Type 5) (carried by approximately 2% of vehicles) had the longest average trip distance with over 800 km.

- Equipment and materials utilized in the transport of goods (Type 16) and goods moved in the course of household (Type 17) accounted for the lowest average loading factors (i.e. less than 50%).

However, it should be remembered that loading factor is a weight based measure and it may underestimate actual utilization of vehicle in sectors where vehicle capacity is defined by volume rather than weight (McKinnon, 2009). More can be said about the commodity flows in Turkey, if the origin-destination information for each surveyed truck would be added to the commodity based analysis, which would be the focus of next step in this research.

Table 8 - Commodity type analysis of the roadside axle surveys

Type	No of Trucks (%)			Average Trip Distance (Km)			Average Pay Load (Ton)			Average Loading (%)		
	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
0	27.5	25.9	30.6	377	389	354	---	---	---	---	---	---
1	9.6	11.4	9.9	610	609	602	15.6	15.5	16.1	90	83	90
2	3.6	3.2	2.8	360	358	419	20.0	23.4	22.1	96	108	105
3	4.2	5.6	5.5	362	388	378	22.8	20.6	20.6	116	91	103
4	11.8	11.9	11.2	624	553	549	15.2	14.6	15.0	87	82	91
5	2.0	1.7	2.1	886	965	739	14.1	13.2	13.2	82	68	75
6	2.7	3.4	3.4	611	525	538	14.4	14.1	14.4	78	72	80
7	4.6	5.2	5.6	427	373	393	18.4	16.8	16.2	94	92	87
8	4.0	3.0	3.2	767	724	650	14.4	14.9	14.0	76	75	75
9	8.6	8.0	7.1	527	490	478	17.9	18.6	18.6	91	87	96
10	3.1	3.5	4.2	653	664	544	16.2	16.2	17.7	80	74	88
11	3.7	3.3	2.1	776	702	721	9.9	10.0	9.9	58	56	62
12	1.5	0.6	1.2	970	821	953	13.6	11.1	11.2	71	59	55
13	2.8	2.6	2.5	662	652	658	8.7	9.0	8.7	61	55	62
14	0.7	0.9	0.9	556	522	460	14.9	17.5	15.4	88	98	79
15	0.4	1.0	0.2	736	655	719	11.8	8.3	4.6	77	62	39
16	1.2	0.5	1.3	452	507	354	6.4	9.4	8.0	38	49	42
17	1.6	1.7	1.6	756	783	782	7.0	7.8	7.6	50	54	56
18	3.0	2.8	2.8	759	816	625	10.4	11.3	9.5	67	64	70
19	0.6	0.4	0.6	573	559	694	12.9	12.1	11.6	59	49	59
20	2.7	3.5	4.3	593	576	624	12.2	10.9	13.4	70	58	75

4. THE TRUCK FREIGHT NETWORK ASSIGNMENT IN TURKEY

In the literature, mostly a simple static all-or-nothing assignment procedure was considered for intercity freight movements, as they are mostly on state roads and motorways; and not subject to congestion effects. In Turkey, the situation is similar with an average trip distance of 500 km and only 5% of them were on provincial roads. Even for the all-or-nothing assignment, one has to define the shortest path (SP) that all the trucks would be assigned. In the absence of any study on the issue, it is possible to test some SP definitions and verify them by comparing the roadside axle survey location and stated O-D (Origin-Destination) information of each surveyed truck. To start with, two different SP definitions were tried to differentiate travel time and travel distance measures as assignment principles: a) time-based shortest path (TbSP) assignment, and b) distance-based shortest path (DbSP) assignment.

Time-based SP (TbSP)*:* This was the path with the shortest truck travel time, calculated as the sum of the link travel times calculated by dividing the link lengths by average truck speeds on the links. On state roads links, space mean speeds for truck (rigid and articulated) measured and published annually by TGDH (TGDH, 2012). Average truck mean speeds on provincial roads were assumed as 40 km/h, which accounted for only 5% of the truck routes in general (see Table 3).

Distance-based SP (DbSP)*:* This was the path with the shortest travel distance calculated as the sum of the lengths of the links on the path. State, provincial and motorway road segment lengths published by TGDH (2012) were used to calculate distance-based shortest paths.

The comparison of the survey locations and two SP definitions for 8104 intercity trucks surveyed in 2008, revealed that 72.3% of the trucks were on a location both on time- and distance-based SPs (see Table 9). Survey location of the 785 trucks (9.7%) was on only shortest time path, while survey location of the 99 trucks (1.2%) trucks was on only distance-based SP. Survey location of the remaining 1363 trucks (16.8%) was neither on TbSP or DbSP, which might be due many things, such as trip chaining behaviour, closed links, or links under construction in that given year. These results suggested that an all-or-nothing assignment with a TbSP principle would verify more than 80% of the truck travels; if speed data is not obtained, a simple DbSP assignment would also be able to explain up to approximately 75% of the truck trips. As the majority of the trucks were surveyed at a

location both on TbSP and DbSP, it is important to study the difference between the two for Turkey. As an example, for the City of Mersin, which has one of the biggest port in Turkey, and therefore, is a main freight transportation demand center, time- and distance-based SP trees are presented in Figure 3.

Table 9 - Evaluation of network assignment principles of surveyed trucks

Survey location on	No. of Trucks	(%)
"Both time-based SP" and "distance-based SP"	5857	72.3
"Only time-based SP"	785	9.7
"Only distance-based SP"	99	1.2
"Either time-based SP or distance-based SP"	6741	83.2
Other Location	1363	16.8

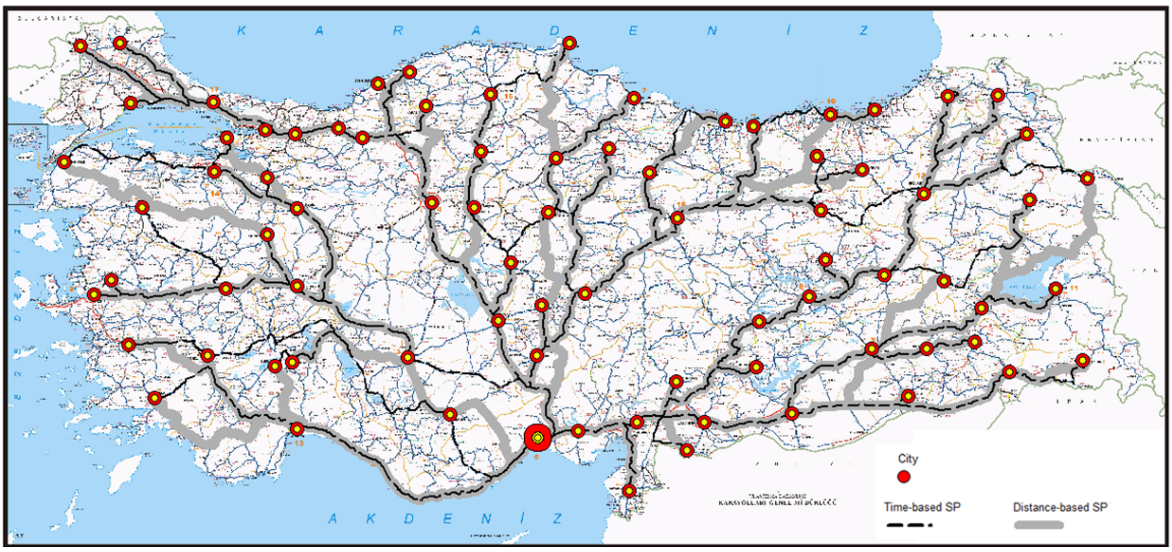

Figure 3 - Intercity distance and time based SP trees of the City of Mersin

As it is seen, there are only minor differences between time- and distance-based SP trees which can be explained by lack of high level connectivity in the current road network in Turkey and lack of congestion on majority of the intercity roads. A country wide analysis of the cities showed a similar pattern, showing a major overlap of TbSP and DbSP definitions. Thus, a 72.3% of trucks were not captured on both TbSP and DbSP unexpectedly.

5. CONCLUSIONS

Turkey as a European Union candidate state, signed Kyoto Protocol in 2009, which required reduction in the greenhouse gas emissions. Road freight transportation accounts for a quarter of the transportation-based emissions, so it is one of the implementation areas for emission reductions. Therefore, is important to figure out current condition and efficiency of the freight movements to develop better policy options to decrease the resulting emissions as well as to determine potential for future intermodal freight movements. Therefore, this study aims to present general characteristics of road freight movements using roadside axle survey data.

It was observed that the market share of rigid truck has been decreasing in terms of ton-km and vehicle-km; the remaining demand being supplied by articulated trucks with increasing market share in truck movement in Turkey. Furthermore, new and cleaner trucks are generally preferred in longer distances. In 2009, 22% of the road truck vehicle-km is performed empty in Turkey, which was very close to 25% average empty running in EU countries. Using NST 2000 commodity type definition used by TGDH, food products, products of agriculture and other non-metallic mineral products are the major transported commodity types ın Turkey. More detailed analysis based on the origin-destination of commodity flows may give more insights on the regional characteristics of truck freight demand in Turkey. Investigation of the roadside axle surveys showed that more than 80% truck trips are observed on their time-based shortest path. Survey location of the remaining 1t%) was neither on TbSP or DbSP, which might be due many things, such as trip chaining behaviour, closed links, or links under construction in that given year.

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