Chapter 6 VRPSPD MODEL TO RE-ROUTE THE SEA BUSES IN ISTANBUL: THE CASE OF BOSPHORUS

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Chapter 6

VRPSPD MODEL TO RE-ROUTE THE SEA BUSES IN ISTANBUL: THE CASE OF BOSPHORUS

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INTRODUCTION

In today's transportation environment, the vehicles' routes, route strategies, temporal strategies, managerial targets, and customer demand must be seen as an integrated process that should be analyzed and structured well. The main purpose of the route strategies in an efficient transportation system is to meet customer demand in time and right place.

The transportation problems are being considered in line with the system approach because of their structural aspects. These systems are multi-disciplinary and may consist of multi models, multi-sectoral or multi-problems. To set a problem in line with targets and to estimate potential changes in different conditions, the relation between systems and their variables that generates the system environment should be investigated in detail. On the other hand, how this relationship affects the system outputs should be analyzed.

A vehicle routing problem may have a different type of variables. Vehicle types or fleet size may be homogeneous or heterogeneous. Cost may be fixed or variable for vehicles based on vehicle usage. On the other hand, time-related conditions may differ. When the horizon is single or multiple, time windows can be hard or soft. In terms of demand nature, operation characteristics may differ. Vehicle routing problems can generally be divided into three groups; vehicle routing problems (VRP), vehicle routing problems with time windows (VRPTW), and vehicle routing problem with simultaneous pick-ups and deliveries (VRPSPD).

VRP involves the design of a set of minimum-cost vehicle routes, originating and terminating at a central depot, for a fleet of vehicles that services a set of customers with known demand. Each customer is serviced exactly once. Furthermore, all customers must be assigned to vehicles without exceeding vehicle capacities (Solomon, 1987). The objective of VRPTW is to optimize route groups

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and to determine the customer schedule which is to be visited for each vehicle by considering vehicle capacities, service time, and time windows. Vehicles can arrive at a specific address at any time in a specific timeline. This is similar to a member who has to visit one place at the time between 10:00 and 15:00 and also visit another place at the time between 14:00 and 18:00. These problems are classified as NP-hard. Finally, on VRPSPD, vehicles should visit the depots at a certain time. In these cases, a strong relation between address and time is in use. Bank deliveries, reverse logistics applications (empty container or box returns) postal deliveries, dial-a-ride service, plane and school bus routing and scheduling can be given as example

The purpose of this study is to minimize the cost of sea bus transportation at Bosphorus in Istanbul by finding the optimal route set for each sea bus. The paper considers a real-life short-term ship routing and scheduling problem which may be described as to find optimal sequencing which is to minimize the transportation cost and the number of sea buses for 260 missions in one day at Bosphorus/Istanbul. The problem was considered as VRPSPD since the route time is limited and the sequence of missions must be in the cycle. Accordingly, the system was modelled via using an integer linear model developed by Bodin et al. (1983).

The paper is organized as follows. In section 2, the existing empirical studies on VRPSPD will be reviewed. Section 3 presents the definition of the problem and methodology. Section 4 discusses the findings and conclusions are drawn in Section 5.

LITERATURE REVIEW

VRP which was first introduced by Dantzig & Ramser (1959) aims to determine an optimal route set for a fleet of vehicles. Based on the type of goods, depots, and customer demand, vehicles have constraints to distribute the goods in time, in place with the required quantity. The problem is to minimize the total costs, consisting of the number of used vehicles and the total distance, subject to the above constraints. Moreover, Josefowiez et al., (2008) emphasize that the objectives may not always be limited to cost. Numerous other aspects, such as balancing workload are taken into account simply by adding new objectives. Lots of a variety of VRP algorithms are reviewed by Koç & Laporte (2018) and Vidal et al., (2019).

VRPSPD is one of the most used types of VRP problems. These problems consist of single or multiple start nodes and single or multiple end nodes. The roots of VRPSPD go back to Solomon (1987) who emphasizes that vehicle routing and scheduling problems with time window constraints must be addressed under the added complexity of allowable delivery times, stemming from the fact that some customers impose delivery deadlines and earliest-delivery-time constraints. First empirical studies on VRPSPD go back to 1989. Min (1989) developed a VRPSPD model and a solution procedure to solve real-world problems. Gajpal & Abad (2009) have developed ant colony algorithms while Dethloff (2001) was defined as a mathematical model for VRPSPD.

Based on the objectives, network, demand, fleet, and cost variables of the problem, the VRPSPD is solved by using a different kind of approaches. Koc et al. (2020) reviewed VRPSPD studies in detail including mathematical formulations, VRPSPD variants, case studies, and main trends. Braekers et al., (2016) and Gansterer & Hartl (2018) have also reviewed VRPSPD studies. In addition to exact algorithms, heuristics procedures are also developed and used in literature (Jun & Kim, 2012; Mu et al., 2016; Subramanian et al., 2010; Subramanian et al., 2013; Zachariadis & Kiranoudis, 2011; Avci & Topaloglu, 2015).

One of the extension models of VRPSPD is the VRPSPD with a time window that involves visiting customers within a given time interval and ensuring that the total demand of all customers in each route respect vehicles' capacity (Blais & Chen, 2020). Koc et al., (2020) exhibit that the most widely studied variant of the one with time windows since many real-world problems require simultaneous collection and deliveries. Several algorithms are developed such as heuristics (Kassem & Chen, 2013), tabu search (Fan et al., 2011), decimal coding (Mingyong & Erbao (2010), genetic algorithms (Wang & Chen (2012). Collection of empty boxes, distribution of foods, home health care logistics, drug delivery, and pick-ups, road-railway transportations, and distribution system of supermarket chains are the main application areas of VRPSPD models. Wang et al., (2016), Drexl (2013), and Yin et al., (2013) used VRPSPD models to solve transportation problems while Belgin et al., (2018) and Zhang et al., (2019) studied on optimization of retailers' distribution system.

Ronen (1993) describes the routing at sea transportation as the process of sequencing the ports which are visited by sea vehicles. And the scheduling was described as the process of dressing up the time window to these routes. Many studies use different types of VRP at sea transportation area. Christiansen et al. (2013) classify maritime routing and scheduling problems in terms of cargo and inventory routing/scheduling. Cho & Perakis (1996) studied container transportation by sea vessels to optimize fleet size. Darzentas & Spyrou (1996) made a simulation study on sea transportation by ferries among the Aegean Islands. The model used a simple "if-then" decision support approach. Ferry routes are prepared via a simulation model that considers seaport capacity, new technology ferries' specifications. Fagerholt (2001) used VRPSPD with time windows on the shipping schedule. Bronmo et al., (2007 and 2010) used column generation and heuristic approach to solve ship pickup and delivery problem with flexible cargo sizes and time windows respectively. Fagerholt & Ronen (2013) studied basic bulk ship routing and scheduling problems using commercial software. One of the recent studies modeled by VRPSPD on sea transportation is exposed by Fazi et al., (2020) who target to minimize transportation costs while ensuring all containers are processed on time. Santos et al., (2020) also present a solution method for maritime cargo routing and shipping problems via multiple type vehicles pick up and delivery problems with time windows (m-PDPTW). Rodrigues et al., (2016) presented a mixed-integer linear mathematical model to VRPSPD with a time window for maritime oil transportation. Similar to their study more recently, Trottier & Cordeau (2019) present a sea vessel routing and scheduling problem with a time window for the bulk vessel fleet.

PROBLEM DESCRIPTION AND MODEL

The Bosphorus sea transportation has a very low percentage (2.5%) in Istanbul transportation when we consider that there is a sea in the city and the city is consisting of two peninsulas. So, sea transportation is an issue which should be developed in Istanbul. In the current status, the Bosphorus sea transportation is performed by vessels, sea busses, ships, and small and medium-sized boats. Among these vehicles, the fastest and most comfortable one is sea busses. Today, the Istanbul Sea Buses Corp (ISB) has a sea vehicle fleet that has 24 sea busses, 10 ferries, and 16 car ferries.

The usage ratio of sea buses is increasing in recent years. And it is expected that the demand for sea transportation by sea buses may increase by adding new routes and improved transportation quality and comfort. The city management also targets to reduce costs and present cheaper and faster transportation opportunities for Istanbul city. In the current status, a total of 17 sea busses are in service on Bosphorus and Marmara Sea coasts (figure 1). These routes and schedules are done by experienced members of ISB via using experience without using any scientific method.

The problem can be defined as the optimal routing problem of the current 17 sea busses which should realize 260 different missions among 19 ports. Each mission is the trip that should be done from one port to another port at a determined time in a day. The output of the model will show us that the minimum cost of the total 260 missions and how many sea buses are required to meet the customer demand.

Pre-Conditions of Problem

The preconditions of the problem are summarized as below;

- The current customer demand is assumed rational.
- Sea buses work at the time between 06:25 am till 21:55.
- The sea buses perform among 19 ports in Bosphorus line: Yenikapi (Ynk), Kartal (Krt), Bostanci (Bst), Kadikoy (Kdk), Bakirkoy (Bkr), Kabatas (Kbt), Karakoy (Krk), Eminonu (Emn), Beykoz (Byz), Uskudar (Üsk), Besiktas (Bjk), Istinye (İsy), Sariyer (Sry), Pendik (Pnk), Avcilar (Avc), Buyukada (Bya), Heybeliada (Hyb), Burgazada (Bgz) ve Kinaliada (Knl)
- The passengers chose the transportation type (vessel, sea bus, small-medium sized boats, etc.) based on transportation fee and departure time.
- The sea buses' waiting time cost, transportation cost with/without passenger is determined via using technical information of sea busses. The transportation cost without a passenger (269 $/hour on average by considering sea bus fleet properties) is calculated by considering oil consumption, diesel consumption, and other variable costs. The waiting cost is calculated as 7.36 $ per hour.
- Table 1 shows the distances (minute) among ports. Insurance, tax, maintenance, economic and technical life of sea busses were not considered on these calculations. The cost matrix (260x260) consists of the cost of the arc n+1 which may be realized after arc n by considering the cost of transportation with/without passenger and waiting time.
- The average speed of sea buses is 29.27 miles per hour.

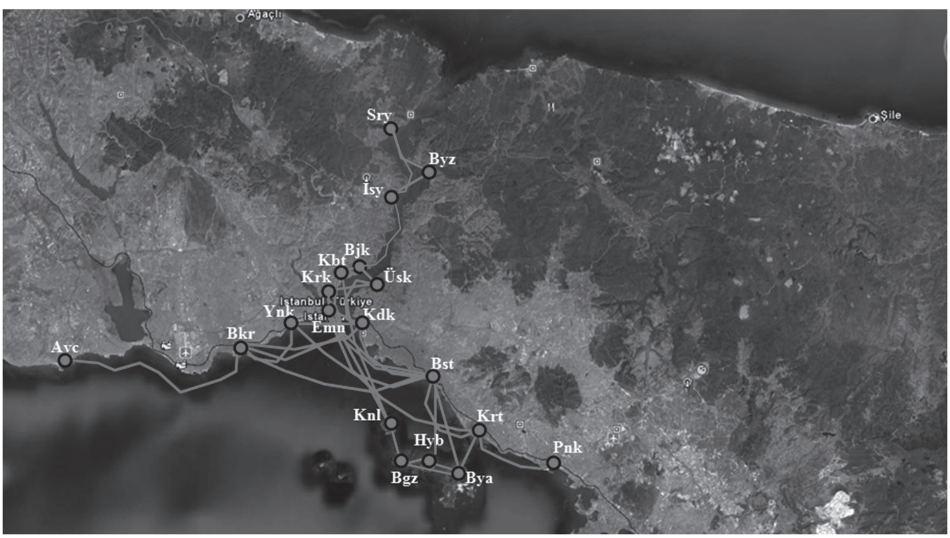

Figure 1. Sea Buses routes in Istanbul Bosphorus.

Table 1. Time matrix among ports (min)

From \ To	Avcılar	Bakırköy	Beşiktaş	Beykoz	Bostancı	Burgazada	Büyükada	Eminönü	Heybeliada	İstinye	Kabataş	Kadıköy	Karaköy	Kartal	K. ada	Pendik	Sarıyer	Üsküdar	Yenikapı
Avcılar	00:00	00:17	00:34	00:49	00:38	00:37	00:41	00:28	00:39	00:44	00:33	00:30	00:32	00:47	00:33	00:52	00:49	00:33	00:26
Bakırköy	00:17	00:00	00:16	00:32	00:21	00:22	00:26	00:15	00:25	00:28	00:16	00:12	00:17	00:32	00:19	00:37	00:35	00:15	00:10
Beşiktaş	00:33	00:16	00:00	00:17	00:19	00:19	00:23	00:04	00:22	00:12	00:02	00:06	00:04	00:30	00:17	00:36	00:20	00:02	00:15
Beykoz	00:49	00:32	00:16	00:00	00:34	00:37	00:43	00:20	00:40	00:04	00:18	00:22	00:19	00:48	00:35	00:53	00:06	00:16	00:32
Bostancı	00:38	00:22	00:19	00:34	00:00	00:13	00:10	00:17	00:11	00:29	00:16	00:10	00:16	00:14	00:13	00:19	00:37	00:16	00:15
Burgazada	00:37	00:22	00:19	00:37	00:13	00:00	00:06	00:18	00:05	00:32	00:19	00:16	00:20	00:12	00:10	00:17	00:41	00:19	00:19
Büyükada	00:41	00:26	00:23	00:42	00:10	00:06	00:00	00:23	00:03	00:40	00:25	00:19	00:25	00:05	00:08	00:11	00:46	00:25	00:23
Eminönü	00:28	00:15	00:04	00:20	00:17	00:18	00:23	00:00	00:23	00:16	00:03	00:06	00:01	00:28	00:16	00:33	00:24	00:04	00:07
Heybeliada	00:38	00:25	00:22	00:40	00:11	00:05	00:03	00:23	00:00	00:35	00:22	00:18	00:22	00:09	00:07	00:13	00:44	00:23	00:21
İstinye	00:44	00:27	00:12	00:04	00:29	00:32	00:40	00:16	00:34	00:00	00:13	00:18	00:15	00:31	00:29	00:37	00:08	00:12	00:20
Kabataş	00:33	00:16	00:02	00:18	00:16	00:19	00:25	00:03	00:22	00:13	00:00	00:06	00:03	00:28	00:17	00:36	00:22	00:20	00:07
Kadıköy	00:30	00:12	00:06	00:22	00:10	00:16	00:19	00:06	00:18	00:18	00:06	00:00	00:06	00:24	00:12	00:30	00:26	00:06	00:07
Karakoy	00:32	00:17	00:04	00:19	00:16	00:20	00:25	00:01	00:22	00:15	00:03	00:06	00:00	00:29	00:16	00:35	00:23	00:04	00:07
Kartal	00:47	00:32	00:30	00:48	00:14	00:12	00:05	00:28	00:09	00:31	00:28	00:24	00:29	00:00	00:13	00:07	00:49	00:30	00:28
Kınalıada	00:33	00:19	00:18	00:35	00:13	00:10	00:08	00:16	00:07	00:29	00:17	00:12	00:16	00:13	00:00	00:19	00:37	00:18	00:15
Pendik	00:52	00:37	00:36	00:53	00:19	00:17	00:11	00:33	00:13	00:37	00:36	00:30	00:35	00:07	00:19	00:00	00:55	00:36	00:34
Sarıyer	00:49	00:35	00:35	00:06	00:37	00:41	00:46	00:24	00:44	00:08	00:22	00:26	00:23	00:49	00:37	00:55	00:00	00:20	00:34
Üsküdar	00:33	00:15	00:02	00:17	00:16	00:19	00:25	00:04	00:23	00:12	00:20	00:06	00:04	00:30	00:18	00:36	00:20	00:00	00:08
Yenikapı	00:26	00:09	00:15	00:32	00:15	00:19	00:23	00:07	00:21	00:20	00:07	00:07	00:07	00:28	00:15	00:34	00:34	00:08	00:00

Model

Based on Koc et al., (2020), four main exact algorithms were developed for standard VRPSPD problems. These models use two to three index variables. The first model on VRPSPD was developed by Bodin (1983). Bodin indicates that simultaneous routing and scheduling problems may be considered as network optimization problems. And he presented 3 different mathematical models. Desrosiers et. al., (1995) also present similar models to Bodin.

The first model of Bodin can be summarized as a single depot and no constraint for vehicles' route time. The second model developed is the enlarged version of a single depot model and work on which vehicles on which depots will serve. Finally, the third model aims to repeat missions within a specific time period again in the sequenced time period. In this VRPSPD model, the route time is limited. For instance, if it is targeted for one vehicle to repeat the same route for the next day, after completing the route this vehicle should be at the first depot of the next day's route. The main difference of this model is that the missions are sequenced as a cycle.

The methodology in this study is used to generate different candidate routes for each vehicle. So, the problem is transformed into an integer linear problem.

The model aims to minimize total transportation cost via sequencing 260 missions and the number of sea buses. In our problem, the route time is limited. The sea buses should depart and arrive at ports at a specific time. Since we need to sequence missions and this sequence must be in the cycle, the problem is determined as Vehicle Routing Problem with Simultaneous Pick-Ups and Deliveries (VRPSPD) with time windows. The main inputs of the model are the departure/arrival time of sea buses, the cost of transportation between ports with/without a passenger, and the waiting time of sea buses. These inputs make routing and scheduling activities simultaneously. The model can be seen below;

$$Z\min = \sum_{:(i,j)\in A_1} c_{ij}x_{ij} + \sum_{:(i,j)\in A_2} c_{ij}y_{ij} \quad (i=1,2,\ldots 260,\ j=1,2,\ldots 260)$$

s.t

$$\sum_{i:(i,j)\in A_1} x_{ij} + \sum_{i:(i,j)\in A_2} y_{ij} - \sum_{i:(j,i)\in A_1} x_{ji} - \sum_{i:(j,i)\in A_2} y_{ji} = 0 \quad \text{for } \forall\ j \in N$$

$$\sum_{i:(i,j)\in A_1} x_{ij} + \sum_{i:(i,j)\in A_2} y_{ij} = 1 \quad \text{for } \forall\ j \in N$$

$$\sum_{(i,j)\in A_1\cap C} x_{ij} + \sum_{(i,j)\in A_2\cap C} y_{ij} \le |C| - 1 \quad \forall\ |A_2 \cap C| \ge 2 \quad \text{for C cycles}$$

$$0 \le x_{ij} \le 1 \quad \text{and binary for } \forall\ (i,j) \in A_1$$

$$0 \le y_{ij} \le 1 \quad \text{and binary for } \forall\ (i,j) \in A_2$$

$$x_{ij} = \begin{cases} 1 & \text{if arc } (i,j) \text{ is operated by a vehicle,} \\ 0 & \text{else} \end{cases}$$

The objective function (1) minimizes total cost. In this problem, there are 260 missions. X_{ij} is the integer decision variable and shows that if the mission (j) will be realized after the mission (i). The X_{ij} arcs are forward arcs and these arcs should be feasible in terms of missions' start and end time. C_{ij} represents the cost of realizing the mission (j) after mission (i). The transportation cost without a passenger (considering distance among ports) and waiting time cost are included in C_{ij}. These costs are calculated for all 260 missions via MS Excel and 260x260 matrix is used as cost input in the model. Y_{ij} variables represent the backward missions. This means that the last mission of a specific route set should be the first mission of another route for the next day. In this way, the closed-loop is guaranteed and minimum transportation cost is achieved.

Constraint (2) imposes to keep closed cycle. Equation (3) imposed that each vehicle should be assigned for a route. Constraint (4) indicates that there must be a backward mission for each cycle. The reason is that the constraint is to maintain cycles for each vehicle. The meaning of C in this constraint indicates the number of cycles in a C cycle. Equations (5) and (6) impose that all the variables are binary. The model ensures that the required missions for a specific time period should be done at a sequenced time period again by the same sea bus. It is not allowed the route time which is longer than Tmax. The node sets have the same meaning as arc sets. Arc sets consist of A1 and A2. A1 is composed of forwarding missions while A2 backward missions.

RESULTS

The model was solved via the LINGO 15.0 program by using branch and bound algorithms. The results show the minimum cost of achieving 260 missions and the number of sea buses required to meet demand.

The solution is obtained by 516 iterations. Based on the results, 16 sea buses can realize the 260 missions instead of 17. This means not only the reduction in the number of sea buses but also the reduction of the number of crew, annual tax, annual insurance of sea buses, and maintenance cost of one sea bus. When the high return on investment duration for sea buses is considered (investment cost is on average 6 million $ /sea bus), the corporate takes a drastic advantage in the market. Saved sea bus can also be used in a new route which may be added to current O-D pairs without buying a new one. The reduction in the number of sea buses also increased the sea bus usage ratio by 5.18 points (Figure 2).

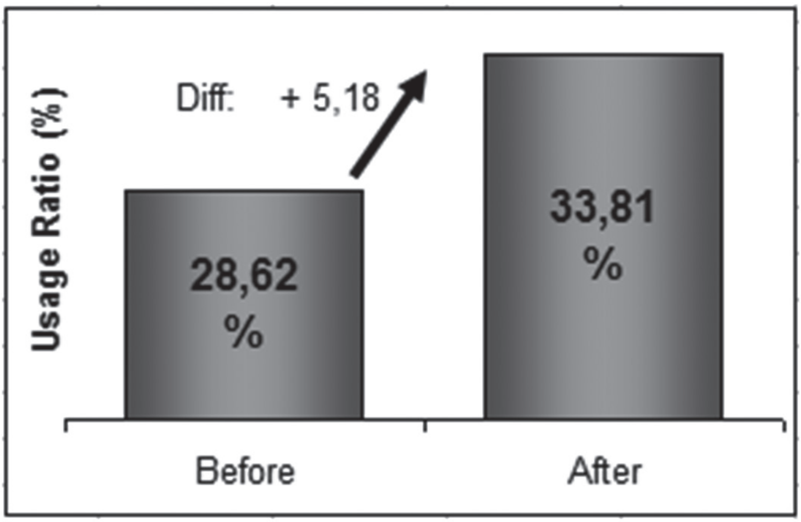

Figure 2. Sea buses usage ratio (%)

The objective value of the solution is 2377 $. This means that the minimum cost of 260 missions is 2377 $ per day (figure 3). This cost includes transportation with/without passengers and waiting time. Besides, daily operational cost reduced to 17.2% This means that ISB will save 142216 $ per year excluding insurance, tax, maintenance, crew, and other expenses.

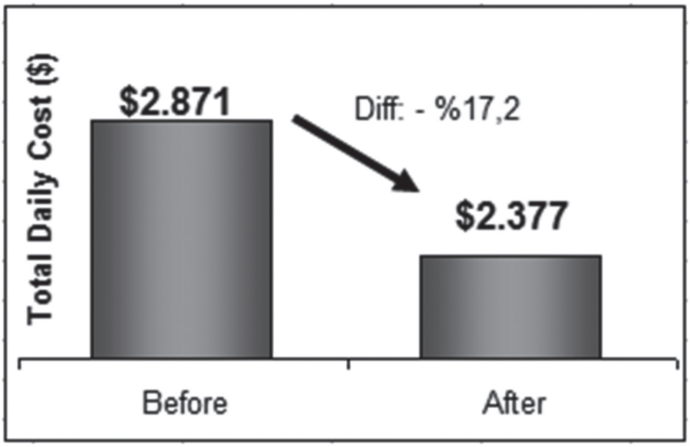

Figure 3. Total daily cost ($)

Based on the results, the 16 different sea busses were assigned 5 different route sets. The two of these sea buses were assigned route 7 and route 11. This means that Karamursel Bey and Oruc Reis V are working the same route everyday. On the other hand, Temel Reis II and Yeditepe sea buses are working at route set 5 (route 10 and 16). 4 of the remaining were assigned to route 1, route 9, route 3, and route 12. These sea buses perform these routes one day after another day. After 4 days, each of them starts to perform their first route. The remaining 8 sea buses are assigned 8 different routes. And these also perform these routes one after another day. Each route set of sea buses is summarized in figure 4. This figure shows that: on route 1, totally 8 sea buses perform. And each day they perform a different route. For instance, sea bus (a) assigned to route set 1 performs route 2, and the other day performs route 8, then route 4, 6, 15, 5, 14, 13, and again route 2. In appendix A, the route details of 4 different sea buses assigned to route set 4 are presented as an example.

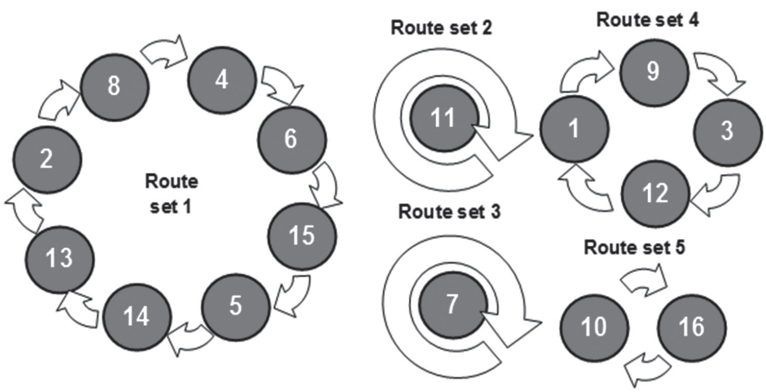

Figure 4. The optimal route set of sea buses

CONCLUSION

Although there are many residential places in the Marmara region and around the seaside, the city cannot benefit enough from sea transportation in Istanbul. The high cost of fast sea transportation mode in Bosphorus makes it also difficult to pull the road transportation demand to the sea.

Based on a mathematical model consisting of 65326 variables and 65847constraints, results show that it is possible to maintain 260 missions at Bosphorus by using 16 sea buses instead of 17. Additionally, the total transportation cost was reduced by 17.2 %, and the sea buses usage ratio improved by 18.1 %. In addition to one less sea bus usage, there will be a significant reduction in operational cost, insurance, tax, maintenance cost, and personal expenses. These results are expected to reflect directly on corporate profitability or ticket prices may be reduced due to the reduction in travel costs.

In this study, passenger capacities and types of sea buses were not considered. Sea buses are assigned the specific routes by considering the passenger demand for a mission after determining the routes. As the real-world process is stochastic based, the simulation models and scenarios may be developed by considering opportunity costs, customer demand deviation, and sea bus variety.

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Appendix 1. Optimal route sets and sea bus assignments

Route		
Name of Sea Bus:	ULUBATLI HASAN	
Mission No	**Departure Port & Time**	**Arrival Port & Time**
54	Bostancı (08:30)	Heybeliada (08:45)
70	Heybeliada (08:50)	Büyükada(08:55)
73	Büyükada (09:00)	Burgazada (09:05)
79	Burgazada (09:10)	Kınalıada (09:15)
83	Kınalıada (09:20)	Kabataş (09:45)
101	Kabataş (10:10)	Karaköy (10:15)
102	Karaköy (10:15)	Eminönü (10:20)
111	Kadıköy (10:35)	Bostancı (10:55)
120	Bostancı (12:30)	Kadıköy (12:50)
125	Kadıköy (13:30)	Eminönü (13:45)
149	Eminönü (16:35)	Kadıköy (16:50)
153	Kadıköy (16:50)	Bakırköy (17:10)
166	Bakırköy (17:30)	Kadıköy (17:50)
175	Kadıköy (17:50)	Bostancı (18:10)
201	Kabataş (18:30)	Karaköy (18:40)
*12	Bostancı (07:30)	Yenikapı (07:50)

Route		
Name of Sea Bus:	PİRİ REİS II	
Mission No	**Departure Port & Time**	**Arrival Port & Time**
4	Bostancı (07:00)	Kadıköy (07:20)
8	Kadıköy (07:20)	Bakırköy (07:40)
21	Bakırköy (07:45)	Kadıköy (08:05)
37	Kadıköy (08:05)	Bostancı (08:25)
55	Bostancı (08:30)	Bakırköy (09:00)
88	Bakırköy (09:30)	Kadıköy (09:50)
95	Kadıköy (09:50)	Bostancı (10:10)
109	Bostancı (10:30)	Kabataş (10:55)
113	Kabataş (11:00)	Karaköy (11:05)
152	Karaköy (16:50)	Eminönü (16:55)
160	Eminönü (17:15)	Kadıköy (17:30)
167	Kadıköy (17:30)	Eminönü (17:45)

(continued)

184	Eminönü (18:05)	Kabataş (18:10)
188	Kabataş (18:15)	Karaköy (18:35)
208	Kınalıada (18:40)	Burgazada (18:45)
214	Burgazada (18:50)	Heybeliada (18:55)
217	Heybeliada (19:00)	Büyükada (19:05)
224	Büyükada (19:10)	Bostancı (19:35)
*17	Bostancı (07:35)	Heybeliada (07:50)

Route		
Name of Sea Bus:	ÇAVLI BEY	
Mission No	**Departure Port & Time**	**Arrival Port & Time**
17	Bostancı (07:35)	Heybeliada (07:50)
26	Heybeliada (07:55)	Büyükada (08:00)
35	Büyükada (08:05)	Burgazada (08:10)
44	Burgazada (08:15)	Kınalıada (08:20)
50	Kınalıada (08:25)	Kabataş (08:50)
72	Kabataş (08:55)	Eminönü (09:00)
75	Eminönü (09:00)	Kadıköy (09:10
81	Kadıköy (09:15)	Eminönü (09:30)
90	Eminönü (09:35)	Kadıköy (09:50)
100	Kadıköy (10:05)	Bakırköy (10:20)
135	Bakırköy (15:30)	Kadıköy (15:50)
140	Kadıköy (15:50)	Bostancı (16:10)
155	Bostancı (17:00)	Kabataş (17:25)
165	Kabataş (17:30)	Karaköy (17:40)
172	Karaköy (17:45)	Eminönü (17:50)
174	Eminönü (17:50)	Kadıköy (18:05)
187	Kadıköy (18:10)	Eminönü (18:25)
196	Eminönü (18:25)	Kadıköy (18:40)
219	Kadıköy (19:00)	Eminönü (19:10)
225	Eminönü (19:10)	Kınalıada (19:35)
241	Kınalıada (19:40)	Burgazada (19:45)
245	Burgazada (19:50)	Heybeliada (19:55)
247	Heybeliada (20:00)	Büyükada (20:05)
250	Büyükada (20:10)	Bostancı (20:20)
*54	Bostancı (08:30)	Heybeliada (08:45)

Route		
Name of Sea Bus:	ULUÇ ALİ REİS	
Mission No	**Departure Port & Time**	**Arrival Port & Time**
12	Bostancı(07:30)	Yenikapı(07:50)
33	Yenikapı(08:00)	Bakırköy(08:10)
46	Bakırköy(08:15)	Avcılar(08:40)
69	Avcılar(08:50)	Bakırköy(09:15)
114	Bakırköy(11:30)	Kadıköy(11:45)
117	Kadıköy(11:50)	Yenikapı(12:00)
118	Yenikapı(12:00)	Bostancı(12:20)
122	Kadıköy(12:50)	Bostancı(13:10)
124	Bostancı(13:30)	Kadıköy(13:50)
127	Kadıköy(13:50)	Bostancı(14:10)
158	Bostancı(17:00)	Kadıköy(17:20)
177	Kadıköy(17:50)	Bakırköy(18:10)
199	Bakırköy(18:30)	Yenikapı(18:45)
215	Yenikapı(18:50)	Bostancı(19:10)
253	Bostancı(20:30)	Kadıköy(20:50)
257	Kadıköy(20:50)	Bakırköy(21:10)
259	Bakırköy(21:15)	Kadıköy(21:30)
260	Kadıköy(21:35)	Bostancı(21:55)
*4	Bostancı(07:00)	Kadıköy(07:20)

*: Backward missions