A SOLUTION FOR TRAFFIC JAM IN ISTANBUL ON EAST/WEST DIRECTION

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Abstract İstanbul is a big city, located on east-west direction and enlarging every day on both direction with full of people living and working on both sides of city and utilizing two bridges both by private cars and by urban transport vehicles. At the same time, İstanbul is a city connecting east-west road freight transit transportation, but unfortunately having only one bridge to be used by transit vehicles. Based on year 2013 figures, daily 173.579 private cars and small vehicles and 1.700 buses passed over Bosphorus Bridge while there are daily 180.318 private cars and small vehicles and 10.200 trucks and trailers and heavy vehicles for Fatih Sultan Mehmet Bridge. The purpose of this study is to determine the benefits of new RoRo lines between Tuzla – Ambarlı on bases of minimizing CO2 emission, number of trucks and trailers diverted from bridges to sea, saving on fuel consumption and time on route gained by diverting these vehicles to new Roro lines.

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1. INTRODUCTION

İstanbul is a big metro city which is geographically located on the east-west direction and enlarging continuously on European and Asian side together with people both living and working on both sides who are using currently two bridges and in the close future including a third one, by both private cars and taxis and public transportation.

Turkey is geographically like a bridge between east and west and this bridge is used commonly as a transit route mainly by road freight and for the time being there is only one bridge, Fatih Sultan Mehmet Bridge FSM, to be used by this international trade activities and this is an important effect on city life since this bridge is also used by urban transportation.

We should take into account that consuming goods within the city plus raw material and semi raw materials to and from the city is also transported via FSM bridge regularly and in both ways and this is also an additional impact on daily city traffic.

These three items which are urban life private and public transportation plus urban logistics in and out transportation and international transit transportation are being served by only two bridges on the Bosphorus. The 3rd bridge which will be opened within 2-3 years time, will have a positive effect to minimize the traffic jam on these two bridges but it will not be long since the population and consuming is increasing every year for Istanbul city.

The usage of the sea, on both north and south of the city, for transportation is far below the expectations. The main solution is “The Sea”. The carriage of transit trucks and the trucks coming out of the city and heading the other side of the Bosphorus on east – west direction, by RoRo ships will be the real solution for minimizing the traffic on bridges. Roll-on/Roll-off ships are used for transport of vehicles and other rolling equipment.

For the time being during rush hours between 0600-1000 and 1600-2200, usage of FSM bridge by trucks is forbidden. But still the traffic jam is one of the main reasons of stress for the citizens. By the end of limited time the waiting trucks are starting to move and then the traffic jam increasing more and then rush hours are exceeding then the planned one. During these periods the average speed on roads connecting the bridge is 5-6 km per hour. This is totaly waste of energy.

Waste of energy means waste of fuel, waste of electricity, waste of man power, stress, increasing CO2 emissions, loss of amortisation of vehicles and waste of money.

The aim of this study is to determine the time and cost savings and positive side effects of carriage of the vehicles which are using mainly FSM bridge for both international and national trades, by a RoRo (roll on / roll off) vessel system operating on east – west direction by terminals located on European and Asian side of the city. The topics of these benefits are listed as below:

- Minimizing traffic jam on bridges and connecting roads

- Saving of fuel consumption and minimizing CO2 emissions
- Minimizing the transport time for urban people using the bridges and minimizing the stress arising from traffic jam

First of all, information has been recorded with a market survey by questioning the truck drivers, who use FSM bridge, during limited time period 0600-1000 and 1600-2200. Later on, the new transport system is explained together with time schedule and capacity of RoRo vessels. As a final step, the benefits and savings of usage of new system is explained.

2. RELEATED LITERATURE

When we have searched the literature we have seen that for RoRo transportation there is no national study and there are limited international studies.

International studies and topics are listed below :

- “Some elements of RoRo terminals”, Planning and management of terminal operations and receiving vehicles and minimizing the negative effect of these Operations on RoRo sailing times, (Maksimavicius, 2004).
- “The securing of rigid semi trailers on RoRo ships”, a mathematical model for securing rigid semi trailers on RoRo ships, (Turnbull & Dawson 1997).
- “Safety level of RoPax ships”, risk modelling and cost-effectiveness analysis for various scenarios, (Guarin & others, 2009).
- “Routing and scheduling of RoRo ships with stowage constraints”, taking appropriate decisions for correct stowage plans together with routing and scheduling of RoRo ships, (Ovstebo & others, 2011).
- “Quality indicators and capacity calculation for RoRo terminals”, as an alternative to road freight to improve RoRo ships service level determining the quality indicators and capacity calculation of RoRo terminals (Fusco and others, 2010).
- “Potential freight distribution improvements using motorways of sea”, analyzing the strategy taken by the cargo carrier by using RoRo ships for a better competition when using the motorways of sea (Fusco & others, 2012).
- “Optimization of stowage plans for RoRo ships”, a mathematical model for carriage of cargo on wheels by Roro ships based on predefined plans, including stowage plans for RoRo ships (Ovstebo & others, 2012).
- “Modelling port/ferry choice in RoRo freight transportation” incorporation of quantitative and qualitative methodologies for an investigation of port/ferry choice in the Ireland/UK and Ireland /Continental Europe markets, (Mangan & others, 2002).
- “Elements of risk analysis for collision and grounding of a RoRo passenger ferry”, analysis of collision and grounding of a RoRo passenger ferry by a software program (Otto & others, 2002).

When we have checked the national studies, we could not find a document especially for RoRo vessels. We have only found out a power point presentation mentioning partly about such a method.

National studies and topics, which are mainly focused on combined and intermodal transportation, are listed below :

- "Logistics & Transportation in Istanbul", evaluation of alternative bosphorus passage routes, (Alkan, 2010).
- "A combined algorithm for placement of rectangular vehicles in a ferry", a heuristic approach in order to find the best solution by abiding the restrictions of vehicle placement algorithm, (Paşalı, 2013).
- "The port location selection for combined transport by FAHP in Turkey", information about basic principles of operation on combined transport to determine the desirable characteristics to be selected ports for this kind of transportation and to prepare the preliminary study for port location selection for combined transport within Turkey, (Erdem, 2012).
- "Research into combined systems of transportation of goods and persons for lakes district" the research of current combined transportation of goods in Isparta and alternative proposals, (Göde, 2011).
- "A research on combined transport systems as an alternative to road transport in the Marmara region" suggestions for transferring the land route transportation to shipping systems so as to reach a more effective structure in the transportation sector of the Marmara region, (Tanır, 2009).
- "A study on the advantages of short sea shipping and its importance in co-mbined transport", comparison of short sea transport and combined transport mode as an alternative to road transportation mode, (Atar ve diğ., 2013)
- "Exhaus gas emissions from ships in Marmara sea" (Kılıç, 2009)

3. MODEL

Statistical number of vehicles using İstanbul FSM bridge is given in Table 1. For year 2013, total daily number of first class vehicles is 180.318 and fourth class is 9.991 (URL3).

Table 1 Total Number of Vehicles Passing by FSM Bridge on Yearly Basis

YEARS	VEHICLE CLASS								
	1.CLASS	2.CLASS	3.CLASS	4.CLASS	5.CLASS	6.CLASS	AVERAGE		TOTAL
	QUANTITY	QUANTITY	QUANTITY	QUANTITY	QUANTITY	QUANTITY	DAILY	MONTHLY	
2008	64.144.822	9.640.364	2.715.916	2.147.660	24.192	144.138	215.937	6.568.091	78.817.092
2009	64.080.688	9.571.764	2.532.486	2.020.398	17.954	155.938	214.738	6.531.602	78.379.228
2010	64.424.352	10.796.500	2.743.644	2.395.002	17.080	154.320	220.633	6.710.908	80.530.898
2011	65.670.476	11.695.142	2.790.562	3.137.066	36.308	149.482	228.710	6.956.586	83.479.036
2012	59.020.820	10.820.382	2.525.740	3.217.456	48.284	157.384	207.644	6.315.839	75.790.066
2013	65.816.326	11.978.890	2.519.542	3.646.908	76.558	2.254	230.248	7.003.373	84.040.478

1.CLASS	**VEHICLES WITH 2 AXLES WITH A DISTANCE LESS THEN 3,20 m (CARS, MOTOBIKES, TRUCKS, VANS, MINIBUS)**
2.CLASS	VEHICLES WITH 2 AXLES WITH A DISTANCE EQUAL AND MORE THAN 3,20 m (TRUCKS, VANS, PUBLIC BUSES JEEP, PICK UP, AMBULANCE, FUNERAL VANS)
3.CLASS	ALL VEHICLES WITH 3 AXLES (1st & 2nd CLASS WITH 1 ADDITIONAL AXLE)
4.CLASS	ALL VEHICLES WITH 4 & 5 AXLES (2nd CLASS WITH 1 ADDITIONAL AXLE), (1st CLASS WITH 2 ADDITIONAL AXLES)
5.CLASS	TRUCKS WITH 6 AND MORE THAN 6 AXLES
6.CLASS	MOTORBIKE WITH KGS TARTING FROM 14/04/2006 // KGS is a code for fast toll passage

The passage of 3-4-5 class vehicles, which are passing from Europe to Asia and from Asia to Europe is forbidden between 0600-1000 and 1600-2200 by Istanbul Transportation Coordination Center (UKOME). The vehicles carrying dangerous goods are permitted only between 0200-0600. Trucks are not permitted to use Bosphorus Bridge (URL 3).

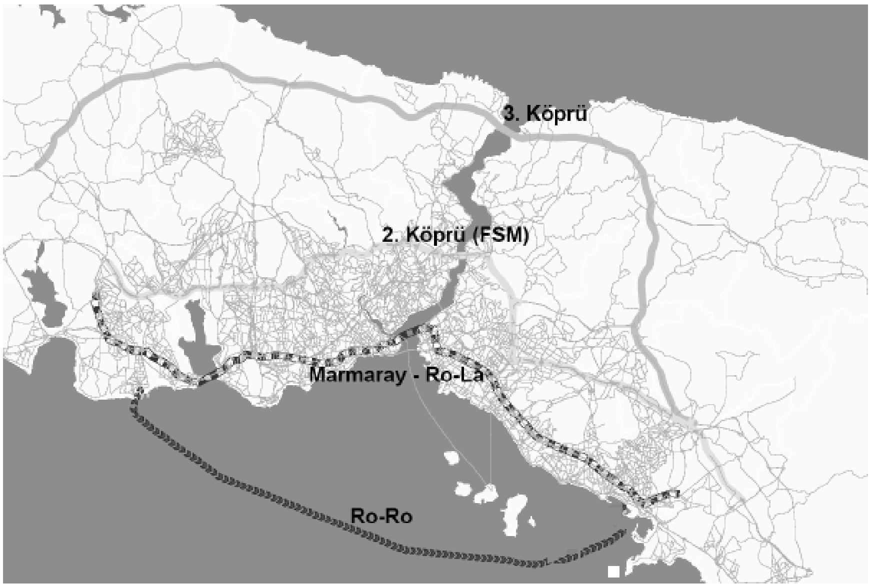

Fig. 1 Routes

The road and sea routes to be used for modelling is described in Figure 1.

- Road:

Start Point: Kurtköy TEM Sabiha Gökçen Exit
Via: Fatih Sultan Mehmet Bridge and TEM
End Point: Avcılar TEM tolls
Total Road Distance: 80 km

- Sea:

Start Point: Kurtköy TEM Sabiha Gökçen Exit
Via: Tuzla Dockyard Region – Ambarlı Port
End Point: Avcılar TEM tolls
Total Sea Distance: 27 mile (43 km)
Total Road Distance: 25 km (15+10)

The capacity and parameters for big truck, small truck and RoRo vessel has been taken into account as below:

- RoRo Vessel

Capacity: 93 small trucks / length 11 m OR 72 big trucks / lenght 15 m
Speed: 14 mile / hour
Fuel Consumption: 1,6 ton / trip
Oil Consumption: 0,03 ton / trip

- Small Truck

Tonnage: 20 ton
Fuel Consumption: 20 liter / one way

- Big Truck

Tonnage: 26 ton
Fuel Consumption: 26,40 liter / one way

Time Schedule and Operation Time Table for RoRo vessel is given in Figure 2.
A is Tuzla Port and B is Ambarlı Port.

- Loading time at port A: 60 min
- Manouvering time for sailing from port A: 15 min
- Sailing time A → B: 2 hours
- Manouvering time for berthing at port B: 15 min
- Discharging time at port B: 30 min
- Loading time at port B: 60 min
- Manouvering time for sailing from port B: 15 min
- Sailing time B → A: 2 hours
- Manouvering time for berthing at port A: 15 min
- Discharging time at port A: 30 min

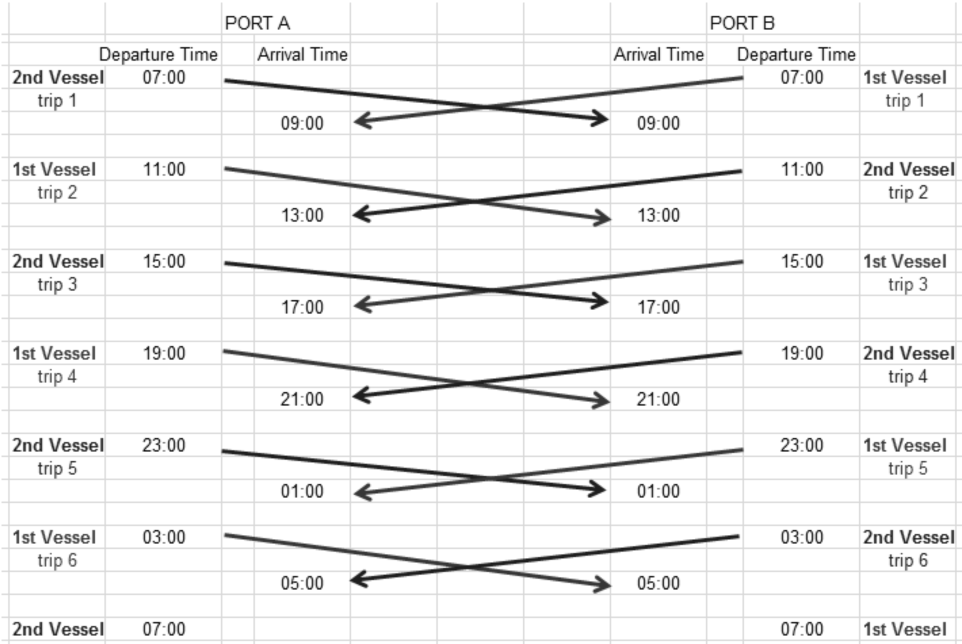

Fig. 2 Time schedule and Operation Time Table for RoRo vessel

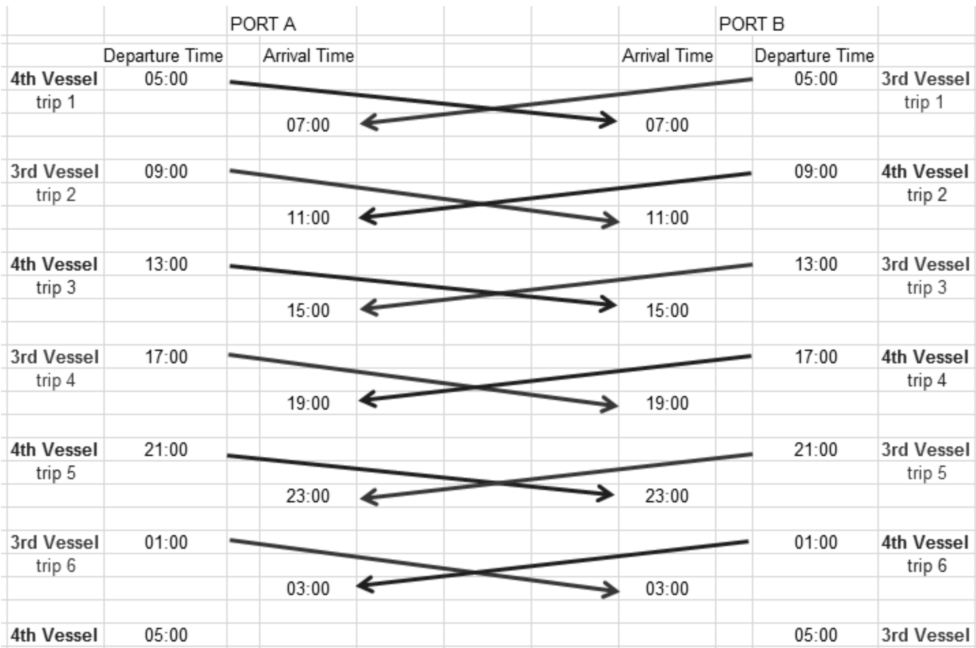

Fig. 3 Time schedule and Operation Time Table for 3rd & 4th RoRo vessel

With only 2 RoRo vessels the total daily one way trip will be 12 and total number of 4th class vehicles carried will be 1116. Based on year 2013 statistical information, the percentage of reduction of total number of 4th class vehicles will be 11.17%.

Based on above time table, without increasing the number of terminals and by using unoccupied times on terminals we can increase the number of RoRo vessels up to 4. Time Schedule and Operation Time Table for 3rd and 4th RoRo vessel is given in Figure 3. For total 4 RoRo vessels, the total daily one way trip will be 24 and total number of carried 4th class vehicles will be 2232. Based on year 2013 statistical information, the percentage of reduction of total number of 4th class vehicles will be 22.34%. By usage of this model, the number of 4th class vehicles using FSM bridge will be decreased and this will lead to a less traffic jam and as a result the average speed of vehicles in the traffic will increase and transport time will decrease and less fuel consumption will be done and CO2 emission will decrease.

Calculation of road and sea transportation will be as follows (URL 2).

CO2 emission = cargo weight x distance x average CO2 emission factor per ton-km

Ton CO2 = ton x km x g CO2 per ton-km / 1.000.000

Small truck emission factor average 83 g CO2 /ton-km (URL 2)

Big truck emission factor average 68,5 g CO2 /ton-km (URL 2)

RoRo vessel emission factor average 60.3 g CO2 /ton-km (URL 2)

Table 2 Relative Table

ROAD ROUTE / ONE WAY							
	Distance		Time		Fuel Consumption	CO2 Emission	Cargo Weight
Vehicle Type	Road	Sea	Road	Sea	TL	ton	Ton
Small Truck	80 km	--	2 / 8 hour	--	105 / 130	12,09	20
Big Truck	80 km	--	2 / 10 hour	--	130 / 180	10,08	26
***** time period between 0600-1000 & 1600-2200 is taken into account to determine min/max time Min : before time period // max : after time period + following traffic jam *****							
RORO ROUTE / ONE WAY							
	Distance		Time		Fuel Consumption	CO2 Emission	Cargo Weight
Vehicle Type	Road	Sea	Road	Sea	TL	Ton	Ton
Small Truck	25 km	43 km	1 / 4 hour	2 hour	30 + 27	8,68	20
Big Truck	25 km	43 km	1 / 4 hour	2 hour	40 + 35	8,05	26
***** figures forFuel Consumption and CO2 Emission are total amount for road+sea route *****							

Based on above figures for each type emission amount will be as follows :

Small truck - ST ➔ E = 20 ton x 80 km x 83 / 1.000.000 = 0,13 ton

Big truck - BT ➔ E = 26 ton x 80 km x 68,5 / 1.000.000 = 0,14 ton

RoRo vessel with 93 ST ➔ E = 1860 ton x 43 km x 60,3 / 1.000.000 = 4,82 ton

RoRo ST road ➔ E = 20 ton x 25 km x 83 / 1.000.000 = 0,0415 ton

RoRo vessel with 72 BT ➔ E = 1872 ton x 43 km x 60,3 / 1.000.000 = 4,85 ton

RoRo BT road ➔ E = 26 ton x 25 km x 68,5 / 1.000.000 = 0,0445 ton

Total 93 ST ➔ E = 12,09 ton

Total RoRo (93 ST) ➔ E = 8,68 ton
Total 72 tır ➔ E = 10,08 ton
Total RoRo (72 BT) ➔ E = 8,05 ton

Based on above results, for fourth class vehicles small trucks and big trucks, fuel consumption and CO2 emission relative chart is given in Table 2.

Benefits of alternative RoRo transportation system are grouped by Time, Fuel Consumption, CO2 Emission and decrease of number of vehicles and are given below in Figures 4-7.

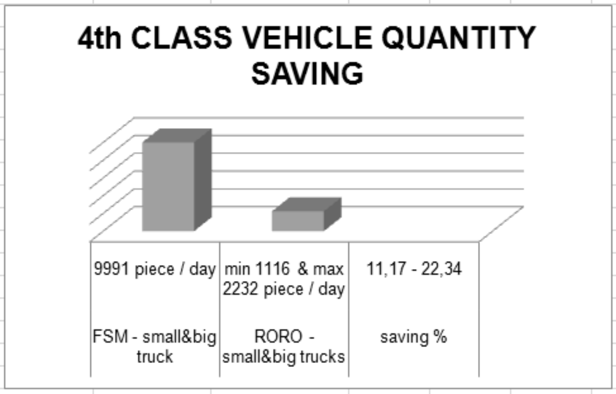

Fig. 4 Benefits of Alternative RoRo System – Vehicle Quantity Saving

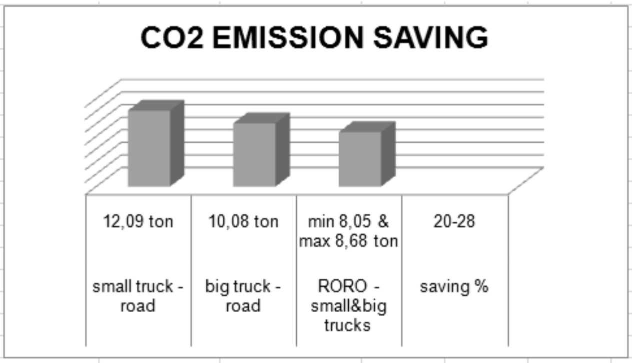

Fig. 5 Benefits of Alternative RoRo System – CO2 emission saving

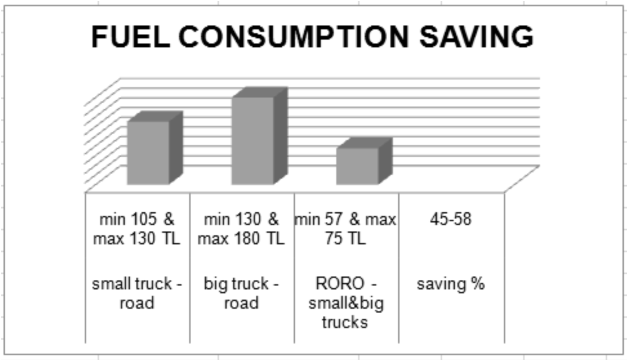

Fig. 6 Benefits of Alternative RoRo System – Fuel Consumption saving

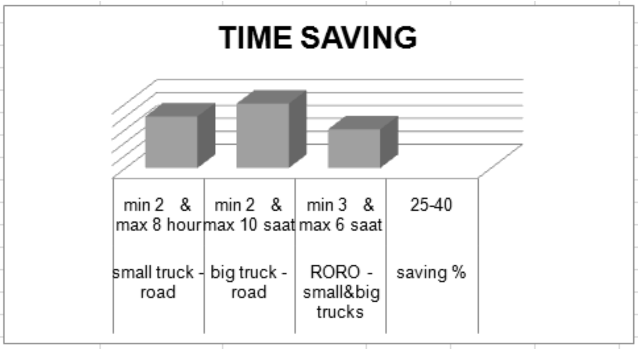

Fig. 7 Benefits of Alternative RoRo System – Time Saving

3. CONCLUSION

Main problem for a human being living in Istanbul is traffic jam. The glaring points of this traffic jam is at the two bridges over Bosphorus. By this study which aims the decrease of number of vehicles on one of these bridges which is FSM bridge, which is also the only one used by the vehicles carrying cargo together with the number of vehicles on connecting side roads, the time table of RoRo vessels as an alternative transportation urban system and the benefits of decreasing Time and Fuel Consumption and CO2 emissions and number of vehicles in traffic are explained.

As a result of executing this system, the percentage of benefits for these four topics are between 11% and 58% and these figures are very important positive outcomes for urban life within Istanbul city.

Especially without constructing a new additional port terminal and starting to operate such a system by using the current port terminals is very important. In fact the better one is to have terminals in both European and Asian side of city which are used only by RoRo vessels to minimize not only the number of cargo carrying vehicles on FSM bridge but also the private cars using Bosphorus bridge. This must be one of the targets of City Municipatility.

By having such a transportation system in sea, city man will be more happy to have a chance to spend his time on sea instead of in traffic jam, to have fun reading books and living in a healthy atmosphere instead of polluting the city he is living in and will be far away from daily life stress.

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BIOGRAPHICAL NOTES

Kayıhan Özdemir Turan was born in 1964, Göle Kars in Turkey and have a master degree on Sea Politics in Istanbul University and is currently a Phd student at Maltepe University on Supply Chain Management & Logistics. He began his career as a naval officer in 1987 and worked on board of different types of war ships untill 1996. After 1996, he started to work in a junior position at a private shipping agent involved in international container shipments, where he was actively involved in local operations. He continued his career in different companies and gradually climbed the ladder to be a general manager of a freight forwarding company. He established his own freight forwarding company, Keyline, in August 2009. He is a board member of UTIKAD – Association of International Forwarding and Logistics Service Providers, acting as a mentor at FIATA Logistics Academy and a lecturer on Rail Transportation at Yeditepe University in Istanbul.