ROUTING OPTIMIZATION FOR CONTAINER DISPATCHING OPERATIONS

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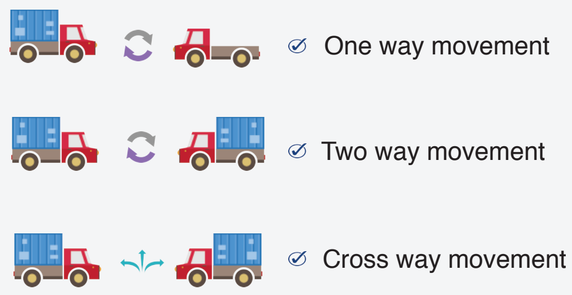
YAŞAR ÜNİVERSİTESİ

ABOUT ALKON LOGISTICS

- Alkon Logistics is located in Izmir Biçerova.
- Started its logistic operations in September 2013 within Nemport Group Companies.
- Service area in Biçerova is 80 acres large and connected to Aliağa ports.

MACRO/ MICRO ANALYSIS

- Approximately 5100 containers/month are dispatched
- There are two different container types, 20-feet and 40-feet.
- Each truck can carry one 20-feet full container or one 40-feet full container.
- Trucks have three different movements called one way movement, two way movement and cross way movement.



OBSERVATIONS AND SYMPTOMS

Observations:
- Inability to apply appropriate dispatch planning in peak times.
- Lack of flexible dispatch planning for alternative policies

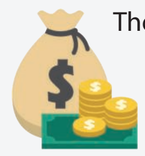
Symptomps:
- Unefficient truck usage
- Empty travels of trucks in peak times
- Renting truck unnecessarily
- Overrun cost such as traveling and storage costs

PROBLEM DEFINITION

DELIVERY TIME = THE MAIN CONSTRAINT OF THE PROBLEM

- Ports → Cut-off times of vessels
- Biçerova → Departure time of freight cars

The objective function of the problem is to minimize total cost.



- Storage cost
- Traveling cost of trucks
- Renting cost of extra trucks

TRUCK UTILIZATION INCREASED %18

TOTAL COST DECREASED %30

SOLUTION TIME: ON AVERAGE 10 MINUTES

MATHEMATICAL MODEL

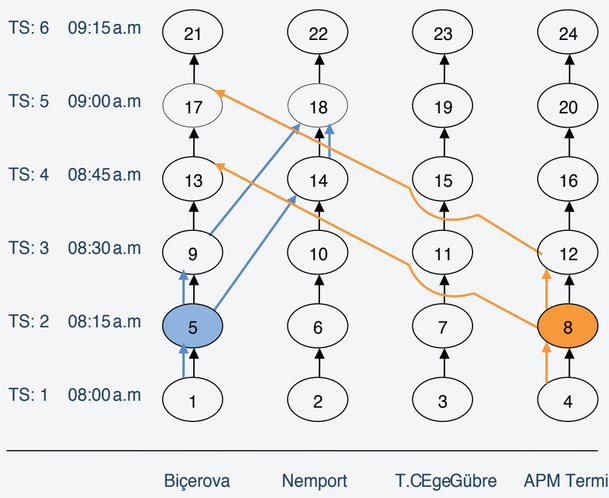
Assumptions

- All trucks are identical
- There is no difference in carrying full or empty containers
- Daily operating time of 2 shifts limited, same and no overtime

Construction of Time-space Graph

- 6 Time Steps

1 hour 15 minutes period



Mathematical Model

Sets and Indices

N = Set of nodes in the base graph, $N = \{1,2,3,4\}$

τ = Number of time periods

N^T = Set of nodes in the time - space graph, $N^T = \{1 \dots \tau . N\}$

A^T = Set of arcs in the time - space graph

D = Set of demand groups $1 \le d \le D$

W = Set of days $1 \le w \le W$

$In(i)$ = Set of nodes which can enter to each node i with arcs, $i \in N^T$

$Out(i)$ = Set of nodes which can leave from each i node with arcs, $i \in N^T$

Parameters

$Amount_d$ = Number of containers in demand group d

o_d = Origin node of demand group d, $o_d \in N$

d_d = Destination node of demand group d, $d_d \in N$

r_d = Release time step of demand group d

u_d = Due time step of demand group d

st_d = Time step which gives starting of free storage time for demand group d

c_{ij} = Transportation cost between node i and node j, $i, j \in N^T$

cf_{ij} = Cost difference among loaded and empty travel between node i and node j, $i, j \in N^T$

$stcost$ = Storage cost per time period

s_i = Number of trucks present at node i at the beginning of the optimization, $i \in N^T$

z_{ij} = A parameter which can take the value of 0 or 1. if arc (i,j) is stationary arc, the parameter will be 0, otherwise it will be 1.

$Hirecost$ = Hiring cost of extra truck

Decision Variables

x_{ij} = Number of trucks on arc $(i,j),(i,j) \in A^T$

y_{ijd} = Number of container on arc (i,j) for demand group d, $(i,j) \in A^T$

h_{ij} = Number of rented trucks on arc $(i,j),(i,j) \in A^T$

$Hired_w$ = Number of rented trucks at node, $w \in W$

Objective Function

(1) $Min \sum_{i,j \in A^T} (x_{ij} + h_{ij}) . c_{ij} + \sum_{w \in W} Hired_w . hirecost + \sum_{i,j \in A^T} \sum_{d \in D} y_{ijd} . cf_{ij} + \sum_{i,j \in A^S \wedge j < d_d + (st_d - 1).N} \sum_{d \in D} y_{ijd} . stcost$

Constraints

(2) $\sum_{d \in D} z_{ij} . y_{ijd} \le x_{ij} + h_{ij}$, $(i,j) \in A^T$

(3) $\sum_{j \in Out(i)} x_{ij} - \sum_{k \in In(i)} x_{ki} \le s_i$, $i \in N^T$

(4) $\sum_{j \in Out(i)} h_{ij} - \sum_{k \in In(i)} h_{ki} \le Hired_w$ $i = 1$

(5) $\sum_{j \in Out(i)} h_{ij} - \sum_{k \in In(i)} h_{ki} \le 0$, $i \in N^T \backslash \{1\}$

(6) $\sum_{k \in In(i)} x_{ki} + \sum_{k \in In(i)} h_{ki} = s_1 + Hired_w$, $w \in W$

(7) $\sum_{j \in Out(i)} y_{ijd} = Amount_d$ $d \in D, i \in N^T$, $i = o_d + (r_d - 1).N$

(8) $\sum_{i \in In(i)} y_{ijd} = Amount_d$ $d \in D$, $j \in N^T$, $j = d_d + (u_d - 1).N$

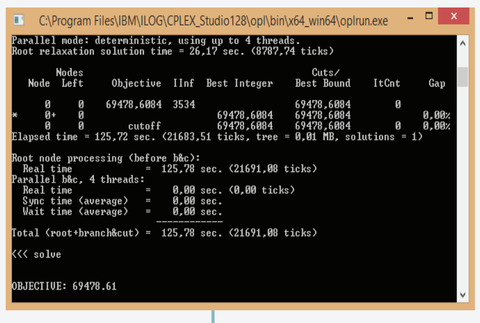
(9) $\sum_{j \in Out(i)} y_{ijd} - \sum_{k \in In(i)} y_{kid} = 0$ $d \in D$, $j \in N^T$

$i \ne o_d + (r_d - 1).N$ and $i \ne d_d + (u_d - 1).N$

DECISION SUPPORT SYSTEM

RUNNING IBM ILOG CPLEX IN EXCEL

DEMAND INFORMATION



Veri Girişi | Haftalık Sevkiyat Planlaması | Sonuçları Görüntüle

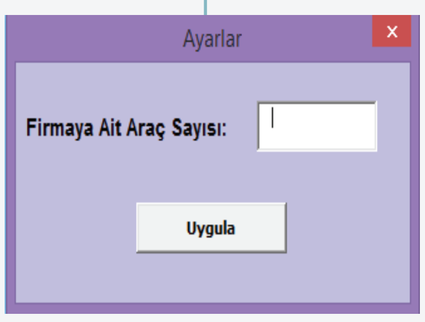
Maliyet Analizi

Firmaya Ait Araç Sayısını Güncelle

- DSS was integrated with IBM ILOG CPLEX

Firmaya Ait Araç Sayısı	15
Kiralanan Araç Sayısı	1
Taşınan Toplam Konteyner Adedi	900
Araç Kiralama Maliyeti	678,00 ₺
Seyahat Maliyeti	69.889,00 ₺
Ardiye Bedeli	6.121,00 ₺
Toplam Maliyet	76.688,00 ₺

- DSS provides users the ability to analyze the outputs in detail. It can be helpful making long-term decisions such as purchasing new trucks.



- User can change number of trucks that are used in dispatching operations

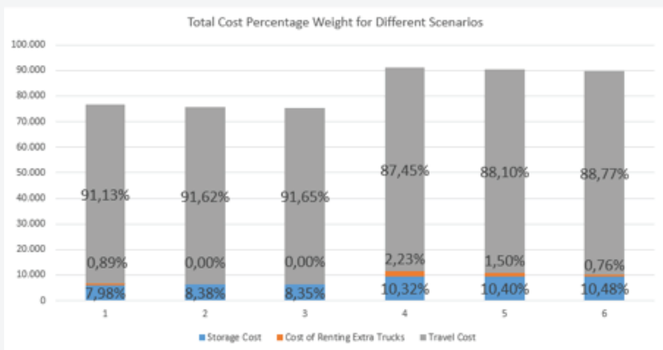
EXAMPLE OF WEEKLY CONTAINER DISPATCHING PLAN IN EXCEL

PAZARTESİ										
Başlangıç	Yola Çıkma Zamanı	Varış	Varış Zamanı	Seyahat Eden Araç Sayısı	Seyahat Tipi	Talep Grubu	Taşınan Konteyner Adedi	Talep Teslim Günü	Talep Cut-Off Saati	Kiralanan Araç Adedi
Biçerova	08:00:00	APM Terminal	09:00:00	15	Dolu Seyahat	Arkas	15	Cumartesi	18:30	3
APM Terminal	09:00:00	Biçerova	10:00:00	15	Dolu Seyahat	VestelBos VestelBos2	14 1	Cuma Salı	23:00 21:00	
Biçerova	10:00:00	T.C Ege Gübre	11:00:00	15	Dolu Seyahat	Vestel	15	Cumartesi	17:45	
T.C Ege Gübre	11:00:00	Biçerova	12:00:00	15	Boş Seyahat					
Biçerova	12:00:00	Nemport	13:00:00	15	Dolu Seyahat	Arkas2 VestelDolu2	10 5	Salı Perşembe	18:45 14:45	
Nemport	13:00:00	Biçerova	14:00:00	15	Dolu Seyahat	Evergreen	15	Cuma	21:30	
Biçerova	14:00:00	Nemport	15:00:00	15	Dolu Seyahat	Vestel Dolu	15	Çarşamba	18:45	
Nemport	15:00:00	Biçerova	16:00:00	15	Dolu Seyahat	Evergreen	15	Cuma	21:30	
Biçerova	16:00:00	Biçerova	16:15:00	10	Bekleme					
Biçerova	16:00:00	Nemport	17:00:00	5	Dolu Seyahat	Vestel Dolu	5	Çarşamba	18:45	
Biçerova	16:15:00	Biçerova	16:30:00	10	Bekleme					
Biçerova	16:30:00	Nemport	17:30:00	10	Dolu Seyahat	Vestel Dolu	10	Salı	18:45	
Nemport	17:00:00	Biçerova	18:00:00	5	Dolu Seyahat	Evergreen	5	Cuma	21:30	
Nemport	17:30:00	Nemport	17:45:00	10	Bekleme					
Nemport	17:45:00	Biçerova	18:45:00	10	Dolu Seyahat	Evergreen	10	Cuma	21:30	
Biçerova	18:00:00	T.C Ege Gübre	19:00:00	5	Dolu Seyahat	Vestel	5	Cumartesi	16:45	
Biçerova	18:45:00	T.C Ege Gübre	19:45:00	10	Dolu Seyahat	MSC	10	Cumartesi	14:45	
T.C Ege Gübre	19:00:00	Biçerova	20:00:00	5	Boş Seyahat					
T.C Ege Gübre	19:45:00	T.C Ege Gübre	20:00:00	6	Bekleme					
T.C Ege Gübre	19:45:00	APM Terminal	20:30:00	4	Boş Seyahat					

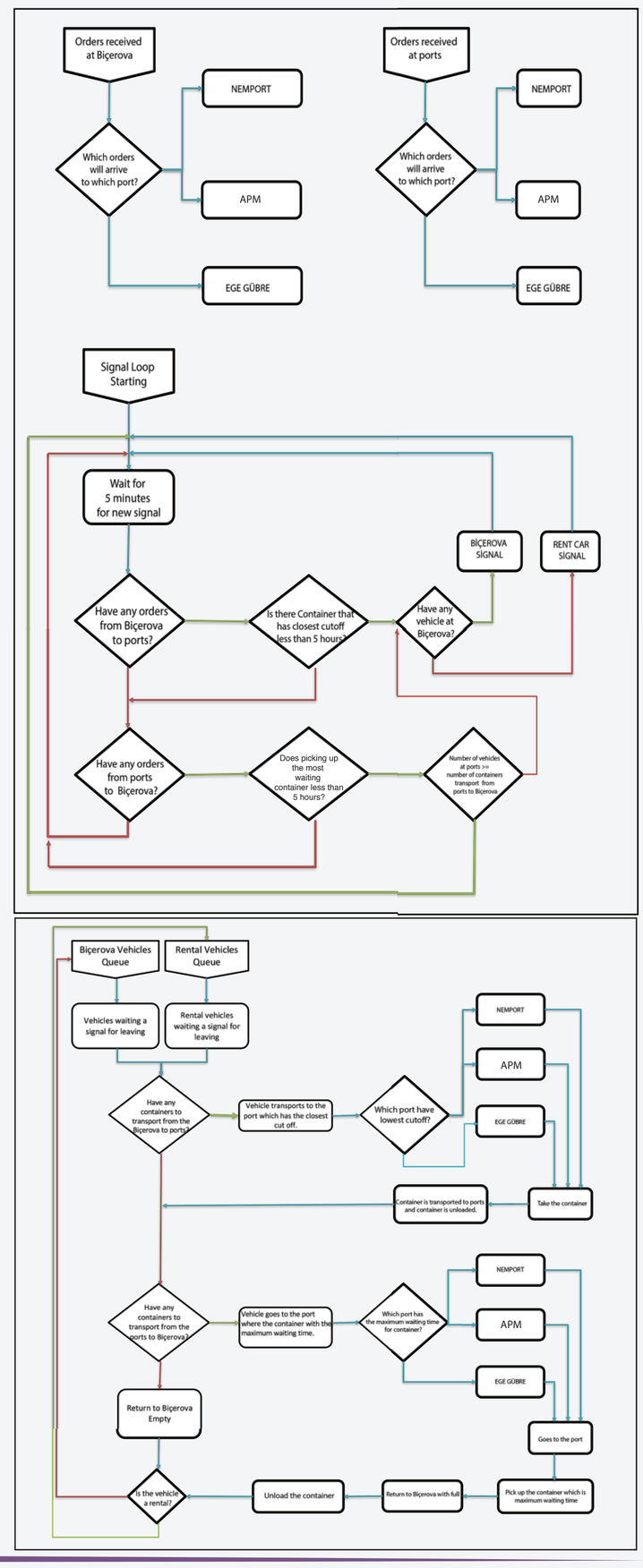
- Weekly container dispatching plan is generated with minimum cost

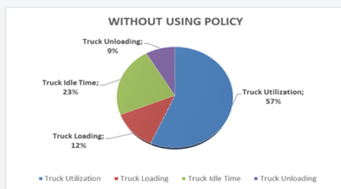
Sensitivity Analysis and Comparison

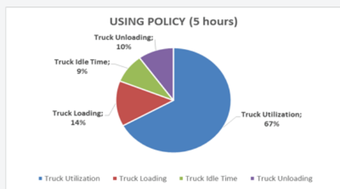
Scenario Number	Number of Container	Number of Trucks	Number of Rented Trucks	Storage Cost	Cost of Renting Trucks	Travel Cost	Total Cost	Solving Time
1	900	15	1	6.121	678,73	69.889	76.689	00:07:01
2	900	16	0	6.328	0	69.211	75.539	00:04:11
3	900	17	0	6.308	0	69.211	75.519	00:04:14
4	1000	15	3	9.413	2.036,19	79.761	91.210	00:06:38
5	1000	16	2	9.414	1.357,46	79.761	90.532	00:05:18
6	1000	17	1	9.414	678,73	79.760	89.853	00:07:13



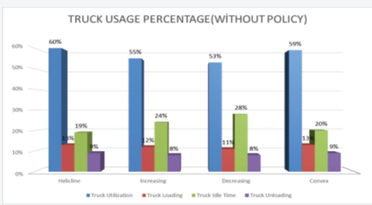
FLOW CHART OF SIMULATION MODEL

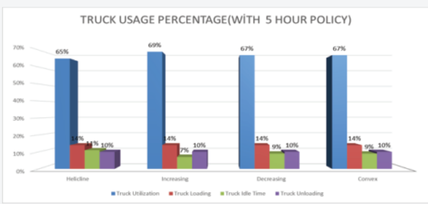






Titles	Data Type	USING POLICY (5 hours)	WITHOUT USING POLICY
How many times Alkon's truck used?	Helicline	300	376
	Increasing	334	445
	Decreasing	306	378
	Convex	333	366
How many times renting truck used?	Helicline	0	5
	Increasing	0	3
	Decreasing	1	3
	Convex	3	3





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