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PREFACE

This book consists of project reports of the senior Logistics Management students of Izmir University of Economics have prepared in the scope of Applied Workshop in Logistics I and II.

The project course program provides the basic skills to senior students to effectively plan, manage and control large scale real world projects especially from industry. The purpose of the program is to have senior students gain real life experiences in the logistics and supply chain management from planning, operations, marketing, warehousing, transportation and production. Accordingly, students find an opportunity to obtain first hand experience in problem definition, solving, modeling, simulation, and cost analysis. Moreover, a special emphasis is given on communication skills by requiring the students to submit periodic reports and oral presentations. The main aim is to strengthen the ties between students, academics, and industry.

The benefits are tremendous not only to the students or the department, but also to the industrial partners. The program has many benefits to the industrial partners by providing access to faculty expertise and laboratory capabilities within the IUE Department of Logistics Management or by providing student team service with a consultancy capacity enabling the industrial partner to address practical challenges, which may be outside the scope or capacity of those normally handled by in-house personnel. Besides, students benefit from this program by having the opportunity to work on a real business problem of direct interest to a company or institution, and thus is motivated by the potential for seeing a tangible impact of his/her consulting efforts on real problems. By interacting with company personnel and learning to work under actual industrial/government conditions, students gain valuable interpersonal skills and technical experience while enhancing personal skills, such as effective time management, developing project management skills, achieving milestones of the project, and making decisions. Furthermore, working with real-life business solutions design and development projects or working with modern information technologies, such as database design, modeling, web design, simulation and visualization tools are also important contribution to the education of students.

The department also benefits from this program by improving the university-industry collaboration and by being aware of challenges faced by the companies. Besides, this helps the department in assessing the curriculum upon the feedbacks received.

The scope of the project involves 4 to 6 students spending around 650 hours of work including the combinations of several logistics management knowledge areas.

The projects are continuously evaluated by the academic advisors and coordinators; updates are provided through fixed milestones such as a proposal, monthly progress reports, two presentations (at the end of each term) and a final report.

The common outcomes of the projects are cost reduction, safety improvement, worker satisfaction, efficiency improvement, productivity improvement, increased capacity, improved decision making and for some projects cost/benefit analysis as well.

As a conclusion, with the collaboration and cooperation of the university and industry partners, valuable as well as beneficial studies are carried out by the project groups, improving all parties to an important extent.

This book would not have been published without the support of research assistant Aysu Göçer. First and foremost, we would like to thank her and all of the editors for their valuable efforts. Besides, we would like to express our gratitude to everyone and in particular to the industry partners and university for providing such an opportunity to us.

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BRIEF CONTENTS

NARLIDERE MUNICIPALITY WASTE MANAGEMENT PROCESS

Serdar Savaşan, Sinan Çavdırlı, Anıl Keklik, Billur Çevikel, Beliz Gülden

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EXECUTIVE SUMMARY

This project focuses on redesigning the routes of dustcarts used by Narlıdere Municipality for waste collection. The aimed achievement was a reduction of fuel consumption and overtime costs, making used of the theoretical background and optimization techniques. The project was carried out with the idea of working for benefit of our country and citizens.

Waste collection process in Narlıdere Municipality currently relies on the experience and intuition of the managers. Dustcart - Region allocation is made by the responsible manager, the exact route routes are determined by the drivers.

The allocatin and routing problem for the Waste collection process in Narlıdere Municipality was initially formulated as a VRP (vehicle routing problem). However after further observations and site visits, the problem was identified as a modified version of VRP, with constrained routes.

Two types of heuristics were applied using the modified formulation: a nearest neighborhood type of heuristic, and a special intuitive heuristic. Furthermore, a modification of a TSP code from the GAMS library was used to solve the same formulation.

Over a sample region, the routes obtained by the GAMS solution were 10% and 12% more efficient than the two heuristics respectively.

The underlying model was further changed by adding and modifying a set of constraints to increase the validity of the model.

As a result, routes for dustcarts have been obtained. In addition to the dustcart – region allocation and route planning, the suggested waste collection frequencies for each region is reported.

1. INTRODUCTION

1.1 General Overview

Municipal waste is formed by household, commercial activities like small businesses, office buildings and institutions such as schools, hospitals and government buildings. It does not include other wastes arising from mining, industrial or construction and demolition processes. It is made up of materials such as paper, cardboard, metals, textiles, organics (food and garden waste).

Waste management is defined as the collection, transportation, processing, recycling and disposal of waste materials with the purpose of reducing the negative impacts that waste has on environment and society. Waste collection and transportation are the two components of the waste management system and we have focused on these components within the scope of this project.

1.2 Motivation

This was a very interesting project for us, because lack of efficiency and productivity has always been outlined as being one of the main problems of the public sector. The ideas of evaluating the performance of municipality operations and trying to improve them have attracted our attention.

Waste collection was one of the most complicated processes for the municipalities. Any improvement on the process would have been of use to the whole public and to the country. Besides, this project could have been applicable in many other municipalities as well.

1.3 Goals

The goal was to reduce the fuel consumption and overtime costs by redesigning the routes of dustcarts with the support of the academic knowledge and techniques.
Because, a better routing plan could have brought:
a) *Operational excellence:* By operational excellence, municipality could have reduced its cost and saved money accordingly. This money, which has been saved, could have been used for another field to serve the citizens. Thus, municipality could have provided more services with its limited budget, through the opportunity cost of spending money.
b) *Effective use of scarce resources:* It was a very significant issue for the country as municipalities' budgets were very limited. Fuel has still been imported. Therefore, municipalities should have used its resources effectively. Besides, time was another scarce resource to be used effectively. So, the new focus area should have been saving time.
c) *Increased service quality:* Through operational excellence, money and time savings, municipality could have had a chance to increase its service quality.
d) *Decreasing harmful effects of exhaust gas for the environment:* If dustcarts could have travelled shorter distances, the air pollution on the environment could have been reduced. This is beneficial also in terms of global warming.

2. PROBLEM DEFINITION

2.1 Main Problem

Routes of dustcarts were not standard in the municipality, because operations were based on the intuition of the dustcart drivers. The problem solution has been planned through designing a new route plan for the dustcarts by using academic and analytic methods instead of traditional methods. While designing the routes, we have considered the population and waste density of areas, shifts, frequency of waste collection, worker overtime costs, time, fuel consumption, etc.

2.2 Challenges

Working on a large scale network and huge amount of data were challenge for us. This has taken a lot of time. While working on the project, being patient, attentive as well as ensuring accuracy in all aspects, were important expectations from the group members. Even a minor error would have created the risk of directly affecting the whole problem solution. Therefore, we have worked in a systematic, regular and coordinated way and accordingly, divided the problem solution into sublevels to decrease the risk of errors. Some problems that have been experienced during the project were loss of data, errors in calculation and errors in data entrance. On the other hand, we have determined these errors on time and managed potential consequences well. Each group member has supported each other to overcome these challenges. Especially, at the last stage of the project, collaboration was perfect.

Adding constraints to the model was a challenge for us as well. We have determined many constraints during the visits, interviews and observations. However, the information should have been converted into mathematical form, for entering them as an input to the software. Some constraints have been uploaded to the software and some have been managed manually. Converting some constraints such as traffic congestion, wrong parked cars, time related constraints into mathematical form was not easy to manage. Therefore, some of them have not been uploaded into the model. Those constraints have been considered separately while interpreting the results.

Data collection and processing was also a challenge for us. A lot of data was necessary for the project, and we should have addressed our requirements to the right person in the related department. Therefore, we have determined from where and whom, related data could have been gathered. Accordingly, we have realized seven visits to the municipality. As soon as all the data has been gathered, we have processed and transformed them to the appropriate form of the model.

3. LITERATURE REVIEW

There were academic studies and cases about waste collection. We have reviewed some of them and noticed that Narlidere Municipality was not the only one facing such a problem.

Efficiency and effectiveness were significant concepts, so some other organizations have worked on similar projects as well. We have considered their findings and focused on the cases by considering dynamics and circumstances of Narlidere Municipality.

1) *A Pilot Study for the Optimization of Routes for Waste Collection Vehicles for the Gocmenkoy District of Lefkosa:* The major objective of the study was to provide an optimal route for the waste collection vehicles of the Gocmenkoy district, for reducing the time consumed and increasing the efficiency as well as providing a better environment for the public and the workers. For this objective, basic method Greedy Algorithm (Minimal Spanning Tree) was used to find the optimal route.

2) *Residential Waste Collection Network Design and Improvement Recycling Process:* The aim of the project was redesigning the routes of company trucks in order to collect wastes from the factories with lower costs. Clarke and Wright method has been used.

3) *Urban Solid Waste Management in Low-Income Countries of Asia:* Case was about how Asia countries would have coped with the Garbage Crisis. In Asian, municipal managers were still facing solid waste management problems. But also, in some cities, innovative ideas and approaches have been implemented on different levels of the solid waste management system like saving heuristic and truck dispatching problem.

4) *Municipal Solid Waste Management: What Is Happening in Other Countries?*
The Social Economic Costs of Flood: A case of the Johor Floods during North-East Monsoon

5) *Optimizing Waste Collection in an Organized Industrial Region:*
The problem could have been classified as mixed integer programming and as GAMS.

6) *Waste Collection Vehicle Routing Problem with Time Windows:* Researchers have focused on commercial waste collection problem in North America. They have solved the problems with Solomon's well-known insertion algorithm which has been extended for vehicle routing problem with time Windows (VRPTW). They have had an extended insertion algorithm and a clustering-based waste collection VRPTW algorithm which have been developed and implemented in a software system. Using the clustering-based waste collection VRPTW algorithm, they could have handled the important practical issues such as route compactness and territory, workload balancing, and computational time.

4. METHODOLOGY

When we consider each garbage container as a node in the network, determining the sequence of containers to be visited is equivalent to the VRP (vehicle routing problem). Therefore, VRP was the method we have chosen for this project. "Vehicle routing problem is a combinatorial optimization problem seeking to service a number of customers with a fleet of vehicles. Often the context is that of delivering goods located at a central depot to customers

who have placed orders for such goods. Implicit is the goal of minimizing the cost of distributing the goods".

We have considered both heuristic algorithms and mathematical programming methods to solve the VRP. Although heuristic algorithms are providing fast solutions, mathematical programming methods could provide optimal solutions and is more applicable for small sized problems. In order to find the most suitable solution method, we needed to perform model simplification, meaning breaking down the large scale problem in to smaller problems. Therefore, we have worked on a sample area and compared related results for selecting the best method. After deciding the exact method to be used, the model has been extended to full scale. The problem on sample has been solved through nearest neighborhood heuristic, intuitive heuristic and mixed integer programming by using GAMS software. We have compared the results and decided to use GAMS software to extend the model. Then, we have applied TSP (travelling salesman problem) formulation and mathematical programming method to the whole problem.

5. DATA COLLECTION AND PROCESSING

We have realized 7 visits to collect data during the project. Two of them were to cleaning services department. Others were to Narlidere Municipality, land registration of the Municipality, Ilica Locality, Muhtar, Uzundere decomposing and waste dump center and Yenikale Locality sample area. Also, we have made some interviews with municipality workers of population office of municipality and petrol-station attendant of cleaning services.

5.1 General Information about the Current System

There were 11 localities and 479 streets in Narlidere District. Municipality has had 10 dustcarts responsible for waste collection. Some dustcarts could have taken 7 - 8 tons of waste and some of them have had only 4 tones of capacity to serve narrow streets. There were three workers allocated to each dustcart, one was the driver and other two working behind the dustcart. If a worker works after 4:30 p.m., municipality has to pay overtime and if they work on Sunday, municipality has to pay three times the regular pay. Cost per worker was around 3,000 TL. and Narlidere's average waste consumption was around 50 tons a day. During Mondays and Thursdays, it has raised up to 80 – 85 tons a day, due to bazaars' waste. Other days, it was around 40 tons. There was not exact information about container numbers. 3,000 containers have been renewed since 2,000 and each container has 400 liters of capacity.

The shifts of dustcarts were from 5 a.m. to 12 p.m. and 7 a.m. to 2:30 p.m. Mithatpasa Street's and school's wastes have been collected each day at 5 a.m. Some of streets' were collected every day, such as Inonu 2nd and Ataturk Locality Streets. For example, some streets like Irmak Street, in Sahilevleri have been collected two times a week due to low population. After trucks are fully loaded, they go to Uzundere, Gediz or Harmandali garbage dumps to unload. In these garbage dumps, separation of garbage by paper, glass, plastic, metal materials are realized. The remaining wastes are converted to fertilizer. Dustcarts were

first directed to Uzundere which was the closest one to Narlidere, but the dustcarts waiting for long queues in Uzundere have been directed to Gediz or Harmandali.

One of the dustcarts has had GPS device which was planned to be tested by next year. It might have been utilized in the whole fleet if the test results have been validated. Due to lack of budget, municipality could not have added a new dustcart to their fleet. However, current fleet was old or depreciated and two dustcarts have been frequently maintained. Maintenance of these dustcarts creates operational problems, in addition to budget and time limitations.

5.2 Required Data for the Model

We have gathered lots of data but the only related data for the model has been listed below:

Worker cost per month: 1.500 TL
Overtime cost for Sundays: 174 TL
Overtime cost per Hour: 10,8 TL
Distance to Uzundere: 15km, 15 minutes
Distance to Harmandali: 70 km, 2 hours
Fuel consumption per dustcart: 56 liters per 100 km
Waste consumption per Residence: 2,1 kg
Waste consumption of Yenikale Locality per day: 4,505 kg

5.3 Data Collection and Processing Process

Data collection process and related assumptions regarding the ways of processing data have been listed below;

Costs of Workers:

- There were three groups with different salaries in which the amount could have differed between workers, even tough, they have performed similar jobs.
- Three workers have been planned per vehicle and so 30 workers should have been included in the model in total with an average salary of 1.500 TL.
- Monthly payments were fixed costs and were not vital for the model as we have focused on variable costs to minimize them. The variable costs were overtime costs in terms of the worker costs.

Overtime Costs:

- For 1- hour work, there would have been a payment of 1.5 hours.
- Daily working hours have been determined as 8 hours and if it has been exceeded, an additional payment of 1.5 times for one hour working should have been given. Considering the monthly working days as 26, the cost would have been 58 TL (daily) and 7.2 TL (hourly)
- Hourly Overtime Cost: 7.2 x 1.5 = 10.8 YTL
- Overtime Work on Sunday: 58 x 3 = 174 YTL

Data related with dustcarts: The data related to dustcarts was very important for the model as they were the principal capacity constraint of the model.

8000kg waste capacity: 3 units

7723kg waste capacity: 2 units
7800kg waste capacity: 1 unit
4800kg waste capacity: 2 units
4000kg waste capacity: 1 unit
3000kg waste capacity: 1 unit

Data that about fuel consumption:

Petrol-station attendant has taken notes about what amount of fuel-oil to which dustcarts have been consumed and written down the km counter only two times, at the beginning and end of the month. The most important problem was that most of the dustcart's km counter has been broken. Only three dustcarts' km counter was working and at this point the handicap was that these dustcarts were the wide capacity dustcarts. Therefore, we couldn't have reached the fuel consumption of small dustcarts per km. However, we have known that small dustcarts were four cylindered motors and big dustcarts were six cylindered motors. Besides, small dustcarts could have carried less weight comparing to others and the consumption of fuel oil would have been lower. The small dustcarts must have oscillated more to Uzundere due to lower capacity. As a result, the km would have been more that they have driven off.

The dustcarts' fuel-oil consumption amounts:

35 UHA 693
Used diesel-oil: 606 liters
Spent km: 1,155 km
Capacity of depot: 250 liters

1,155 km — 606 lit
100 km — X
X= (606 x 100) / 1,155 = 52.47

35 CJJ 56
52 liters in 100km
Used diesel-oil: 569 liters
Spent km: 983km
Capacity of depot: 300 liters
57.88 liters in 100km

983 km — 569 lit
100 km — X
X= (569 x 100) / 983 = 57.88

Backup big dustcart
Used diesel-oil: 140 liters
Spent km: 239 liters
Capacity of depot: 230 liters
58.57liter in 100km

35 AD 0923
Used diesel-oil: 518 liters
Spent km: unknown
Capacity of depot: 250 liters

239 km — 140 lit
100 km — X
X= (140 x 100) / 239 = 58.57

UK 175
Used fuel-oil: 792 liters
Took diesel-oil once a week on average

BRC 56 Small dustcart (4 cylinder)
Took fuel-oil every few days
Used fuel-oil: 475 liters

Capacity of depot: 110 or 120 liters

In the model, we have planned to use three dustcarts that have been averaged out the fuel-oil consumption per km. 52 + 58 + 58 = 168 / 3= 56. We have set fuel consumption of small dustcarts as 45 liter per 100 km as their engine capacity was less than others. Their engine was 4 cylindered.

Uzundere decomposing and waste dump center:

We have visited the facility to learn the reason of dustcart queues and density. We have negotiated with Mehmet Yilmaz and gathered information about the facility. Uzundere garbage heap was advantageous according to Harmandali, because of the highway connection and closeness to Narlidere. When the institution was out of order, it hasn't accepted the wastes belonging to the municipalities and so the dustcarts must have been driven off to the Harmandali. Hence, we have required forming a flexible model. If Uzundere was out of order the dustcarts would have gone to the Harmandali garbage heap in the model.

The basic information about the facility was that;
The facility has been constructed in 1988
250 - 300 ton of waste has come daily (on average)
The facility's capacity was 170 - 200 tones per shift (8 hours)
Double shifts on summer
Only the 3% of the wastes could have been decomposed
Whether decomposition has started from houses this percentage could have reached to 9%.
One tones of paper has saved 10 trees.
Everyday 15 trees have been saved in this facility.
35 people were working.
Facility has been operated by private company.

5.4 Demand Calculation:

We have organized a visit to the land registration or zoning department to learn the lengths of the streets which were vital in terms of calculating costs. We also needed to learn the population of the streets, which was vital in terms of demand satisfaction constraints. We have got a scaled map during the visit. Thus, we have measured the length of the streets. Also we have reached the residence number per street data by entering to Population Office of director's website from municipality's database.

The residence numbers by localities

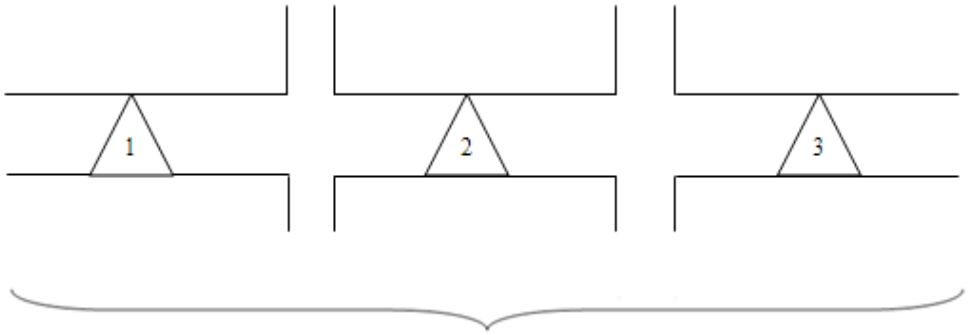
1) Yenikale Locality : 2,145
2) Ilıca Locality : 4,441
3) 2. İnönü Locality : 2,443
4) Altıevler Locality : 791
5) Atatürk Locality : 1,738
6) Çamtepe Locality : 2,845
7) Çatalkaya Locality : 2,482
8) Huzur Locality : 2,696
9) Limanreis Locality : 1,071

Narlidere District waste consumption: 50.000 kg

$\frac{50,000}{24,205}$ waste consumption per residence = **2.1 kg**

10) Narlı Locality : 2,780
11) Sahilevleri Locality : 773
TOTAL **24,205**

Calculating and Assigning Demand to the Nodes:
We have calculated and assigned demand to the nodes to be able to use dustcart capacity constraint and to know in which node the capacity of dustcart has got filled. When assigning demand, our approach was to use proportion between lengths of the streets. The length of the streets and related residence numbers were known, so the demand of nodes could have been determined by making proportion to the streets.



Length of whole street: 100 m
The residence number of street: 50
Node 1: 35 m

Excel Formula

The length of the street	100
residence number	50
demand point length	35
residence number of node 17,5	
demand as kg	37

$$\frac{50 \times 35}{100} \times 2{,}1 \text{ kg} = 37 \text{ kg demand}$$

6. IMPLEMENTATION

Yenikale Locality has been determined as our sample area, due to its size and shape and assigned node edges of each street. We have assumed that if all nodes have been visited, the demand of each street would have been satisfied. Best route should possess the following features: minimum distance, minimum cost, minimum travel time. The aim of the model is to pick up wastes from streets and deliver them to the Uzundere with minimum possible distance and cost. We have solved the VRP defined on the sample area with two heuristics and GAMS.

Operational Constraints

- The number of dustcarts have been fixed as *m=10*, but could have been set flexible if required as well.
- The total demand transported by dustcarts could not have exceeded the capacity.
- Time window would have been ignored in the first simple model. However, time related constraints have been planned to be added to find overtime costs. Therefore, vehicles could have been managed real-time. GIS, GPS, traffic flow sensors could have provided real-time data the GPS data could not have been received from the municipality.
- The dustcart had to go to Uzundere, which was 15 km away, or to Harmandali which was 70 km away, to discharge wastes after the capacity has got full.

As a simplified VRP:

Given:

A set (fixed number) of pick-up points,

The demand at every pick-up (determined),

A set (fixed number) of vehicles = 10

All relevant distance information across pick-up points.

Solution:

Assigning pick-up points to vehicles

Sequencing pick-up points on the route of each vehicle

Objective:

Minimizing the total distance traveled by the dustcarts.

Constraints:

Every route terminates at the Uzundere garbage heap

The capacity of vehicle was restricted to 8 tones

Each pick-up point has been visited once only. It has meant that all nodes would have been visited

All waste collection demand would have been satisfied

Traveling Salesman Problem:

$$\sum_{(i,j)\in A'} c_{ij}x_{ij}$$

subject to

$$\sum_{i\in V'\setminus\{j\}} x_{ij} = 1, \quad j \in V',$$

$$\sum_{j\in V'\setminus\{i\}} x_{ij} = 1, \quad i \in V',$$

$$x_{ij} \in X, \quad (i,j) \in A',$$

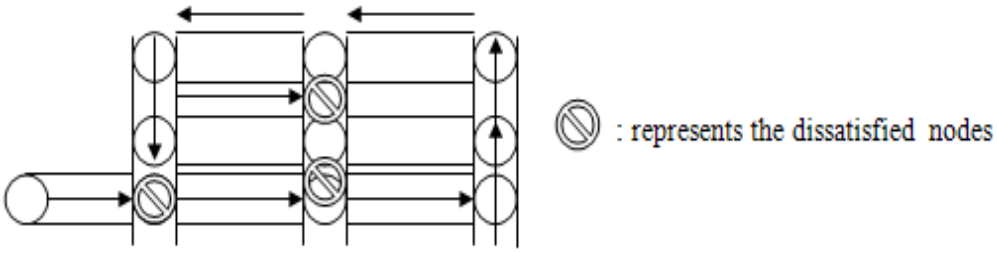
$$x_{ij} \in \{0,1\}, \quad (i,j) \in A'.$$

6.1 First Model Results

GAMS SOLUTION
Total distance: 1525.54
NEAREST NEIGHBORHOOD HEURISTIC SOLUTION
Total distance: 1606.56
INTUITIVE HEURISTIC SOLUTION
Total distance: 1704.87

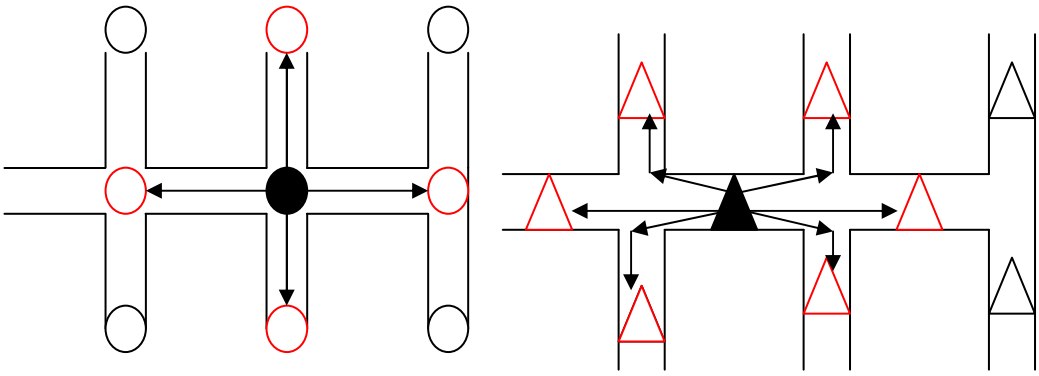
Result: GAMS has given the best solution. However, when the route has been outlined, it has been realized that there were dissatisfied streets although all nodes were visited. Therefore, we needed a new model and we have decided to change the location of the nodes. The new nodes were located in the middle of the streets. Thus, the problem could have been solved.

Model 1



6.2 Second Model and Results

Model 1 Model 2



Important note is that Model 2 has brought high mobility to the model. In model 1, one node was connected to only 4 nodes. However, in model 2, a node is connected to 6 nodes. Suppose, if the dustcart was at the black node, the red nodes would have been alternative nodes for the dustcart.

New Results with Model 2:

- ✖ GAMS solution was **12%** more efficient than Nearest Neighborhood solution.
- ✖ GAMS solution was **10%** more efficient than Intuitive solution.
- ✖ When the problem size has got bigger, the gap between GAMS solution and intuitive would have definitely been increased.

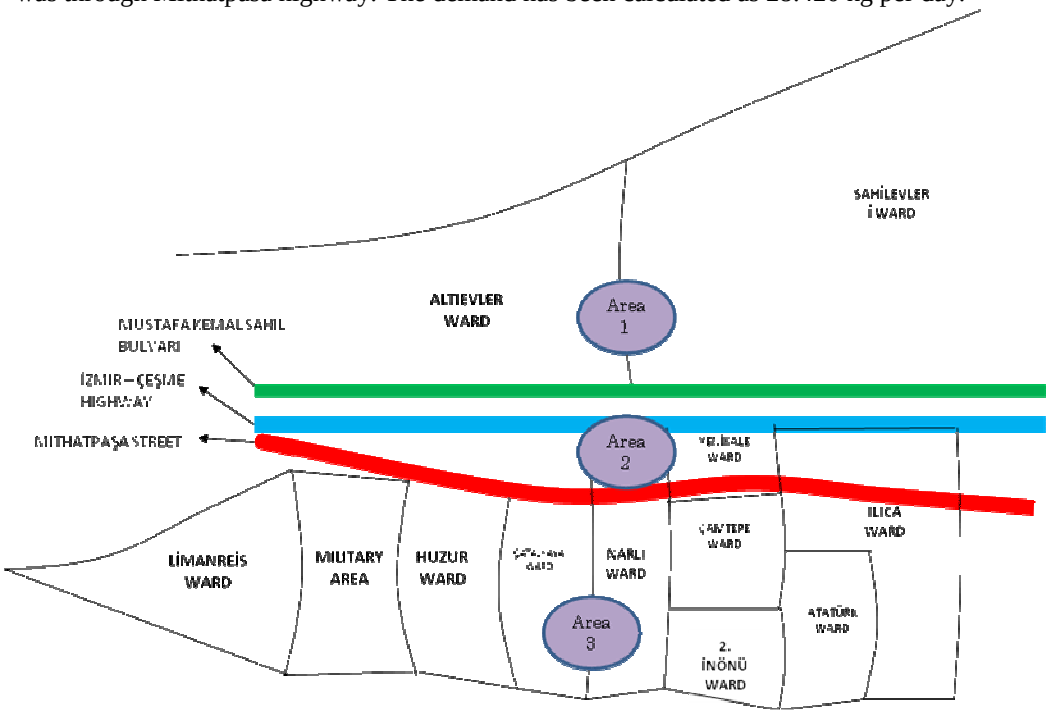
GAMS SOLUTION
Total distance: 2558 m
Satisfied demand: 1204 kg
NEAREST NEIGHBORHOOD HEURISTIC SOLUTION
Total distance: 2.879 m
There was one unsatisfied node.
INTUITIVE HEURISTIC SOLUTION
Total distance: 2.796 m

NOTE: GAMS have given the best results again. Therefore, we have decided to eliminate two heuristics and to expand the model with GAMS software.

6.3 Expanding Model

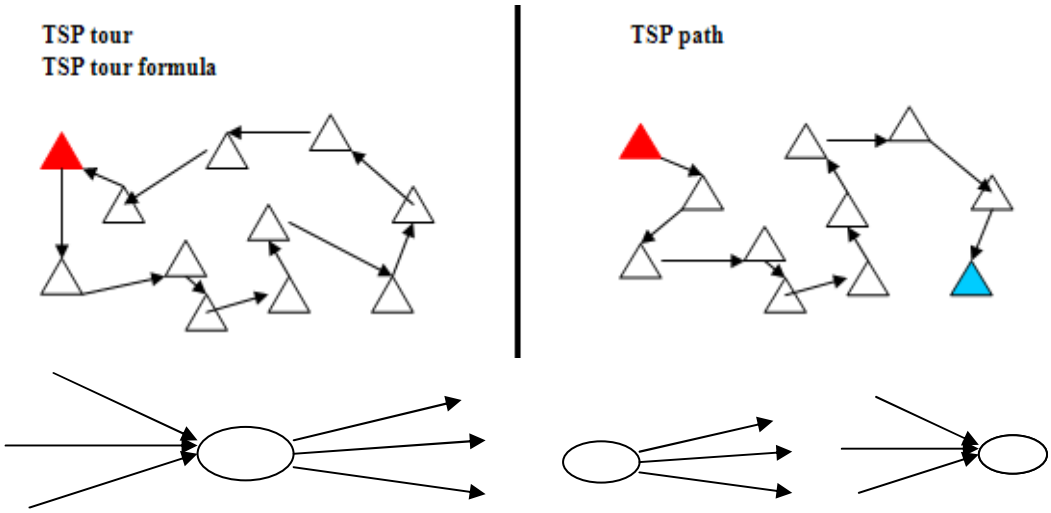
The model, which was constructed only for the sample area should have been expanded so that it includes all localities. In other words, we should have applied the model to the whole Narlidere district. We have decided to divide the problem into three parts due to geographical characteristics of the district since Narlidere has been divided into three parts in line with three highways, Izmir-Cesme express highway, Mustafa Kemal Sahil Boulvard and Mithatpasa highway as shown in the following figure.

Area one has consisted of two localities and this part was on Izmir-Cesme express highway. The demand of area one has been calculated as 3.361 kg per day. Area two consists of Yenikale locality and some parts of other two localities, between Mithatpasa highway and Izmir-Cesme express highway. This area's demand has been calculated as 6.550 kg per day. Demand could have been satisfied by one dustcart. Area three, which was the biggest one, was through Mithatpasa highway. The demand has been calculated as 28.420 kg per day.



Converting from TSP tour to TSP path

According to the first model, the dustcart has made a tour, that is dustcart has started with one point ended at the same starting point. This situation obviously causes higher distances to be travelled by the dustcarts since they do not have to turn to starting point. This situation has negatively changed the route. Also, this would have caused a problem when dustcart has started to the second tour after dustcart has turned back from Uzundere to Narlidere. Therefore, we should have converted the tour TSP to path TSP to prevent unnecessary returns.



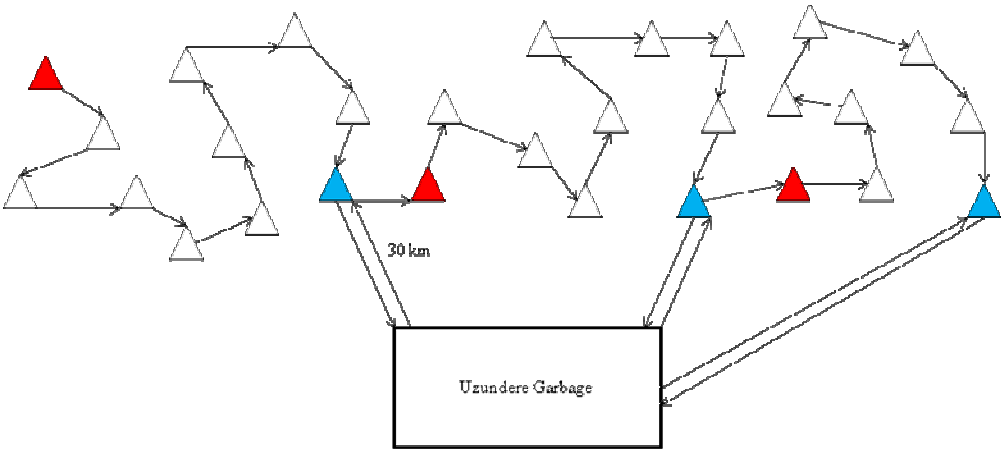
TSP path Formula

According to TSP tour, all nodes has had back and forth arcs but according to TSP path, first node has only outgoing arcs and the last node has only incoming. The remaining all nodes have to have both incoming and outgoing arcs. Definitely, TSP path would be shorter than TSP tour. According to TSP path, the dustcart has got filled at blue node and this node would have been the starting point of the second tour while the dustcart has discharged its load to the Uzundere garbage.

Capacitated TSP

In the first model, we have ignored the capacity constraints. However, the constraints should have been added to make the model more realistic. The most important constraint was dustcart capacity constraint and the other constraint was Uzundere garbage constraint. We could have not entered these constraints to the software at first. Therefore, we have planned to add them manually.

The red nodes have represented the starting points and blue ones have represented the ending points which dustcart capacity has got filled.



7. RESULT ANALYSIS

DAYS	AREA	WASTE AMOUNT	ALLOCATED TRUCK	TOTAL UZUNDERE VISITS
Bazaar Waste		16,000 kg	8000a, 8000b	
Monday - Thursday	1	4,052 kg	4,000a	28
	2	8,028 kg	8,000c	
	3	47,958 kg	7,723a, 7,723b, 7,800a, 4,800a, 4,800b, 3000a, 4,000a Second Shifts: 4,000a , 7800a, 3000a	
Tuesday - Friday	1	2,658 kg	do not collect	12
	2	5,146 kg	7723a	
	3	32,253 kg	8000a, 8000b, 7723b, 4000a, 4800a	
Wednesday - Saturday	1	6,019 kg	7,723b	16
	2	6,550 kg	7,723a	
	3	38,150 kg	8,000a, 8,000b, 8,000c, 7,800a, 4,800b, 3,000a	

Capacity Utilization

Dustcarts	Monday - Thursday	Tuesday - Friday	Wednesday - Saturday
8,000a	100%	100%	96%
8,000b	100%	95%	88%
8,000c	100%	-	100%
7,723a	100%	67%	86%
7,723b	100%	98%	85%
7,800a	95% (avg. two shifts)	-	98%
4,800a	100%	100%	-
4,800b	100%	-	100%
4,000a	95% (avg. two shifts)	100%	-
3,000a	96% (avg. two shifts)	-	100%
Avg. Capacity Utilization 56 times Uzundere Facility	97,5%	94%	93%

- In bazaar days, all dustcarts have to operate, because of 80 – 85 tones waste
- After the bazaar days (Tuesday and Friday), the waste amount decreases the 40 tones.
- Therefore 4 dustcarts do not have to operate. These dustcarts can be sent to collect the school, hospital or military wastes.
- Wednesday and Saturday; the waste amount is 50 tones and not collected waste of Area 1 (2,658 kg).
- These days dustcarts, which is not operated in Tuesday and Friday, are used.
- If our dustcart was not use its capacity efficiently, in Monday – Thursday would make more shifts and also the other days back-up dustcarts would operate.
- Thus, Uzundere Facility travels would increase. We estimate least 7 unnecessary travels saved.
- This is 7 x 30 km = 210 km per week. Also, dustcarts saved the travel distance due to better routing.
- Overtime should be paid 7,800a workers for second shift.
- Total Uzundere visit distance per week: 56 x 30 = 1,680 km

What if analysis?

What if 8,000a and 4,800a are broken?

DAYS	AREA	WASTE AMOUNT	ALLOCATED TRUCK	TOTAL UZUNDERE VISITS
Bazaar Waste		16,000 kg	8,000b, 8,000c	
Monday – Thursday	1	4,052 kg	4,000a	26
	2	10,796 kg	7,800a, 3,000a	
	3	47,958 kg	7,723a, 7,723b, 4,800b Second Shift 8,000b, 7,723a, 4,000a, 4,800b, 3,000a	
Tuesday – Friday	1	2,658 kg	do not collect	12
	2	5,146 kg	7723a	
	3	32,253 kg	8,000b, 7,800a, 7,723b, 4,000a, 4,800b	
Wednesday - Saturday	1	6,019 kg	7,723a	18
	2	6,550 kg	7,800a	
	3	38,150 kg	8,000b, 8,000c, 7,723b, 4,800b, 4,000a, 3,000a, Second Shift 3,000a	

Capacity Utilization

Dustcarts	Monday - Thursday	Tuesday - Friday	Wednesday - Saturday
8,000a	Broken dustcart	is under	repair
8,000b	97% (avg. two shifts)	100%	97%
8,000c	100%	-	100%
7,723a	99% (avg. two shifts)	67%	86%
7,723b	100%	100%	100%

7,800a	100%	98%	86%
4,800a	Broken dustcart	is under	repair
4,800b	100% (avg. two shifts)	100%	100%
4,000a	100% (avg. two shifts)	100%	97%
3,000a	99% (avg. two shifts)	-	100% (avg. two shifts)
Avg. Capacity Utilization 56 times Uzundere Facility	99,6%	96%	97,5%

- Generally second shifts are done by low capacity dustcarts, because they get filled more quick than bigger dustcarts.
- Therefore, they can catch the second shift within work hours. Thus, Narlıdere Municipality does not face extra overtime costs.
- Only, on Monday and Thursday, overtime money should be paid to the 8,000a workers.
- Capacity utilizations are increased because of lack of 2 dustcarts.

Monthly Analysis

- ✖ Total Travelling Distance: 8,653 km
- ✖ Total Uzundere Visits: 224 times
- ✖ Total Fuel Consumption per month: 4,586 Lt
- ✖ GAMS Result: 1,239 pages

8. PROJECT EVALUATION

8.1 Project Outcomes

We have tried to reduce the fuel consumption and overtime costs by designing the routes of dustcarts as well as applying the most effective and efficient routes to the Narlidere municipality's localities. We have tried to reflect the real results to the Municipality.

8.2 Contribution to Company

The project has contributed to Municipality to see the operational and academic method of designing the waste collection routes of the localities for the Narlidere municipality and to be informed about the technique of using the technology to reach the efficient rate results of the routes by GAMS. The aim was to show municipality different perspectives of reducing the oil consumption and we have chosen the most effective and efficient way to suggest them.

8.3 Contribution to Student

This project has educated us for the business sector and given us an idea about the authorized person in the Municipality and also we have had an experience on how to deal with them and how to carry on a business by ourselves. We have experienced to overcome hard jobs using the time efficiently and to work in a team and understood how it is difficult.

8.4 Performance of Team

The team performance was really good. We could have handled all the duties. Sometimes, some duties have taken lots of time, but we have not run out of the schedule. In addition, we have faced some difficulties and found solutions. We have helped each other and done our best.

8.5 Performance of Company

Responsible people in the Municipality has helped us a lot and provided all necessary information on time.

8.6 Performance of Academic Advisor

We have realized one hour of meetings on Tuesdays with our academic advisor Muhittin Hakan Demir. Our academic advisor has taken a strong interest in the project and directed us carefully and successfully. He has shared his opinions and explained them briefly. Also he has listened to our ideas about the project and evaluated them accordingly.

9. CONCLUSION

At the end of the project, we have concluded that, if the real location of containers could have been determined, the problem could have been solved. We have proved it by designing route plan which have visited all streets. Also similar problems could have been solved with the model by GAMS if the required data has been arranged.

Besides route plan, we have made suggestions to Municipality about allocating dustcarts to the areas. Also we have made cost analysis of the operations.

As a result we have expected reduction in fuel consumption and overtime cost due to better routing. Thus, service quality of citizens might have been increased, excess air pollution could have been prevented, time could have been saved or money could have been saved due to less fuel consumption.

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WASTE MANAGEMENT OF BALÇOVA MUNICIPALITY

Yegül Aykaş, Selen Güllüdağ, Okan Tümbaş, Haluk Korkmaz, Sarper Çolakoğlu, Oktay Kaan Hügül

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EXECUTIVE SUMMARY

The aim of this project is to improve the process of household waste collection for Balçova Municipality. A network model of the process is presented along with a definition of associated nodes and arcs.

The project started by meetings with the managers of the municipality, and data collection. A street map indicating the current process flow (which truck collects the garbage from which territory), distances driven by a single truck, consumption of trucks, length of streets, number of garbage containers as well as number of workers, number of streets and number of domiciles were used as inputs to the project.

A predetermined division of the total area into 6 regions was decided at the beginning of the project, whereby the remainig problem turned into a routing problem. Each region was assigned to one of the group members.

A heuristic method was then applied to each region. Finally, the integration of the routes for the 6 regions formed the proposed solution.

The project also involved the creation of a web-page, for sharing information with possible interested parties.

1. INTRODUCTION

1.1 General Overview

This project focuses on improving the waste collection process of Balcova Municipality with the objective of efficient and optimum routing of garbage collecting vehicles, reduction in fuel consumption and time saving. To achieve these objectives, the group has arranged regular meetings with the municipality personnel working at the office of garbage collection hub. In order to be able to process the data obtained from municipality in the most effective way, regular meetings with the advisors and group members have been arranged. According to the decisions taken in internal meetings, project has been directed to get most efficient solution for municipality. Based on the schedule, regions have been shared between members and matrix in Excel to be applied in Matlab has been prepared. In addition, directions on the maps have been drawn and according to distances, heuristic approach has been used.

1.2 Motivation

Balçova Municipality waste collection was a challenging problem for us in terms of applying optimization, studying on maps, working with experienced people, applying different types of methods such as heuristics, route optimization and VRP approach.

Applying optimization was an important opportunity for the group to practice previous studies regarding optimization in business life which could have improved abilities and knowledge about optimization. Map studies on real organizations have thought us that carrying out a project would require professional solutions and besides, applying heuristic has created awareness on the realities of the streets that we live in.

Being able to take place in the same organization with experienced people, have helped us to achieve a high level of success. On the other hand, the idea of benefiting from the experiences of the advisors and employees in municipality, have directed us to choose this project. Besides, opportunity of applying wide range of different methods in municipality project was another reason for us to prefer this project, as it would have created difference for us in future business life.

1.3 Goals

- ✓ Applying the heuristic for each region to provide garbage waste collection routes in the most efficient way
- ✓ Less fuel consumption for cost saving
- ✓ Efficient use of trucks
- ✓ Efficient use of employees
- ✓ Speed in operation
- ✓ Efficiency while unloading
- ✓ Interviewing authorized people about alternative routes
- ✓ Minimizing undesired situations

1.4 Background of Balçova Municipality

Balçova municipality has been founded in 01.03.1963. Balçova is 15 km away from the city center. Balçova Municipality is serving with 12 garbage trucks to the area.

2. PROBLEM DEFINITION

The main problems of Balçova Municipality were determined as follows;

1. **Excess Fuel Usage:** Due to manual design of the routes and irregular settlement, trucks were using more fuel than usual. Excess fuel usage problem has been considered in the fourth stage of the implementation.
2. **Lack of Employees:** 12 of 32 workers were losing time while waiting for discharging the garbage. Lack of employees was an obtacle in front of cleaning the streets of Balçova and that's why it was not effective at the same level in every territory at the same time. Workers who were wasting most of their times during discharge and cleaning of streets, were not sufficient enough at servicing to public. Lack of employee problem has been considered in the first stage of the implementation.
3. **Lack of Equipment:** The equipments of the municipality were being repaired in the related department of the municipality, and some of the equipments have partially been available by the department itself with limited resources. Lack of equipment has been studied in the second stage of the implementation.
4. **Lack of Place of Disposal:** Izmir's waste disposal places were few and these places have not been placed strategically. Balçova Municipality was using Uzundere Garbage Station for the disposal of garbage. Lack of equipment has been considered in the second stage of the implementation.
5. **Loss of Time:** As stated before in "Lack of Employee" part, irregular settlements have caused excessive usage of time as well as excessive fuel consumption. Loss of time has been considered in the fifth stage in the implementation.

2.1 Challenges

In order to solve the excess fuel usage, we have decided to build an integer programming model and selected the heuristic as a solution method. Each group member was responsible in implementing the same heuristic to his/her own area to find the routes and calculate the best solution. Finally, putting these together, vehicle route has been determined.

3. LITERATURE REVIEW

As the project group has conducted a literature research on the project title, an academic research paper has been found. This study has stemmed from the need to address the problems in waste collection for the cities of Ghana, where the hot weather and the lack of resources were the main issues. Also the combination of these two factors has made the problem more significant from environmental and health point of view. The research paper has also expressed the collection process of waste and mentioned that all containers along the streets must have been collected by a fleet of vehicles without exceeding the capacity of the

vehicle but, large institutional sites such as schools, hospitals, and apartment complexes have needed larger metal/rubber containers. The collection process of a vehicle has started from the depot at the start of the day and the vehicle must have returned there empty at the end of the day. The first trip has begun where the vehicle has collected waste along the streets. When the vehicle was full, it has gone directly to the dump site located at some distance from the city to unload the refuse. Then, the vehicle has gone back to the city to begin its second trip. After completing its final trip, the vehicle has proceeded to the dump site to unload for the last time, and finally returned to the depot. Each tour was a sequence of two or more trips. One feature of the situation in the urban areas was that there were two or more dump sites from which to choose to empty the vehicle, which were distributed round the city. The depot was not generally a dump site. The research paper has also indicated that the possible approach for the related work was to find a giant tour and then decomposed it into a set of routes which were feasible with regard to the vehicle capacity. Another commonly used approach was the path-scanning procedure, which was based on the construction of one cycle at a time using a certain myopic optimization criterion. In forming a cycle, an edge that looks most promising has been added until vehicle capacity was exhausted; then the least cost path to the depot has been followed to form a complete cycle.

Christofides (1973) has developed construct-strike algorithm for the solution of the undirected Capacitated Chinese Postman Problem (CCPP). The basic idea of this algorithm was to construct feasible vehicle routes and this procedure was repeated until no feasible vehicle routes could have been determined.

Insertion procedures for the Travelling Salesman Problem (TSP) have been used by Chapleau et al. (1984) to develop their heuristic, known as parallel-insert. Finally, the research paper has indicated that the algorithm could have worked with the combination of two different objective functions: the minimization of the total cost (time or distance) of the operation and the inconvenience due to smell.

3.1 Waste Management Strategy

The waste management strategy and institutional strengthening component of the Novgorod Solid Waste Management Project has focused on strategic planning and institutional aspects of the entire Waste Management System.

3.2 Strategy Framework

The strategy for future management of waste has contained a proposal for the development of the waste collection system to include source separation of MSW by means of a decentralized collection point system and a central source sorting and waste transfer station. Selected waste materials would have been separated with the purpose of sale to specialized industrial enterprises while residual wastes have been transferred to the landfill.

Currently, twelve (2006) points for collection of separated waste were in operation. According to investigations carried out in 2005, per capita small-sized mixed solid waste

(MSW) generation in modern residential areas of Novgorod have amounted to 1.76 m3/year (approx. 265 kg/person/year). The above average amount of MSW has comprised household wastes and yard cleaning wastes. According to investigations carried out in 2005, the MSW production in Novgorod per capita (size of households untold) has been presented below:

- The average density of the MSW was 151 kg/m3.
- Big-sized MSW average per capita, from the above mentioned residential areas have amounted to 0.420 m3/year, 75 kg/ person/year.
- The average density of the big-sized MSW was 177 kg/m3. The big sized MSW has comprised worn-out furniture; refrigerators, TVs, large cardboard boxes, apartment, renovation wastes, as well as green waste i.e. mowed grass and branches from yard trees.

4. APPROACH

At the beginning, the network of the pilot region has been determined and integer programming model and corresponding heuristics solution was developed for this pilot region only. Then, each group member implemented the same methodology to his/her own region If any capacity problem was to emerge in integrating different regions a new truck would have been moved. After timing has been formed, traffic and the period of waste collection would have been considered.

By applying several VRP algorithms, the most proper model have been created and after eliminating all the mistakes, related costs have been checked. In case of a situation of not being able to solve the problem after focusing on fuel cost and other expenditures, project has been directed to other minimum cost solutions.

As a result of the research that has been made, VRP programs have been remarked as being high priced. At the stage of program determination, we would have considered the data capacity of the program. After having received the maps, we would have decided on the most proper VRP program for the project. Furthermore, the program called Lingo that we have used at the university would have been observed. First of all, we have created the model which was related to waste collection. Then, this model has been executed by the Lingo application. However, we have faced some problems. Afterwards, we have tried to understand to Chinese Postman Problem approach and studied over. Then, we have created heuristics on the basis of this study. This approach has led to double passes on each arc due to odd nodes. We have tried to minimize it. Heuristic was an experiment method. So, we have tried to use matlab for the heuristic method in order to outline the differences between manual and computerized applications.

5. DATA COLLECTION & ANALYSIS

5.1 Data for the first semester

The data which has been collected in first semester after preparing heuristic was as follows;

- The map of Balçova
- There were 640 streets in Balçova
- There were 30.000 domiciles in Balçova
- Balçova Municipality has had 12 garbage trucks and 2 backup trucks
- Balçova Municipality has had 32 workers (Workers were working according to a shifting periods).
- Daily shifts have begun from 8:00 am and ended at 17:00 pm. There were some definite times announced by municipality to gather garbage collected from the houses, as “Ata Avenue at 8:30”.

5.2 Data for the second semester

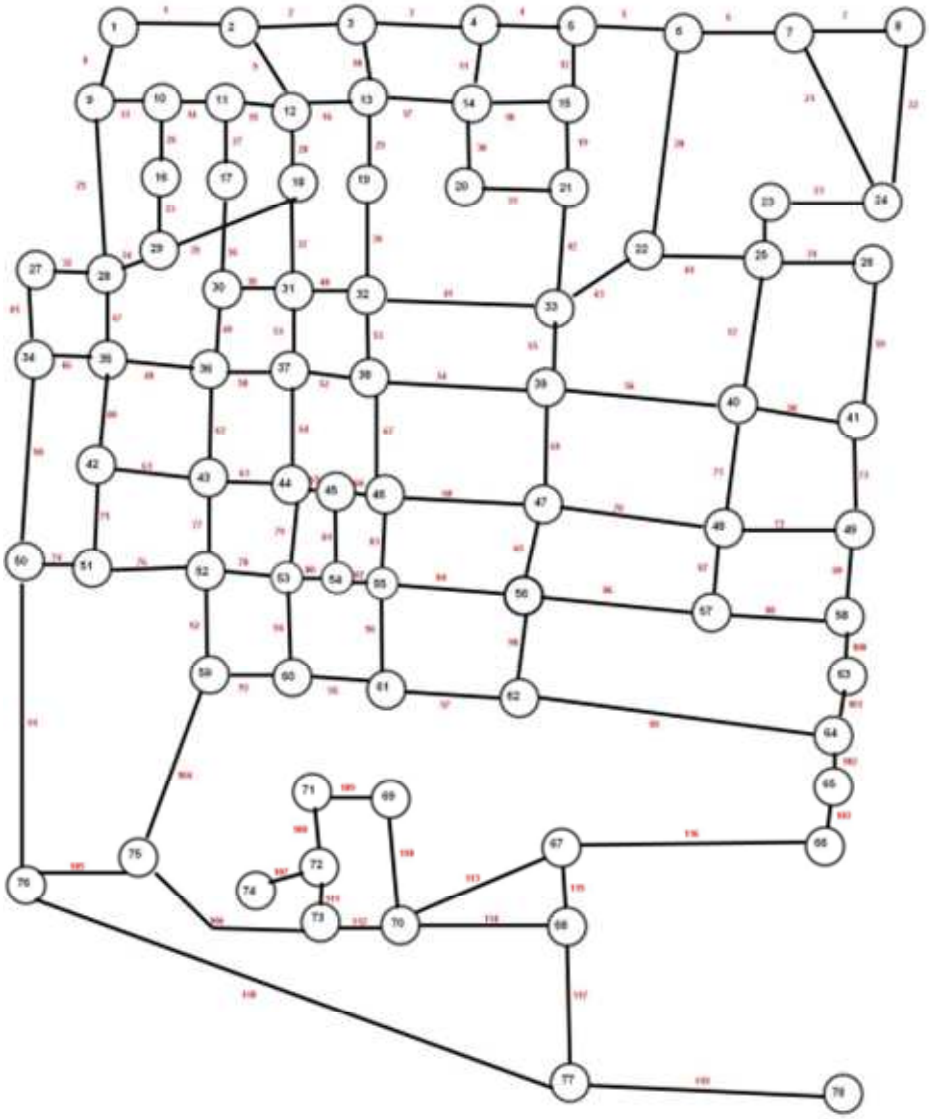
The data which has been gathered in this semester after preparing heuristic was as follows;

- Truck data (In total there were 14 garbage trucks belonging to Balçova Municipality. In usual operations, 12 trucks have been used. The 2 of these trucks were small with 2 tons of capacity while others having 4.5 tons)
- The average number of 800, 400 lt containers and plastic boxes gathered by 4,5 tons of trucks, was 98.
- The fuel consumption of 4,5 tons of trucks at 63 km was 15 lt. (including a back and forth route in discharge area of 22 km)
- According to the map provided from municipaltiy, it was definite that each truck was able to visit each street; as a result, it hasn’t been required to study and got measurement on GPS.

6. IMPLEMENTATION

Balçova area, that the municipality was responsible for, was beginning from Üçkuyular metro station to 9 Eylül Hospital, including Inciralti as well. Before solving the model, map has been divided into six regions, every territory has been modeled and distances between each street have been calculated after defining the nodes. First of all, the network of the pilot region has been calculated, the nodes and arcs have been defined and the model has been set up accordingly.

6.1 Sample Network for the Region Near IEU



6.2 Sample Model for the Region Near IEU

Objective = Minimize total route cost.

Constraint = All streets (node) to be visited.

$\text{Min} \sum_{ı,j} C_{ij} X_{ij}$

$\sum_{ı} X_{ij} = 1$ (Each node to be visited)

$\sum_{j} X_{ij} = 1$ (Should not stop at an intermediate node)

$\sum_{i,j} X_{ij} = n$ (Prevent sub-tour) n: number of nodes

$Xij = \{1, \text{if j was visited right after i}, 0, \text{otherwise}\}$

After this, we have tried to execute heuristics.

6.3 Heuristic

6.3.1. Infrastructure of Heuristic:

1. Nodes and length of arcs have been defined (start and ends of the streets)
2. Odd nodes have been defined and marked.
3. The smallest arcs connected to odd nodes have been chosen among the arc connected to odd nodes.
4. The lines double passed have been defined in the predicted route.
5. In order to measure the level of success, steps listed below have been followed:
   - ✓ Summations of each arc distance have been calculated.
   - ✓ The lengths of double passed arcs have been calculated.
   - ✓ Summation (length of drawn route)

First, summation of the shortest arcs connected to odd nodes and length of each arcs have been calculated. Then, result of this calculation and the result of group's calculation have been compared. Outcome of this comparison has shown the success rate. The double passes over shortest arcs have been connected to odd nodes, because odd nodes have increased the level of success, they have been chosen to pass.

6.4 Specifications of Regions and Regions Heuristics

As expressed before, the project area has been divided into 6 regions, and each region has had their own characteristics and statistics.

6.4.1 Yegül's Region

This region has succeeded by %92. This part was near the university and surrounded by avenues. Northern border of region was Mithatpaşa Avenue, southern border of region was Sakarya Avenue, eastern border of region was Ata Avenue and western border of region was Vali Öğütçen Avenue. Length of arcs were similar, they were generally short. Domiciles have been located in an order. In this match structure, every node was generally in order. Yegül's region has been linked by Selen's region.

Technical Information about Yegül's Region

Yegül's Success Rate

- Total route: 5.4
- Optimal route: 5.4 + 1.25 = 6.65 (1.25 was the total of optimal double passes)
- Yegül's heuristic route: 5.4 + 1.82 = 7.22 (1.82 was Yegül's total of optimal double passes)
- 6.65 / 7.22 = 0.919068 ≈ 0.92

Figure 1- Yegül's Region

6.4.2 Selen's Region

This region has succeeded at a rate of 97%. Selen's border has started from Ortanca Street and then continued with Yasemin St. and Nilüfer St. Then Manolya St., Nane St., Sarmaşık St., downwards Yiğit St., Çağatay St., Kaan St., and Demirci Efe St have been located. When continued, Ahlat St., Uygar St., Neşe St., Kamelya St. and finally there was Ortanca St. The arc distances between the streets were generally 0.02 – 0.05 and 0.06-0.14 km between avenues. The structure of the area was crooked. The borders have directly been linked by Sarper and Yegül's borders.

Figure 2- Selen's Region

Technical Information about Selen's region

Selen's Success Rate

- Total route: 14.3
- Optimal route: 14.3 + 2.62=16.92 (2.62 was the total of optimal double passes)
- Selen's heuristic route:14.3 + 3.25=17.55 (2.62 was Selen's total of optimal double passes)
- 16.92 / 17.55=0.964103 ≈ 0.97

6.4.3 Sarper's Region

This region has succeeded at a rate of 98%. Sarper's area has included Fevzipaşa district. Its borders were Ata Avenue on the west, Sakarya Avenue on the south, Çağatay Street on the east and Mithatpaşa Avenue on the north. Structure of residential area was heavily irregular. Sarper's region was connected to Selen and Kaan's region.

Figure 3- Sarper's Region

Technical Information about Sarper's Region

Sarper's Success Rate

- Total route: 19,6
- Optimal route: 19,6 + 0,24= 19,84 (0,24 was the total of optimal double passes)
- Sarper's heuristic route: 19,6 + 0,71 = 20.31 (0,71 was Sarper's total of optimal double passes)
- 19,84 / 20,31 = 0.9763 ≈ 0.98

6.4.4 Kaan's Region

This region has succeeded at a rate of 91%. The streets and avenues taking place in eastern border were Mithatpaşa Avenue, Ziya Gökalp Street. The northern frontier has been drawn by the extension of Ziya Gökalp Street until Orhun Street and this part of border has continued with Ata Avenue till the western side of the territory and ended with Sokullu Street. There has been a territory in this region that has expanded as crooked structure during the development period of region due to unplanned constructions.

Figure 4- Kaan's Region

Technical Information about Kaan's Region

Kaan's Success Rate

- Total route: 3,980
- Optimal route: 3,980 + 0,84= 4.81 (0.84 was the total of optimal double passes)
- Kaan's heuristic route: 3.980 + 1.295 = 5.27 (1.295 was Kaan's total of optimal double passes)
- 4.81 / 5.27 = 0.912 ≈ 0.91

6.4.5 Okan's Region

This region has succeeded at a rate of 96%. Okan's region was near to the Ata Avenue. There haven't been any avenues at this region. But, there were so many streets. Northern side was Destan Street, southern side was Kerim Tekin Street, eastern side was Uğur Mumcu Street and also western side was Ata Avenue. They have been orderly configured. Some streets were mainly longer, few streets were short or small. This region was connected to Haluk's region and Kaan's region.

Figure 5- Okan's Region

Technical Information about Okan's Region

Okan's Success Rate

- Total route:9.72
- Optimal route:9.72+2.7 =12.42 (2.7 was the total of optimal double passes)
- Okan's heuristic route:9.72+3.23 = 12.95 (3.23 was Okan's total of optimal double passes)
- 12.42 / 12.95 =0.9590 ≈ 0.96

6.4.6 Haluk's Region

This region has succeeded at a rate of 93%. Haluk's borders were Timurlenk Street at the west, Ata Avenue at the east, Kadir Paşa Street at the south east and Sarıpınar Street at the south west. There were totally 81 nodes and 70 arcs taking place in this border. The mean distances of the streets were generally 700 meters (0.07 km) and the mean distance of the avenues were generally 1200 meters (0.12 km). The structure of domicile was regular in the northern part of the area, but the southern part the structure of domicile was scattered. This region's borders have directly been linked by Sarper and Okan's regions.

Figure 6-Haluk's Region

Technical Information about Haluk's Region

Haluk's Success Rate

- Total route:3.42
- Optimal route:3.42+0.61 = 4.03 (0.61 was the total of optimal double passes)
- Haluk's heuristic route:3.42+0.91= 4.33 (3.23 was Haluk's total of optimal double passes)
- 4.03 / 4.33 =0.9307 ≈ 0.93

6.5 Capacity

Based on the capacity constraints, 4,5 tons of garbage was equal to 98-100 piece of plastic containers, 400 and 800 lt. containers. So, after visiting 80-100 nodes, the truck has been fully filled and moved to discharging area by leaving its routes to another truck.

6.5.1 For Yegül's Region

In total, for a region with 80 nodes, the distance of a truck was about 7.22 km. The truck, which has begun collecting garbage from the entrance of Vali Öğütcen Avenue through Inciraltı, has visited 80 nodes and fully filled its capacity, as it has arrived to Izmir University of Economics.

6.5.2 For Selen's Region

The region in which there were 148 nodes, 17.55 km has been driven by truck. The truck, which has begun the collection by the street of Cagdas Avenue through Inciraltı, has visited 84 nodes and fully filled its capacity when it has reached to intersection of Sinem and Seğmen Streets. Then, another truck has continued to collect the remaining 64 containers by moving from Inciraltı. At the final point of 64th node, truck has moved through Sarper's region after being filled in Selen's region.

6.5.3 For Sarper's Region

There were 230 nodes in this region and 20.31 km has been driven. After the truck has completed the collection at Selen's region, it has moved to Sarper's region. And when it has reached to the 20th node at the end of Orkide Street, it has moved to discharging hub as being full. Then, an empty truck has continued the operation by begining from 20th container until it has reached the 104th node in Feslegen Street as being full and moved to discharging hub. Then, another truck has continued from this point and passed to Kaan's region after finalizing the Sarper's region.

6.5.4 For Kaan's Region

In the territory, there were 128 nodes and 5.27 km has been driven. The truck that has passed after completing Sarper's region has moved through discharging place as it has been filled in the 38th hub in Kaan's region. So, another empty truck has joined the operation by begining from the 8th node until the 128th node where it has been filled in capacity.

6.5.5 For Okan's Region

In the region, there were 84 nodes, 12.95 km has been driven. The most crooked and reverse structured streets have taken place due to suburban domiciles. So, 4.5 tons of trucks were not able to serve in these streets. 2 pieces of 2 tons of trucks have served instead of a 4.5 tons of truck. As there were no apartments, the amount of garbage was less than other domiciles. The truck has begun collection from Nesir Street and has been filled when it has come closer to Duygu Street and has moved to unloading hub. Then, another truck has been replaced instead of the full one.

6.5.6 For Haluk's Region

This region has consisted of 82 nodes and 4.33 km has been driven. One 4.5 tons of truck has been used in this region and this truck has left for the discharging location after utilizing full capacity. For this region, a fully utilized 4.5 tons of truck was working.

Table 1 - Combination of Region for using overall capacity of trucks

Truck Type	Starting Node	Region	Transit	Ending or Continuing Node	Region	Transit	Ending Node	Region
4,5 t.	1	Yegül	--------	80	Yegül			
4,5 t.	1	Selen	--------	84	Selen			
4,5 t.	84	Selen	--------	148	Selen	---------	20	Sarper
4,5 t.	20	Sarper	--------	104	Sarper			
4,5 t.	104	Sarper	--------	184	Sarper			
4,5 t.	184	Sarper	--------	230	Sarper	---------	38	Kaan
4,5 t.	38	Kaan	--------	128	Kaan			
2 t.	1	Okan	--------	42	Okan			
2 t.	42	Okan	--------	84	Okan			
4,5 t.	1	Haluk	--------	82	Haluk			

7. RESULTS AND ANALYSIS

7.1 Usage of Truck

There were 10 trucks serving, in which eight of them were 4.5 tons of capacity and the other two were 2 tons of capacity. These trucks have served (with their license plates) in;

Table 2 – Which truck has served at which region?

Plate of Truck	Starting Node	R	T	Ending or Continuing Node	Region	T	Ending Node	R
35 CJJ 37	1	Yegül	-	80	Yegül			
35 CJJ 37	1	Selen	-	84	Selen			
35 AD7518	84	Selen	-	148	Selen	-	20	Sarper
35 CJJ 46	20	Sarper	-	104	Sarper			
35 AD3646	104	Sarper	-	184	Sarper			
35 AD3647	184	Sarper	-	230	Sarper	-	38	Kaan
35 EBC 47	38	Kaan	-	128	Kaan			
35 UC 501	1	Okan	-	42	Okan			
35 UC 503	42	Okan	-	84	Okan			
35 AD3646	1	Haluk	-	82	Haluk			

7.2 Usage of Day

One of the 2 tons of trucks, #35 UC 503, has served at Balçova bazaar on Saturdays. The other 2 tons of truck, #35 UC 501, has served at Dokuz Eylul University Hospital on Tuesdays.

Also, this truck has collected garbage at Ata Caddesi and Sakarya Caddesi after 10 pm and traveled 28.7 km in total.

Figure 7 – Which truck has served at which colored region?

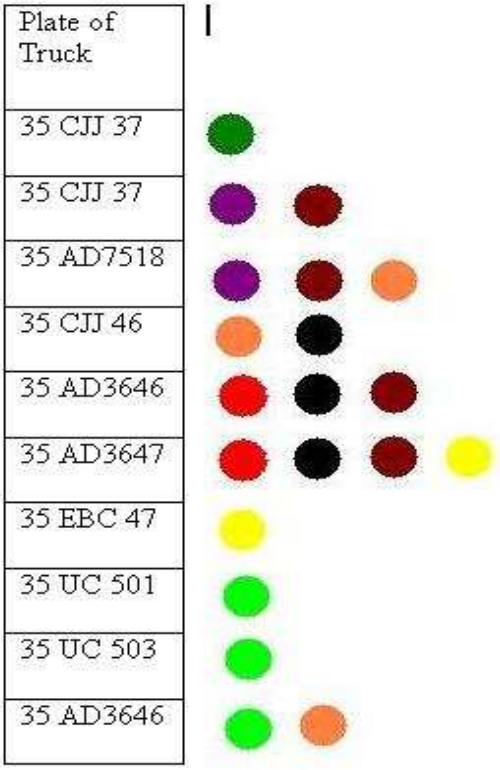


Table 3 – Codes of Regions

Code of Regions	Starting Node	R	T	Ending or Continuing Node	Region	T	Ending Node	R
1	1	Yegül	-	80	Yegül			
2	1	Selen	-	84	Selen			
2	84	Selen	-	148	Selen	-	20	Sarper
2	20	Sarper	-	104	Sarper			
2	104	Sarper	-	184	Sarper			
2	184	Sarper	-	230	Sarper	-	38	Kaan
2	38	Kaan	-	128	Kaan			
1	1	Okan	-	42	Okan			
1	42	Okan	-	84	Okan			
1	1	Haluk	-	82	Haluk			

According to the region codes, garbage collection procedure has been applied to region #1 on Mondays, Wednesdays and Fridays. Regions #2 has served on Tuesdays, Thursdays and Saturdays.
At the same time, region #3, which was referred to Dokuz Eylul University Hospital, has served on Tuesdays. Region #4, which was referred to Balcova bazaar, has served on Saturdays by 2 tons of trucks.
For region #5, on every evening except Sundays, 2 trucks have collected garbage that has been left under the trees in the streets.

Table 4 – In which days, which trucks have collected garbage of which region?

Code of region	Days of code of region	Plate number of truck for serving to region	Color representation from map for regions or special regions
1	Monday Wednesday Friday	35 CJJ 37	
2	Tuesday Thursday Saturday	35 CJJ 37	
2	Tuesday Thursday Saturday	35 AD 7518	
2	Tuesday Thursday Saturday	35 CJJ 46	
2	Tuesday Thursday Saturday	35 AD 3646	
2	Tuesday Thursday Saturday	35 AD 3647	
2	Tuesday Thursday Saturday	35 EBC 47	
1	Monday Wednesday Friday	35 UC 501	
1	Monday Wednesday Friday	35 UC 503	

1	Monday Wednesday Friday	35 AD 3646	
3	Tuesday	35 UC 501	Dokuz Eylül Hospital
4	Saturday	35 UC 503	Market Place
5	After 10 p.m. everyday except for Sunday	35 UC 501	Ata – Sakarya Street

7.3 Total distance traveled per week and total fuel consumption per week

Table 5- Overall km in a week for forward and back route for discharging garbage

Code of region	Days of code of region	Plate number of truck for serving to region	Three times in a week, forward and back route to discharging garbage
1	Monday Wednesday Friday	35 CJJ 37	11x2 = 22 22x3 = **66**
2	Tuesday Thursday Saturday	35 CJJ 37	11x2 = 22 22x3 = **66**
2	Tuesday Thursday Saturday	35 AD 7518	11x2 = 22 22x3 = **66**
2	Tuesday Thursday Saturday	35 CJJ 46	11x2 = 22 22x3 = **66**
2	Tuesday Thursday Saturday	35 AD 3646	11x2 = 22 22x3 = **66**
2	Tuesday Thursday Saturday	35 AD 3647	11x2 = 22 22x3 = **66**
2	Tuesday Thursday Saturday	35 EBC 47	11x2 = 22 22x3 = **66**
1	Monday Wednesday Friday	35 UC 501	11x2 = 22 22x3 = **66**
1	Monday	35 UC 503	11x2 = 22

	Wednesday Friday		22x3 = **66**
1	Monday Wednesday Friday	35 AD 3646	11x2 = 22 22x3 = **66**
3	Tuesday	35 UC 501	**22**
4	Saturday	35 UC 503	**22**
5	After 10 p.m. every day except Sundays	35 UC 501	22x6 = **132**

Overall km in a week for only back and forth route for discharging garbage area = 836
The distance from Balçova to discharge location was 22 km; 11 km for departure and 11 km for arrival.

Table 6 – Overall km for regions

Region	**Km**
Yegül	7.22
Selen	17.55
Sarper	20.31
Kaan	5.27
Okan	12.95
Haluk	4.33

Overall km in a week for only regions = 67.63x3 = 202.89

28.7x6=172.2

202.89 +172.2 = **375.09 km**
Overall = 67.63

In a week the milestone = 836 + 375.09 =**1211.09 km**
In a week usage of fuel =**288.33 lt**

7.4 Comparison with heuristic applied on Narlıdere Municipality's Yenikale Locality
Another project group working for Narlıdere Municipality has applied GAMS on Yenikale locality and traveled their whole route with 2.6 km.
Our result with our heuristic approach to Yenikale locality was;
Yeni Kale's Success Rate

- Total route: 2.3
- Optimal route: 2.3 + 0.4 = 2.7 (0.4 was the total of optimal double passes)
- Yeni Kale's heuristic route: 2.3 + 0.5 = 2.8 (525.34 was Yegül's total of optimal double asses)
- 2.7/ 2.8 = 0.9643≈ 0.97

Results at the region which have been solved with GAMS were 2.6, while the result found by heuristic was 2.8. This has shown that our heuristic could have been accepted as successfully working.

7.5 Matlab Application

Besides the heuristics studies, the matlab code has been developed.

Input : Distance Matrix

- Identify Degrees of Nodes
- Identify Odd Nodes
- Identify Shortest arcs connected to each odd node
- For each pair of odd nodes
- Check if;

Length of arc connecting these two node < Sum of lenght of shortest arcs connected to each node

If it is true, replace the shortest arc with the arc connecting the two nodes.

Start with the initial node

Node-count =1

Check Node =10

Working node =Initial Node

Check Distance matrix of the working node

Visit the nearest unvisited node, visited node, add visited node to the set visited nodes, add visited arc to the set visited-arcs

Working node = Visited Node

Node-count = Node count + 1 if node count =check nodes

Check if there is an arc connecting visited nodes, and nor in the path (set of visited arcs)

Add that are to the psth by passing it twice

Node-count = 1

Check-nodes=10

Else;

Check-nodes=5

- Visited nodes ={ initial node}
- Visited arcs = { }

This Matlab logic was different from our heuristic logic.

7.6 Benefits to Balçova Municipality

1. By using days precisely and utilizing fully, weekly usage of trucks have been decreased from 14 to 8.
2. Improved route tracking has enabled lower fuel consumption.
3. Decreased truck usage has enabled less labor usage.
4. Less labor usage has enabled spare workers to be channeled to street cleaning. That would have lowered the social complaints.

Total cost would have been surely decreased, due to both truck and labor usages.

8. PROJECT EVALUATION

8.1 Project Outcomes

In first semester, some models have been developed by defining the nodes and arcs. There were some practices only made over garbage collection routes by ignoring many other problems of municipality. As a conclusion, a heuristic has been developed.
And accordingly, we could have reduced the costs and reduced the fuel consumption. We have reached our goal. Social complaints could have been decreased while people's satisfaction could have been increased.

8.2 Contribution to Company

Company has been given the Balçova Municipality map, garbage collection routes and borders, frequency of garbage collection. So, below data has been provided;

- ✓ 640 streets
- ✓ 30.000 domiciles
- ✓ 12 garbage trucks + 2 backup trucks
- ✓ 32 workers (Daily shifts from 08:00 to 17:00 – Night shifts from 03:00 to 11:00)
- ✓ Authorized people in Balçova Municipality
- ✓ Our internship experiences
- ✓ Theoretical knowledge based on our lectures
- ✓ The area that the municipality was responsible for was beginning from Üçkuyular metro station to 9 Eylül Hospital also including Inciraltı.
- ✓ Truck data (in total there were 14 garbage trucks belonging to Balçova Municipality, in usual operations, municipality has used 12 trucks. The 2 of these trucks were small having 2 tons of capacity while others have 4.5 tons of capacity.)
- ✓ The average number of 800, 400lt containers and plastic boxes gathered by 4,5tons of truck, was 98.
- ✓ The fuel consumption of 4,5 tons of truck at 63km was 15 lt. (including back and forth route from discharge area of 22km)

8.3 Contribution to Student

8.3.1 Yegül Aykaş

Yegül was the group leader. Her duties were organizing the group for researches and presentations and getting in touch with advisors to direct the group according to definite schedule. In addition, Yegül has evaluated performances of members. She has carried out her responsibilities very well.

8.3.2 Oktay Kaan Hügül

Kaan's duties were translations and grammatical controls. He has contributed the group a lot through gathering information and translating the presentation. He has facilitated translation and grammatical control studies.

8.3.3 Selen Güllüdağ

Responsible for keeping the project book in which the decisions and involvements have been recorded. Selen has written the book on daily basis. Also, she has contributed on the research stage to provide required information that could have been critical.

8.3.4 Sarper Çolakoğlu

He was responsible for transferring data and information to the computer and for shaping the report. Moreover, he also has checked the translation mistakes. He has contributed especially in the mathematical aspect of the project.

8.3.5 Okan Tümbaş

He was liable for searching and gathering information from authorized people and providing academic sources that could have been important for improvement of group. On the other hand, Okan was responsible for preparation of power point slides.

8.3.6 Haluk Korkmaz

He was responsible for providing information for the reports and project and he also has taken place at transferring information to computer. Haluk has prepared our project web site. He has helped a lot on the preparation of power point slides.

8.4 Performance of Team

Performance of Balçova Municipality Team was very satisfactory as we could have reached the most useful results.

8.5 Performance of Company

Company has provided the data which has affected the project positively.

8.6 Performance of Academic Advisor

The academic advisor was Muhittin Hakan Demir. He has helped us in finding a heuristic model and he always has controlled the heuristic model. Additionally, he has found Matlab program and learned to use it. He always has supported us.

9. CONCLUSION

- ✓ By using days precisely and utilizing fully, weekly usage of trucks could have been decreased from 14 to 8.
- ✓ Improved route tracking has caused less fuel consumption.
- ✓ Decreased truck usage has caused less labor usage.
- ✓ Less labor usage has enabled spare workers to be channeled to street cleaning. That would have lowered the social complaints.

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LOADING OPTIMIZATION PROJECT FOR SCHENKER ARKAS

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EXECUTIVE SUMMARY

This project is about loading optimization in Schenker- Arkas, which is a part of integrated quality management. During the project, our main concern was LCL truck shipments. Loading optimization is deciding where to put several goods with different dimensions and weight, in a container in the most efficient way. It is an important problem for companies today because; loading optimization is directly related to effective loading, address match in delivery and cost management.

There are several reasons that Schenker-Arkas gives attention to this subject. First of all, Schenker-Arkas is a competition provider company, not a survivor in the competition. Therefore, being agile and fast is crucial for them. Completing the delivery without damage and increasing operational efficiency of truck shipments are other reasons. Finally, it is important to decrease the process costs, if there are not any decreases in general costs.

In this frame, the common objects of this project are increasing the operational efficiency in LCL truck shipments, becoming more competitive in the transportation market; helping to make the fastest decision in the unit time; contributing to well integrated process structure and decreasing customer complaints while supplying their demands.

We propose both manual and computerized solutions. Wecan say that by using software for loading optimization company can increase its control on loading operations, minimize human error in loading, simulate shipments before loading and most significantly they would use trailers in the optimum way. The only weakness of this kind of system is; it requires additional time for entering the inputs and some changes in the information sharing process of the company.

1. INTRODUCTION

1.1. General Overview of the contents

This project aims to reach the optimum level of loading in shipments by developing a systematic approach. In the next sections, we present the information about the project development, company, our teamwork and problem solving statements. Briefly, this report highlights what we have done during two semester project period in terms of problem statements, researches, analysis, methodologies and evaluations.

1.2. Motivation

When we have first started this project, we have had some gaps about the context of the project. The logic behind the topic was not confusing but the future activities and the solution alternatives were not clear enough for us. There were several ideas in our minds, but we should have begun the kick off without any confusion. Our advisors' and our company partner's expectations, behaviors and attitudes have also motivated us a lot.

1.3. Goals

Our goal was to help Schenker-Arkas for the optimization of loading in truck shipments. Logistics is a race against time so generally there is no time for wasting. Our project objective was to maximize the fill rate of trucks in Schenker-Arkas, in the mean time while increasing company's profitability and customer service level. Therefore, company could have gained competitive advantage against other companies in the industry for land transportation.

The main challenge for Schenker-Arkas was not being able to use the space in the containers in the most efficient way. This problem has affected the company's profitability growth negatively. Hence, they have required us to find a better way, method or idea. They haven't had an exact deliverable in their mind so they were open to any kind of idea. We have brought some new ideas considering their limited warehousing areas.

1.4. Company Background

In 1995, a joint venture between Schenker and Arkas Group has been established. The name today is: Schenker-Arkas Transport and Trading A.S. Today, Schenker- Arkas/Turkey operates with more than 300 staff in offices in Istanbul (Corporate and Branch Office), Izmir, Bursa and Denizli. The offered services are related to the entire Logistic activities. With annual sales of 8 billion Euros, 39,000 employees and about 1,100 offices around the world, Schenker is one of the world's leading providers of integrated logistics services, offering land operations, and air and sea freight as well as comprehensive logistics solutions and global supply chain management from a single source. Schenker is a part of the Transport and Logistics Division of Deutsche Bahn AG.With its headquarters in Essen, Germany, Schenker AG has proven its continuance since the company was established by Gottfried Schenker in Vienna, Austria, more than 130 years ago. The company vision is to create an edge by linking information and transportation management. Schenker- Arkas masters and finances supply chains. The company mission includes central values like working in their own global group

of companies, bearing responsibility for their customers, employees, the public and the environment.

2. PROBLEM DEFINITION

Considering the scope of the project, we defined the future activities and the solution alternatives by searching the related literature and understanding how the academicians were looking at the problem. There were several algorithms such as; bin-packing problem, knapsack problem, packing problem, partition problem, subset sum problem and multiprocessor scheduling problem. The bin-packing problem was the closest model to our subject. The problem was also divided into two groups as two-dimensional (2D) and three-dimensional (3D) bin-packing. Our concern was 3d bin-packing.

After the problem has been modeled, we have taken a loading list from the company which we would have applied on our problem. The solution turned out to be satisfying but, we have realized that solving a problem manually would have taken plenty of time. The difficult part was that there were no standard dimensions for the cargoes. For this reason, the problem should have been solved for every shipment separately.

Since the logistics is a race against time, solving the problem and finding a solution should not take too much time. Therefore, a solution methodology should be computerized. We have had two options; to write a computer program or to find a software package already able to solve custom bin-backing problems. Since we did not have advanced programming skills and are not allowed to work with a programmer, we had to find an already existing program. The web was a great source. Although, there was a huge amount of information, little amount of them were useful. Eliminating redundant ones, we have found what we have needed. These programs have been listed below:

* CargoWiz
* PackVol
* MaxLoad Pro
* LoadPlanner
* 3D Load Planner

These programs have their own advantages and disadvantages. Some of them are allowed for only temporary usage during trial period, some of them have not provided easy usage and some of them were not visualizing the shipment in a required way. We have tried all of them and decided to use CargoWiz for our project.

Our next step was the software's application to the company. After, we have requested the cargo information of a shipment. In order to make an entrance for a cargo to the system, we have requested related data such as; dimensions, weight, amount and allowed information for each cargo. We have learned that, the only way to obtain each shipment's dimension data was to measure all of them before the shipment has been realized, at the warehouse. However, we should have waited for some time because of the procedures and process, itself.

During that time, we have contacted with different transportation companies which we had a connection, to show them the software. We have seen that, system was working and it was easing the operational aspect of shipments. Also we have learned that, packing list should have contained information about the dimensions of the cargoes. A specialist should have submitted the packing list to the transportation company while exporting. After one week we have taken necessary information which we have requested.

We have agreed to follow a shipment and compare it with the output of the CargoWiz program. That subject would have been explained with details in the following parts. Planning the shipment with software has only taken 5-10 minutes but it has eliminated possible human errors during loading and shortened the time to load the truck. During usage of this software, we could not have detected any particular obstacle which could have been perceived as a disadvantage. However, it has taken some time to enter all related inputs to the software. As we were planning the shipment by the help of the CargoWiz program, the depot clerk, who was organizing shipments manually, has taken a look at it. He has also compared the loadings that he has done manually, with results that obtained from the software.

We have observed shipment process. After the shipment process has been completed, a problem was detected. All the cargoes have been loaded without a priority consideration. Normally, they all have had a loading priority according to their discharging points. However, some of the cargoes which were supposed to be discharged first were loaded at the back of the trailer. At the first discharging point, the place of cargoes which were inside the trailer would have to be changed again. This process would have taken extra time and caused additional work for the personnel. If a container storage program has been implemented, none of this would have happened.

3. LITERATURE REVIEW

In this project, our major resources were algorithms (knapsack algorithm, bin-packing algorithm, C++ algorithm, etc. - we have selected the most suitable one after we have had more information about the processes in the company and more related data), computers (to systemize the project, in modeling the project), the knowledge of our academic advisor, the experience of the employees in the company and the most important input would have been our ideas and our heuristics for loading.

Knapsack problems are widely studied due to their ability to closely represent real world problems and their frequent appearance as sub-problems in more complex models. The objective of the setup knapsack problem (SKP) is to select specific items, which belong to mutually exclusive product family sets, for placement in a capacitated knapsack while either maximizing its value or minimizing its cost. However, an item can only be selected if a setup charge for placing the family of items in the knapsack is incurred. The SKP has been identified as a significant sub-problem for the solution of capacitated scheduling problems. A series of 0-1 programming SKPs, one for each capacitated machine, is solved in each iteration

of a sub-gradient algorithm. Due to the relatively large storage requirements of dynamic programming, they have emphasized the importance of designing good upper bounding schemes and heuristics to be embedded in efficient branch and bound algorithms. In addition to appearing as a sub-problem in scheduling capacitated machines, SKP by itself can model a variety of resource allocation problems. Consider a freight consolidation problem in which a capacitated transport vehicle can carry several different product families as defined by commodity type, shipper, or destination. The objective of the decision problem is to select the product families and quantities of items to ship in order to maximize the value of the line haul.

Product category management, where a supplier is allocated limited retail shelf capacity and must determine the mix of product families and items to stock, provides a second example. Each product family included in the lineup has a fixed setup cost for administration, inventory maintenance, and billing, while associated with each item and stocking quantity is an expected profit contribution. The decision is to select the mix of families and items that maximizes the expected value of the product category. Other potential applications are in portfolio management where each investment opportunity is associated with an account setup, subscription or membership cost and expected return. The objective is to select the mix of investments and quantity of each to maximize the expected return of the portfolio.

The bin packing problem (BPP) belongs to the large family of grouping tasks, which consist in dividing sets of elements into separate subsets. The one-dimensional BPP can be formulated as follows. We have n bins with the capacity of C and n indivisible elements, each having the weight (i.e. value) of $w_i \leq C$ $(1 \leq i \leq n)$. The elements have to be packed into the bins in such way that the minimal number of bins should be used and bins capacity should not be exceeded.

4. APPROACH / METHODOLOGY

Our next step was the application of the software for the company. For that, we have requested the cargo information of a shipment. To make an entrance for a cargo to the system we have requested the dimensions, weight, amount and allowed information for each cargo. We have waited for some time and the activities that we have continued to do was well defined in early sections of the report.

We have seen that, CargoWiz software was working and it was easing the operational aspect of shipments. Important requirement of the software was that packing list should have contained information about the dimensions of the cargoes. A specialist should have submitted the packing list to the transportation company while exporting. After one week we have taken necessary information which we have requested.
We have agreed to follow a shipment and compare it with the programs results. That subject would have been explained with details in the following parts. Planning the shipment with

software has only taken 5-10 minutes but it has eliminated possible human errors during loading and shortened the time to load the truck.

As we were planning the shipment by the help of the program, the depot clerk, who has organized shipments manually, has taken a look at it. He has also compared the loadings that he has done manually, with results that has been obtained from the software. We have observed shipment process. After the shipment process completed, a problem was detected. During usage of this software, we could not have detected any particular obstacle which could have perceived as a disadvantage. However, it has taken some time to enter all related inputs to the software.

All the cargoes had been loaded without a priority consideration. Normally, they all have had a loading priority according to their discharging points. However, some of the cargoes which were supposed to be discharged first were loaded at the back of the trailer.
At the first discharging point, the place of cargoes which were inside the trailer would have been changed again. This process would have taken time and caused inessential additional works for the personnel. If a container storage program has been implemented, none of this would have happened.

5. DATA COLLECTION&ANALYSIS

Logistics is flow of money, goods and information. Goods are transferred from the supplier to the end user, money is transferred from the end user to the supplier, but information must be transferred within both directions. Hence, we could have said that information flow is crucial in order to provide a smooth transaction between the logistics activities.

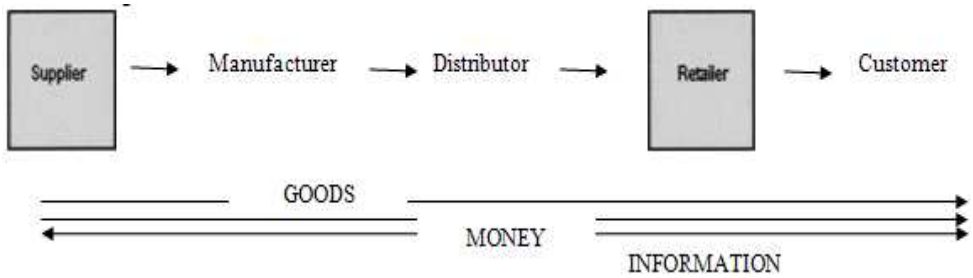


Figure 1 - Flow of elements in supply chain

Figure 1 represents the importance of information in a supply chain. During the project, we would like to give special emphasis to information flow inside the company. To find an optimum loading level, the dimensions of the cargoes are one of the most important information which is required. Normally, this information is declared by the exporter to the transportation company with packing list. The export operation department receives the packing list, but the information is not sent to the warehouse operations. Warehouse personnel receive the loading list from export operation department without any dimensions.

NO	FİRMA ADI	ADRES	ADET	TÜRÜ	AĞIRLIK	MAL CİNSİ	ÜLKE	CBM	SIRA
1		STAFFORDSHIRE	8	PALET	4,402.70	SERAMIK MALZEME	UK	17.19	2
2		BRISTOL	3	KUTU	15.00	YEDEK PARCA	UK	0.03	1
3		LONDON	8	KOLI	64.00	ELEK. ESYA	UK	0.61	1
4		GALWAY, IRELAND	5	KASA	2,805.00	KLIMA AKSAMI	UK	1.92	7
5		CWMBRAN	4	KASA	2,788.00	FREN AKSAMI	IR	3.07	3
6		CWMBRAN	1	KASA	636.00	FREN AKSAMI	IR	0.76	3
7		N.YORKSHIRE	3	PALET	1,382.25	RULO BALATA	UK	0.72	1
8		W.YORKSHIRE	4	PALET	2,742.00	TEKSTIL	UK	8.80	9
9		MANCHESTER	4	PALET	3,427.00	TEKSTIL	UK	12.50	8
10		HERTFORDSHIRE	3	PALET	2,330.00	TEKSTIL	UK	6.90	2
11		CANNOCK	4	PALET	1,720.00	MERMER	UK	4.60	5
12		OXON (OXFORD)	1	PALET	150.00	OTO YEDEK PARCA	UK	1.66	1
13		WALSALL	1	PALET	123.40	OTO YEDEK PARCA	UK	0.28	1
14		LONDON	1	PALET	320	LAZER KESIM MAK.	UK	1.38	1
15		LIVERPOOL	124	KOLI	1,353.00	TEKSTIL	UK	11.38	8
			174		24258.35			71.804	

Figure 2 - Loading list for a truck

The clerk in the warehouse receives the loading list which is displayed in Figure 2 and loads the cargoes according to their weights, total volume, quantity and the discharging priority. When he receives this list, he looks at the total volume which is 71,804 and estimates that it fits in a 90m3 trucks without any problem. Of course, he has an experience and more information about loading operations compared to our knowledge but simulating the shipment before loading would assist him, not hurt him.

To ease the operations, the dimensions of the cargoes must be received by the depot clerk with the loading list. To use container storage program the company should able communicate through the information flow given below.

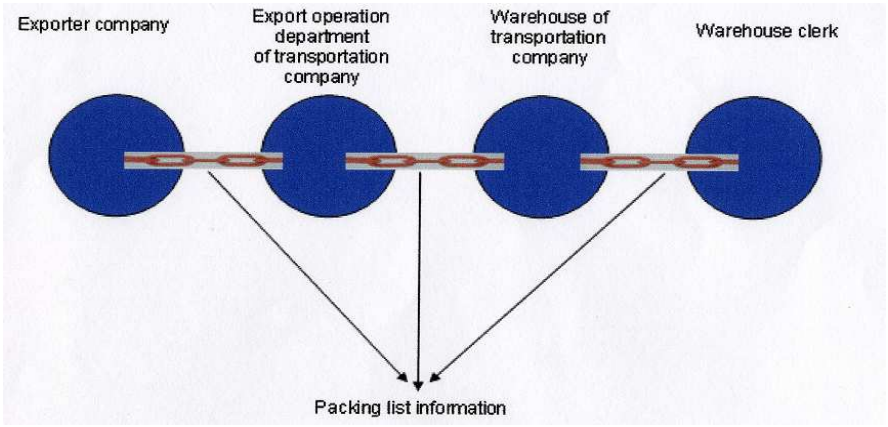


Figure 3 - Possible information flow to use a container stowage program

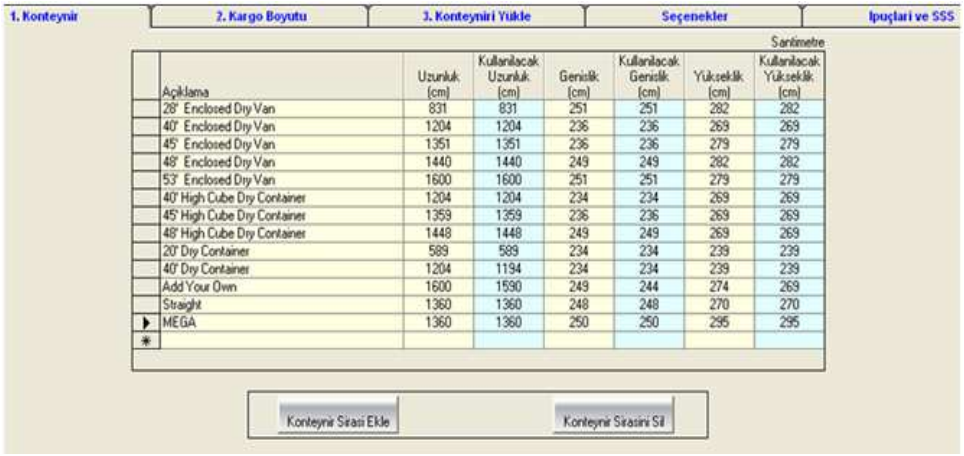
The information flow illustrated in Figure 3 should be built in order to use a container storage program. A company could build this flow in so many possible ways. One could transfer the

information manually by only adding the dimensions part to the loading list, one could build an interface between the storage program and the software which company currently uses (when the export operation department enters the dimensions of the goods the this information will be transferred to container stowage program and no more additional time would be spent for the input entrance to the stowage program). The third way is to enter the dimension information through the bar-coding system. When the depot clerk is bar-coding the cargoes, the information could be transferred to the storage program and the program could make the loading without any additional time. This also requires an interface between the bar-coding system the storage software.

We believe that using an interface would have more additional cost and it would also have increased the density of the usage of company's current software. When you use the current software which the company is using non-stop for a long-period, the speed of the system decreases and data input for other units inside the company becomes harder. If the information is transferred manually, it would give less damage to other business processes. The only disadvantage for this method is the clerk should make the data entrance for the storage software 5-10 minutes prior to the loading operation. Considering the benefits such as elimination of human error and increased control over the shipments, 5-10 minutes is only a little amount of time.

6. IMPLEMENTATION AND RESULTS

To see what outputs the software gives, we were supposed to make a trial shipment using the program. We have collected the necessary information and made a virtual shipment with the software in 5 minutes. The results were shown to the clerk and took inspiration the results and made the shipment. During the loading of the cargoes; we have also analyzed how he was loading and taking the plan of this shipment. The facts have been explained in Figure 4.



Açıklama	Uzunluk (cm)	Kullanılacak Uzunluk (cm)	Genislik (cm)	Kullanılacak Genislik (cm)	Yukseklik (cm)	Kullanılacak Yukseklik (cm)
28' Enclosed Dry Van	831	831	251	251	282	282
40' Enclosed Dry Van	1204	1204	236	236	269	269
45' Enclosed Dry Van	1351	1351	236	236	279	279
48' Enclosed Dry Van	1440	1440	249	249	282	282
53' Enclosed Dry Van	1600	1600	251	251	279	279
40' High Cube Dry Container	1204	1204	234	234	269	269
45' High Cube Dry Container	1359	1359	236	236	269	269
48' High Cube Dry Container	1448	1448	249	249	269	269
20' Dry Container	589	589	234	234	239	239
40' Dry Container	1204	1194	234	234	239	239
Add Your Own	1600	1590	249	244	274	269
Straight	1360	1360	248	248	270	270
MEGA	1360	1360	250	250	295	295

Figure 4 - CargoWiz step 1

For this shipment, which the dimensions were 1360cm*250cm*295cm, mega size truck have been used. The data entry screen has been shown below. This data has been entered according to the loading list. The loading list would have been given in the appendix.

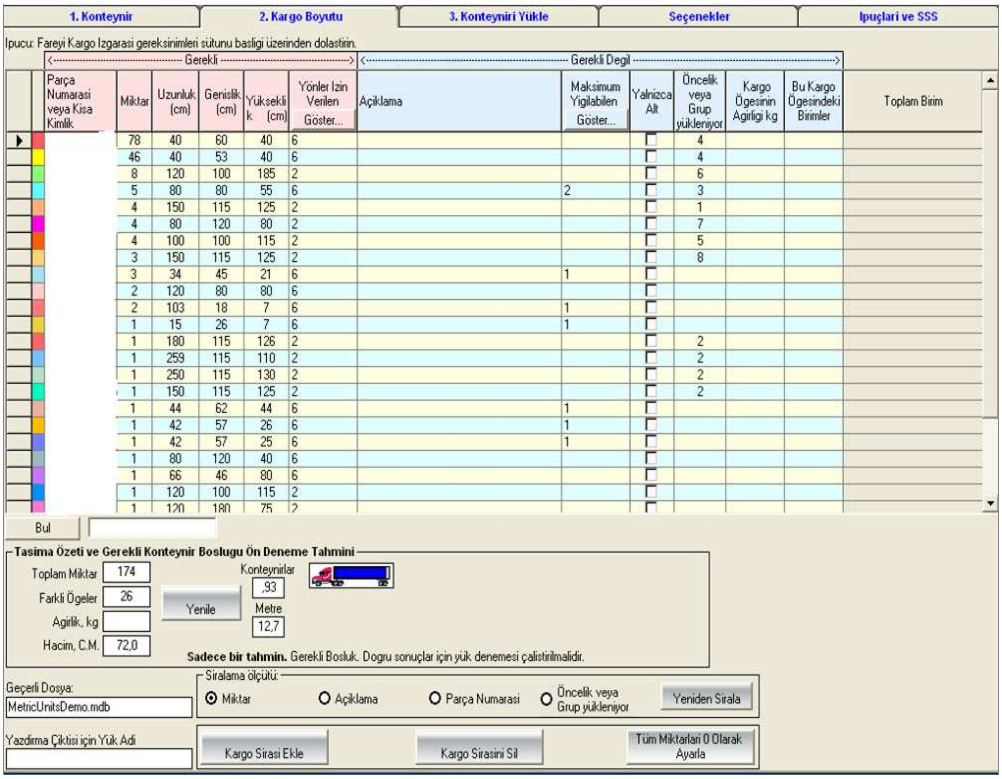


Figure 5 - CargoWiz step 2

Finally the shipment has been completed and all of the finished loading details are given in Figures 6-7 below. All of this process has taken 5 minutes.

Decision of loading operations like how it will be done, loading of shipments related to unloading sequence etc. are taken by only one employee who is responsible for exporting depot operations in the company. Depot officer loads shipments via its experiences. In last loading operation which we followed in there, he had to account for loading without consideration of loading-unloading sequence. The product, which will be unloaded at first arrival point, loaded on the rear of products which will be unloaded in second arrival point. Because if the goods were loaded according to unloading sequence, one product could not be fit into container and it will lead to a much bigger problem. It means that in the first arrival point, there is some extra time cost for the company and its customers. At the departure point of this loading (in depot of Schenker), no problem appears, but most probably a extra handling will be needed in the first arrival point because of the loading sequence. The sequence of the loading is not considered to be the major problem by managers of company,

but indirect results of the arbitrary loading sequence can lead to serious losses for company like customer satisfaction.

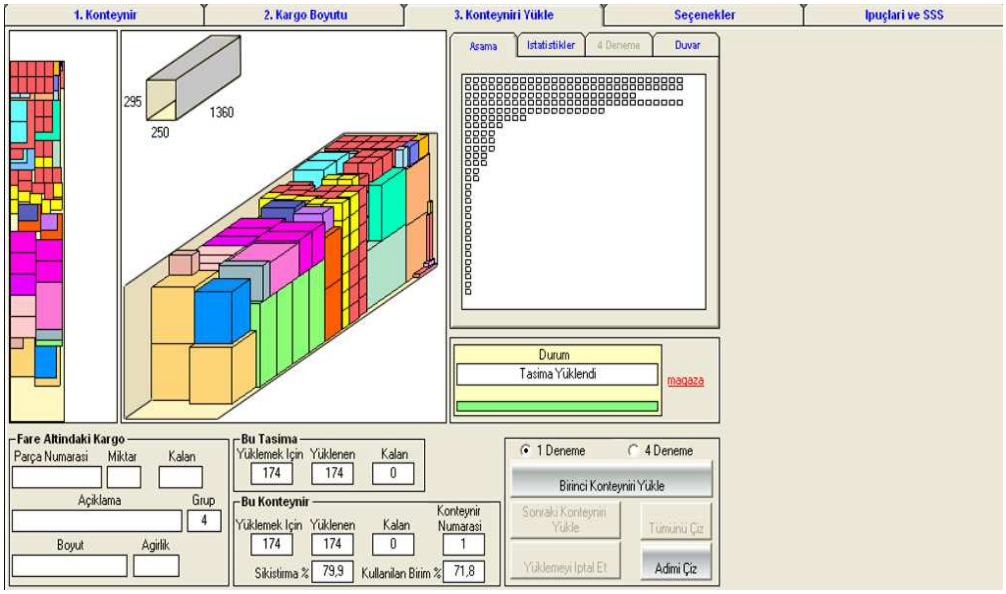


Figure 6 - CargoWiz step 3

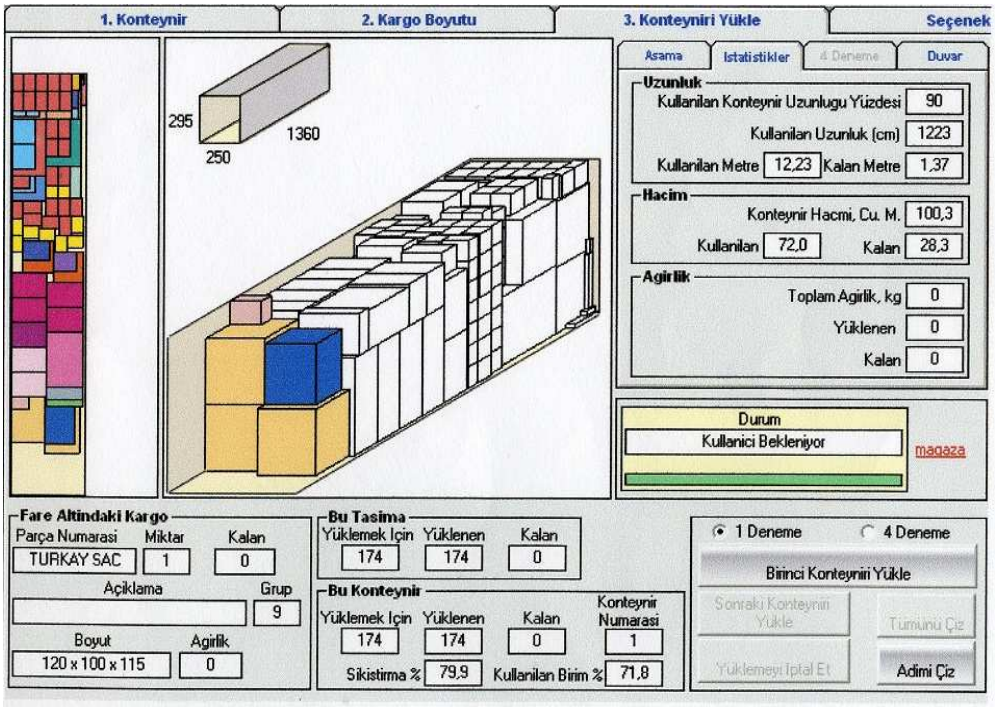


Figure 7 - CargoWiz step 4

If whole decisions of loading operations are taken upon to experiences, risks of operations will increase in same direction. Actual loadings are completely done by traditional methods, of course experiences of employees are important in operations but it must not be entirely dominant. At least, there must be a stowage plan on the hand of employee and he must arrange it if there will be any problem in operation. In today technologic world, in logistics sector, maybe computers are not indispensable but exactly complementary. So, a company which is one of the most dominant logistics companies in Turkey should use and complement a software program into loading operations in last phase.

Last parcel loadings' stowage (shipment) plan, which we have gained through drawing while following operation has been placed in appendices part of this final report. There were many differences between our software shipment plan and Schenker's applications, based on employee experience loading operations. However, today's competitive business world, details could have led to competitive advantage or disadvantage for firms. Assembling a software program in loading operations for Schenker could have led to operational efficiency for the company. The most important benefit of using software program was the ability of handling stowage plan as a hard copy before starting to load goods onto the truck. Cargo-wiz's output has prevented the faults about loading sequence or presented to the responsible for loading if all shipments would have fit into a container or not. If an output of the software program would have been taken into consideration there would have been no need for extra time for loading a truck. Because employee could have been able to assume which products would have been loaded first and what the loading sequence of goods should be. Therefore, before truck arrives in Schenker depot, he could have arranged the places of goods in the depot, which have been delivered from customers by cartages, related to loading sequence in depot. Also operational costs like the total distance that forklifts travel during loading operations, have been decreased and more effective use of time before loading or while loading could have been provided.

In summary, Cargo-wiz could have provided competitive advantage in loading and unloading operations to the company. Maybe there would have been no exact improvement in operations if Schenker would have used a software program about loading details. But, even if using software program has provided a little extra concrete benefit to the company in the short-time period, it has meant that it would have provided more abstract benefits in the long-term. Our suggestion was creating a harmony of a software program and experience of employees in the loading operations.

7. PROJECT EVALUATION

7.1 Project Outcomes

Working for a company in the light of the advisors and the academic education has added a lot of value to us. Now, at the final stage of our project period, we are proud of our-self because we have done what we have believed in and wanted to do. This ambition leaded us during the project and now, we are satisfied with the results.

7.2 Contribution to Company

Our project was an idea suggested and required by the company. After the whole process, we were very content that the company advisors were also satisfied of the final position or destination. As we have mentioned before, due to being in the technology era, information system based solutions have always been assisting to the big and open vision companies.

7.3 Contribution to Student

The most visible contribution from our aspect was self contribution certainly. After spending a whole senior year together with the satisfaction purpose for the project, first of all, our friendship became really strong. Secondly, we learned how to use our qualifications in balance. Thirdly, we learned about academic researches related with our project and technological issues also. Next, before the graduation, we felt integrated in a company which is a very strong and well- known company in our sector. Finally, we learned how to present our ideas and make other people listen them.

7.4 Performance of Team

Our group performance was always high because we have worked as a group. We have not challenged our work oppositely; we have tried to make our works coherently. Both the leader and the members have participated to the project and we have enjoyed a lot. Hence, this positivity has been reflected to our studies.

7.5 Performance of Company

Schenker-Arkas performance for this project was quite good. The advisors from Schenker - Arkas were warm and pleasant. We have work together in a harmony due to the mutual understanding.

7.6 Performance of Academic Advisor

Our academic advisor has given us any kind of information that could have been helpful for us and focused with us to the problems when occurred. She has oriented our project by giving advices and making suggestions that would have been good for the way the work was going.

8. CONCLUSION

To load the trucks at the optimum level, we strongly suggest the company to use a container stowage program. The program which we have recommended has no cost and its trial version was adequate to use for simulating the shipments. The only obstacle for using this program was related with the information flow within the company and the solution for this was really simple.

On the other hand, the warehouse clerk has affirmed that he has had no problems with the current shipment process and he does not need to use this kind of program. He must have realized that the software was helpful tool for him. Of course he has had an experience with

the related topic, but still he could have used the program as a complementary. He could have combined his knowledge with the programs one.

Using stowage software would have enabled the company to have more control on their loading process; they would have known how many empty spaces have been left inside the truck, minimize human error, visualize the shipments before they have been loaded, and most importantly has given the ability to use their trailers in the optimum way. It only requires additional 5 minutes, which could be seen as a disadvantage by some individuals but its benefits highly have overcome its costs.

Today information technology was in the center of trade activities, and with the usage of IT we were living a new generation in trade means. If we have considered the industrial revolution as the first phase of world trade, the containerization and multimodalism could have possibly been the second phase. The third generation was the IT generation in trade. Besides money and goods, the most important feature in world trade has been information and the one who has used information technology in their business systems, would have been the one who could have competed with other companies. The more usage of IT inside your business, the more automated and competitive you have been.

9. APPENDIX

As it has been shown in the Table 1 below, 9 units of cargo has been loaded from export depot without the optimum loading process and this would have caused potential time consumption at the discharging points. There has not been any case situation like this for the Shipments made by Cargo-wiz. Also, it was possible to make manual arrangements on the Cargo-wiz printed- out. As a result, shipments would have been made both by diminishing the mistake ratio to the minimum professionally and by supporting with personal experiences effectively.

TABLE 1. the actual loading plan

	QTY	DIMENSIONS	TYPE	UNLOADING SEQ.	OPTIMAL LOADING SEQ.	LOADING SEQ. DEPOT PERSONNEL
1	8	120*100*185	Palet	4	6	6
2	2	103*18*7	Kutu	1	9	9
2	1	39*12*9	Kutu	1	9	6
3	1	15*26*7	Koli	1	9	7
3	1	44*62*44	Koli	1	9	7
3	1	42*57*26	Koli	1	9	7
3	1	63*89*50	Koli	1	9	7
3	1	42*57*25	Koli	1	9	7
3	3	34*45*21	Koli	1	9	7
4	5	80*80*55	Kasa	7	3	3
5	4	80*120*80	Kasa	3	7	7
6	1	80*120*80	Kasa	3	7	7
7	2	120*80*80	Palet	1	9	9
7	1	80*120*40	Palet	1	9	9
8	4	150*115*125	Palet	9	1	1
9	1	150*115*125	Palet	8	2	2
9	1	180*115*126	Palet	8	2	2
9	1	250*115*110	Palet	8	2	2
9	1	250*115*130	Palet	8	2	2
10	3	150*115*125	Palet	2	8	7
11	4	100*100*115	Palet	5	5	5
12	1	120*180*75	Palet	1	9	9
13	1	66*46*80	Palet	1	9	9
14	1	120*100*115	Palet	3	7	8
15	78	40*60*40	Koli	6	4	4
15	46	40*53*40	Koli	6	4	4

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SIMULATION PROJECT FOR PINAR SU PRODUCTION PROCESS

Ceyda Koyuncu, Mert Dikerler, Tuğçe Şengül, Simay Şenkalyoncu

Asst. Prof. Dr. Muhittin H. Demir

EXECUTIVE SUMMARY

This project is aimed towards modeling the filling facility of Pınar Su using simulation.
Through simulation, the ultimate goal is to help Pınar Su to evaluate alternate decisions and visulalize their potential consequences in a fast and efficient manner.
Based on this motivation, the project was started with the focus of modeling the carboy process.
The model building, model validation and verfification steps were carried out through plant visits and observing the production flow.
The software program Rockwell ARENA® was chosen for simulation, due to its modeling capability and the visual presentation
have prepared the model of carboy simulation with water fountain. Then, we have included it with real data into the Arena program and run it accordingly. We have understood and explained the model of solution and tried to reach on the best solution alternative for Pınar Su.

1. INTRODUCTION

1.1. General overview

Simulation is a modeling technique, which the reflection of theoretical or real physical systems reason and result relations to a computer modeling. The real transactions, events or projects, could be followed in different conditions through computer programs and models.

The main aim of simulation modeling is to make assumption analysis. User of the simulation could put different design and strategies to a real transaction via simulation.

The user could improve the performance by using different techniques on the set simulation model.

Simulation could have been used in some areas to benefit the users, these areas are;

1 - Forecasting the results and helping on the decision process
2 - Observing the potential consequences of agreed decisions
3 - Determining the problems before investment
4 - Determining the affects of modifications
5 - Finding the variables of systems
6 - Evaluating the ideas and determining unproductive areas
7 - Encouraging new ideas and improving new opinions
8 - Testing the integrity and feasibility of plans

Simulation is mainly used for reaching the answers of what, when, where and how. These questions and answers could be applied in the systems in a most effective way through simulation. That is, simulation is more effective in operational side of the projects. It has many variables which have different attributes and its ability to accumulate these variables in one model makes simulation a vital part of complex systems in today's business environment.

In a production system, the alternatives for better synchronization of machines, pallets, forklifts, transactions, vehicles and routes of transportations are infinite. So, computerization in today's world is not a necessity, it is absolutely vital. That’s why the trend is designing practical systems in computer environment.

1.2. Motivation

The group has choosen simulation of production process, as simulation is an up-to-date subject of logistics. The aim was getting informed about simulation and improving it up.

Increase in customers’ demands, rapid changes in technology and challenging conditions to survive in global competition, force companies to clarify how to produce the product and provide the service in a more faster, effective, qualified and efficient way.

For the last twenty years, the importance of customer satisfaction is increasing. For obtaining customer satisfaction, both quality and variety of the products should have been increased and cost and price of the products or services should have been lower than the other firms as well. While the general input with the market’s rivals have the similar technology and similar labor sources, the cost and quality of the supplied items, variety of its products, production process and service strategies would create an important advantage to the firm. If the firm does not produce the product with focusing on the customer’s demand or does not provide qualified,

low costed variety of products in line with the customers' expectations, the firm could not succeed in the long run.

The solution to problems could have been developed by working on different alternatives in a system. In order to identify and remove the causes of the problems in the system, it is necessary to examine and understand the relation between the elements in the system which operate together, even though they seem to be independent of each other. Besides, the sensitive parameters in the system should have been identified as well as responsiveness to certain changes should have been tested and ensured.

The engineers and managers, who could understand the system well and have full knowledge on the logic of operations, could respond to such kind of problems to a certain extent. However, it could almost be impossible to find someone having full knowledge of a system which is physically large, technologically complex and consisting of many operations or variety of product groups. Furthermore, it would be much more difficult to combine the experiences of people knowing different parts of the system for common understanding of the whole system or making revisions or working on several alternatives. Such a method should also involve risks. The changes realized on the basis of these experiences might not provide the expected result. In this situation, if the applied revisions require financial investment, it would be impossible to withdraw it.

1.3. Goals

Main goal of this project was to prepare a model for the production process of Pınar Su filling center and to build a simulation model of the production facilities of Pınar Su. And accordingly, we were planning to provide the company a beneficial decision support system and to propose on some solution alternatives. The aim behind was to reduce risk and increase the performance. By using this simulation model, company would have a chance to see the consequences of any potential problems or decisions prior to occurence of any risks. Company was expecting us to build a model which is very similar to their facilities, so we have visited and observed their facilities and defined their production processes.

We have started with the closest one; Madran, Aydın and investigated the flow of business in details for the optimum solution of the model. Afterwards, real data have been uploaded and the model has been prepared. Finally, the results of the model have been examined to be able to evaluate the possible alternatives of increasing the efficiency of Pınar Su operations.

1.4. Pınar Su Background

1984: Participated in Yasar Group. Turkiye's first Non-Recycable Packaged Spring Water with Pınar Sasal Brand has been produced. (1,5L PVC Package)

1985-86: Pınar Sasal Water in PVC Packages of 0,33 and 3L have been introduced to the Market.

1990-91: Bottled Water Production has been started in PVC Bottles of 5 and 0.5L.

1995: Annual production volume has been reached up to 100,000 tones. New resources have been started to be searched.

1996: Pınar Madran Facility, the most modern water establishment, has been started to be set up.

1997: The first Madran Water in Plastic Bottle of 1.5L has been produced. Turkish Standards Institution has awarded Golden Package with the Plastic Bottle of Madran Memba Water.
1998: Pınar Madran 5L Water in Plastic Bottle, which was Turkiye's first Self-Handled Bottle, has been produced.
1999: Water in 5 and 0.5L Plastic Bottles have been started to be produced instead of 5 and 0.5L PVC Bottles; and specially designed 3.78L PVC Bottle has replaced Water in the 3 L PVC Bottle. ISO9002 Quality Management System Certificate has been obtained.
2000: The capacity of production has been doubled by means of new Blowing and Filling Machines for 5L Plastic Bottles purchased in Pınar Sasal and Pınar Madran Facilities. Pınar Madran Water in 8L Plastic Bottle has been launched.
2001: ISO 14001 Environmental Management System Certificate has been obtained. Pınar Madran Water in 2.5L Jag Shapes Bottle has been produced. Pınar Su has been awarded Golden Package Prize. It has become the first and the only Turkish Beverage Company that has been entitled to have the Quality Certificate from NSF based on the USA with its qualified and delicate production.
2002: Pınar Madran's quality has been controlled and approved by Fresenius Institute, which has been based on Germany, an international independent and effective institution controlling the conformity of the Spring Water with the Standards and Regulations of Germany and EU. 19 Polycarbonade Water has been produced.
2003: Pınar Madran Water in glass of 0.33L and 0.75L with one way has been introduced to the Market. Two new Filling Plants in Adapazari and Hendek joined the Family. The Products of these Two Plants have been launched as the brands of Pınar Yasam Pınarım and Pınar Denge.
2004: Pınar Rain, Turkiye's first Aromatic Water has been introduced to the Market in four different sorts. Pınar Madran has been approved as "Natural Mineral Water" by the Authorized Officials in Germany.
2005: Clean Room Sytem has been activated in every Pınar Madran Facility. HACCP Food Safety Management Certificate has been obtained.

Facilities of PINAR

1.4.1. Pinar Madran Water Filling Facility

It has been established in 1996 in Bozdoğan, Aydın on 64.000m2 of which 14.000m2 is covered. Later, covered area has reached up to 17.000m2 with the additional investments in 2005.

Pınar Madran is one of the most qualified waters in Turkiye, having sources away from the residents, chemical qualifications not changing during the year and being found out after long reseraches. Its hardness degree is 1.65 French and it is one of the softest waters that can be drunk easily.

Pınar Su, carrying out filling practices in the filling rooms, where air inflow is prevented and the air is always kept clean, controls water in every step of the production from the source to the bottling in physical, chemical and microbiological terms. The facility has also been controlled periodically, as a result of the analysis carried out within the scope of the Regulation by the Ministry of Health.

Pınar Su, producing in the facilities where water is bottled without spoiling the natural structure and changing the mineral balance in it, has put Class 100 Isolator and Clean Room System into practice. Pınar Su has created hygienical environment above the standards by means of this system.
In the Class 100 Isolator and Cleanroom system that Pınar Su has bought, following up the most advanced technological developments in the water sector, the filling machines could carry out filling practices in the sterile environment with laminar flow in the filling rooms, where air inflow has been prevented by keeping sterile air under pressure and the air has always being kept clean.
Pınar Su has adopted Class 100 standards in accordance with E.S Federal Standard 209 E and started to bottle its products, having been offered to the consumers in a healthy way with this system up to now, in an ultra-hygienical environment under the surgery conditions.
Filling of 0.33L, 0.5L, 2.5L, 5L and 8L plastic bottles; 0.33L, 0.75L NRB glass bottles and 19L Polycarbonade carboy has been implemented. (filling capacity is around 570.000 tone/year)

1.4.2. Pinar Yasam Pinarim/Adapazari Water Filling Facility

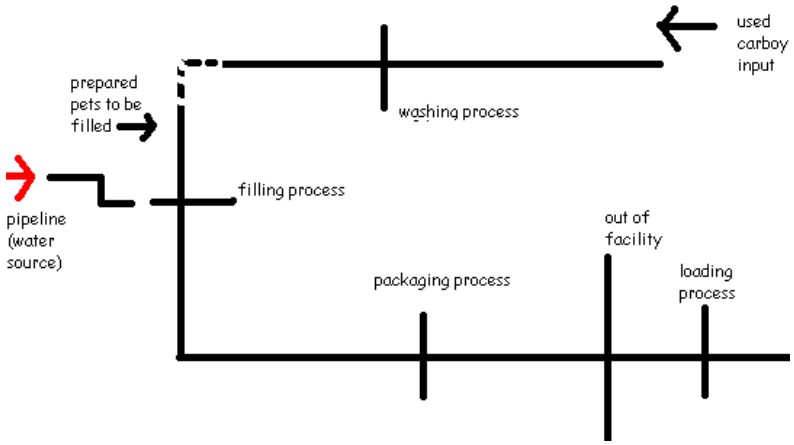
In this facility, filling of 0.33L, 0.5L, 2.5L, 5L plastic bottles and 19L Polycarbonade carboy has been implemented. (filling capacity is 203.500 tones/year)

1.4.3. Pinar Denge/Isparta Water Filling Facility

In this facility, filling of 0.5L, 1.5L, 5L plastic bottles has been implemented. (filling capacity is 40.000 tones/year)
Pınar Su goes on to be Turkiye's only leader in exporting packaged spring water. It exports to various countries, in particular, Germany, Turkish Republic of Northern Cyprus, England, Denmark, Poland, Azerbaijan, Kirghizistan, the USA, Canada, Malta, Belgium, Bahreyn, France, Iraq, Qatar, Kuwait, Australia, The United Arabian Emirates and is still a leader in spring water market exported from Turkiye to Germany.

2. PROBLEM DEFINITION

The question "What If?" has been the fundamental approach in every step of the project. Because, there are so many uncertainties through the production processes and firms should be ready for most of them for not to fail. Testing is a way to get prepared for any problem, but it costs a lot. That is, when a machine, causing 1 hour of delay in the production line, needs to be repaired, turning off the machine would cost a lot. Or, the real consequences of a decision could not be estimated definitely before the implementation.
Those uncertainties have also been observed in the production processes of Pınar SU.
Production facility of Pınar Su has been outlined as below;



The project was not for finding any solutions to the problems. The plan was to reflect the existing condition with simulation, so that the alternatives for using the resources of Pınar Su more effectively could be evaluated and presented accordingly. This would also help them to review some bottlenecks in their processes and visualize the most effective production process strategy, through simulation.

2.1. Challenges

When we have been first assigned to the simulation project, we hadn't know anything about simulation and ARENA® program. The advisors Muhittin Demir and Burcu Adıvar have helped us to understand the subjects and proposed us some materials to review.

We have also visited the facilities of Pınar Su. Accordingly, we have developed some assumptions, instead of using the actual data, which have improved the forecasting ability and team working capability. Different models have been prepared and then execution trials have been realized in ARENA® with forecasted data.

For the following semester; we were planning to prepare bottles' simulation, but Pınar Su has required us to execute the developed simulation model with real data. But later, they have re-agreed on preparing the carboy simulation model with water fountain and two depots. Accordingly, we have prepared the model and asked Murat Ildız to provide the necessary data. When he has joined the lesson, we have showed him the model. He has agreed on the model and given permission to the distribution group to provide us the data.

3. LITERATURE REVIEW

The group has performed an extensive literature review to learn about simulation technology. We have made researches on many academic articles as well. Simulation is a very efficient technology, however in Turkey, it has not been applied well enough.

- **“Simulation Article” by Roger D. Smith**

This article describes the science, technology, and tools of computer simulation in a language and style that average people can grasp very quickly. Simulation is the engine or brain behind all forms of believable computer generated worlds or business analysis tools. It allows virtual worlds to be more interactive, computer games to represent smarter opponents, business analysis tools to extrapolate information more accurately, and elaborate special effects to be driven by software. The article is an excellent reference for news stories, classroom lectures, term papers, research projects, and career guidance.

- **“Simulation: The Engine Behind the Virtual World” by Roger Smith**

Problems of interest in the real world are usually much more complex than it has seen. Infact, they may be so complex that a simple mathematical model can not be constructed to represent them. In this case, the behavior of the system must be estimated with a simulation. Exact representation is seldom possible in a model, constraining us to approximations to a degree of fidelity that is acceptable for the purposes of the study.

Models have been constructed for almost every system imaginable, to include factories, communications and computer networks, integrated circuits, highway systems, flight dynamics, national economies, social interactions, and imaginary worlds. In each of these environments, a model of the system has proved to be more cost effective, less dangerous, faster, or otherwise more practical than experimenting with real system.

4. APPROACH/ METHODOLOGY

At the beginning, we have agreed to learn how to model in a software program. The selected software program for modeling was Rockwell ARENA®. The success criteria have been to model the production process of Pınar Su as realistic as possible and to make it work in ARENA®.

Arena is the world's most effective simulation technology for modeling systems in manufacturing, transportation, logistics, warehousing and business processing.

Typical scenarios include:

- Detailed analysis of any type of manufacturing system, including material handling components
- Analysis of complex customer service and customer management systems
- Analysis of global supply chains that include warehousing, transportation and logistics systems
- Predicting system performance based on key metrics such as costs, throughputs, cycle times and utilizations
- Identifying process bottlenecks such as queue build ups and over-utilization of resources
- Planning staff, equipment or material requirements
- In addition to the Arena Professional Edition, Rockwell Automation offers a full suite of products to provide enterprise-wide simulation, optimization, and 3D model animation

After we have visited the factory and observed the product flow, the model has been prepared and transferred into the Arena program. At the end of the semester we could have solve the product simulation of the factory. The carboy simulation with water fountain has been modeled. After defining the problem, we have learned how to model a production process with ARENA ® software.
Defining the problem and then starting to learn to model in ARENA ® have been the most important milestones for the project.

5. DATA COLLECTION

During the first semester, all project groups of Pınar Su, have attended a meeting and got general information about the Company. Second meetings have been organised on group basis. So, the group could have specifically been informed and have reported accordingly, the expectations of Pınar Su regarding the simulation project.
We have observed Pınar Su's filling center and warehouse at Nazilli, got information about their production process and the main flow. We have transferred the model into the Arena program and at the end of the semester we could have solved the product simulation of the factory. The carboys' simulation has been modeled in this semester with the forecasted data, instead of real data.
During the second semester, as soon as the necessary data has been received from Pınar Su groups, the model of carboys with water fountain has been developed and with the inclusion of real data, Arena program has been executed. Therefore, we could have explained and understood the model of solution.

6. IMPLEMENTATION

During the implementation phase, simulation has been applied to an individual process in line with the project plan or with business needs. So, once a suitable application for the Project has been confirmed and a Project team has been assembled, the implementation steps could have begun accordingly.

Consists of six steps:

6.1. Plan the Simulation Project

As a first step, we have learned what simulation is and why Pınar Su has required us to simulate their production. Main goal was to model all the production processes of Pınar Su filling center. When we have started the project, there were two main subjects, carboys and bottles. But, this project was very difficult for us as we have never learned simulation before. We have been separated and started to learn what simulation is individually. Then, the project advisors Muhittin Demir and Burcu Adıvar have helped us and given important information about simulation and Arena program.
At the beginning, we were planning to model all the processes (both carboy filling process and bottles filling process). But then, we have preferred to focus on carboys filling process

only. In line with the goal, we have started to learn how to model with a software program. We have used Rockwell ARENA® software program to model.

6.2. Collect and analyze data

During the first semester, all Pınar Su groups have attended a meeting and got general information about Pınar Su Company. Second meetings have been held on group basis, so the group has had a chance to learn and discuss Pınar Su's expectations regarding simulation. After the second meeting, the group has reported Pınar Su's expectations from the project. We have observed Pınar Su's filling center and warehouse at Nazilli and got information about the production process, evaluated the flow, transferred the model into the Arena program and at the end of the semester, solved the production simulation of the factory. Only carboys' simulation could have been modeled in this semester with forecasted data, instead of the real data.

During the second semester, the necessary data has been provided from other Pınar Su groups. And so, we could have made the model of carboys with water fountain based on the real data and run the Arena program accordingly. Therefore, we could have explained and understood the model of solution.

6.3. Build the model

We have visited the factory, observed the production flow and prepared the model accordingly. All the group members have worked on modeling individually. Afterwards, we have come together, discussed on the model alternatives and chosen the best model. Then, we have uploaded the selected one into the Arena program and worked on the model. We have learned how to upload information and execute the model in Arena program. As a result, we have succeeded in preparing the model in Arena.

At the end, we have discussed why we have used this model, therefore, explained and understood the model of solution better. In the meantime, we have prepared some reports to be delivered to the academic advisers, such as proposal and progressive reports. We have done the best to provide the most effective solution for Pınar Su.

6.4. Verify and validate the model

When we have visited the facilities, two processes have been created; current carboys and new carboys. The model has been started with new carboys, then proceeded with the carboys which have been transferred to the line and passed through the line 1. Afterwards, the carboys have been checked by two workers to asess whether they have been damaged or not. If any of the carboys have been damaged, they have been sent to the trash. If not, they have been passed through the line 2 and continued with the washing process. At this point, we have verified the model and created a new process, called water fountain. In this process, when the water has flown through the water fountain, it was filled in match. There were two operations; sending to the filling centers and going to dispose. Dispose was refered to the circulation of the model as the carboys have been filled and sent to the customers, the water has been consumed and the empty carboys have been sent back to the transfer line. After the carboys filling center has passed to the line 3, labeling process would start. Again it passes through the line and damage check process has been repeated. Non damaged ones have been

transferred to line 5 and accordingly covering process starts. At the end, finally packed carboys have been sent to the distributors. When the empty carboys were returned, they have been circulated through the same process.

6.5. Conduct experiments

When we have prepared the new model, "carboys simulation with water fountain", we have created data and uploaded them in the model, but couldn't have run it at the beginning, because we were studying with the student version and the data was too large to be managed by that version. So, we have created new data and changed some processes in the model. At the end, we were able to run it.

6.6. Analyze, document and present results

When we have executed the model in the Arena programme, some reports could have been downloaded.

These reports were:

- Category overview
- Category by replication
- Entities
- Queues
- Resources

We have analized all these reports and received effective solutions.

7. RESULTS AND ANALYSIS

The results of the simulation study or trainings session should have been documented and disseminated to interested parties. These parties could identify the degree to which the simulation has answered specific questions and areas for future improvements.

The first document was Category Overview in which we could have found key performance indicators. This indicators' average was 54.

The second one was Category by Replication in which we could have found value added time, non-value added time and wait time averages.

Third one was Entities in which we could have found the Entity Detail Summary listing 200 carbory's numbers and 48 water numbers; 6 carboys going to the trash and 48 waters going to the disposes.

Fourth one was Queues in which we could have found the queue detail summaries, look and analyse the waiting time and number waitings.

Last one was Resources in which we could have checked the resources' detail summaries.

As a result, by looking at these solutions, we have summarized that 6 of the 200 carboys have been sent to the trash and 48 of them to the dispose. But, those 48 carboys have been returned to the facilities, only water has gone for disposal.

This has meant that the filled carboys have been delivered to the customers. And as the customers drink the water, the carboys which have been send back to the distributors, were emptied. The empty carboys have returned to the facility within 15 days and passed through

the related lines again. The carboys filling process has taken 10 seconds in match process. If we have increased the seconds, all of the carboys could have been filled, but as the average of rainfall rates have been changed, it was not possible.
Therefore, if Pınar Su would like to use the simulation effectively, they should discuss and develop their data, resources and time plans, so that the results could provide more realistic solutions.

8. PROJECT EVALUATION

8.1. Project Outcomes

During the first semester, the group has worked on Pınar Su's expectations from simulation project. We have build the carboys simulation model with water fountain. We couldn't have used the real data, so couldn't have realized the targets as planned. Still, it was very beneficial for Pınar Su, as modeling of production process has been completed successfully which would provide an important support while making their decisions.
During the second semester, we have executed carboys' simulation with water fountain in Arena program with the real data, as per the request of Murat Ildız. So, the existing conditions could have been reflected in the simulation program and accordingly we could have discussed and presented Pınar Su how their resources could have been used more effectively. As the model has been solved, it has been concluded that by making some revisions in their processes, they could run the production simulation processes more effectively.

8.2. Contribution to Company

In general, the project was mainly focusing on the simulation of the production processes. The main goal was improving the production processes through a more effective manner. The group has believed that the simulation project would have been very beneficial for the improvement of Pınar Su's operations.
Because, if business process analyses could have been done, firms' production processes would have been more effective, operations could have been faster and profitable, with lower risks and solutions to the problems could have been found faster.

8.3. Contribution to the Group

The most important contribution of this project was experiencing simulation and Arena software program. Because we have never learned this subject before. We also have developed the communication skills while contacting with the firm, developed forecasting abilities while making assumptions on the data which could be also useful during the professional life and we have experienced the importance of a team work. Moreover, we have also learned how to prepare professional reports and make presentations.

8.4 Performance of Team

During the first semester, the group was consisting of four members. First, we have faced some problems regarding coordination, division of labor and communication. But we could have overcome all, in a short while.

Time was a valuable resource for this project as we have needed to learn ARENA ® software or prepared reports. We have arranged regular meetings every Wednesday at school and every Sunday in Simulation Labs to proceed in the project. Group's performance, communication and coordination were very satisfactory. We have visited Pınar Su filling center at Aydın and group members were very observant during the trip.
During the second semester, one of the members have left the group. So, number of group members has been decreased to three. But, this have not affected the group's performance, we have worked harder in a more effective and efficient way. All the members have contributed to the project with new ideas.

8.5 Performance of Company

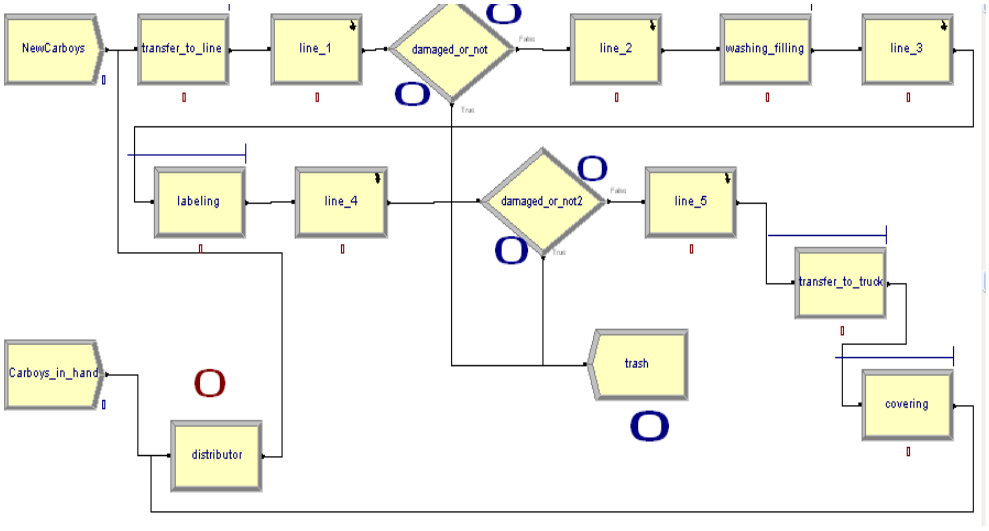
Murat ILDIZ is the Logistics and Planning Manager of Pınar Su. He has shared all his knowledge about the general progress of the production with us. When we have visited the facility, he has informed us regarding the process of the company. During the first semester; Pınar Su has contributed to the project very much. They have organized a trip in Pınar Su facility. Those visits were very useful and informative for the project. During the second semester; they were still helpful and kind towards us and supported the project by providing valuable feedbacks continiously.

8.6. Performance of Academic Advisor

The group's advisor was Muhittin Demir. He has worked for Pınar Su before and he was also experienced on simulation. He has shared all his knowledge with us for the success of this project. Both of the project advisors, Muhittin Demir and Burcu Adıvar, have helped us a lot and given very important information about simulation and Arena program through beneficial and effective meetings.

9. CONCLUSION

We were really concerned a lot when the project has just started, as we haven't taken this course before. All of us have been challanged in many ways by the consultance of some teachers and reviewing some books about simulation. And we have concluded that the most important thing was to make the model correctly and include the valid data in Arena. We have started to prepare the model. All of us have created diffierent data and then compared the models. Then, we have combined them and created the first model.

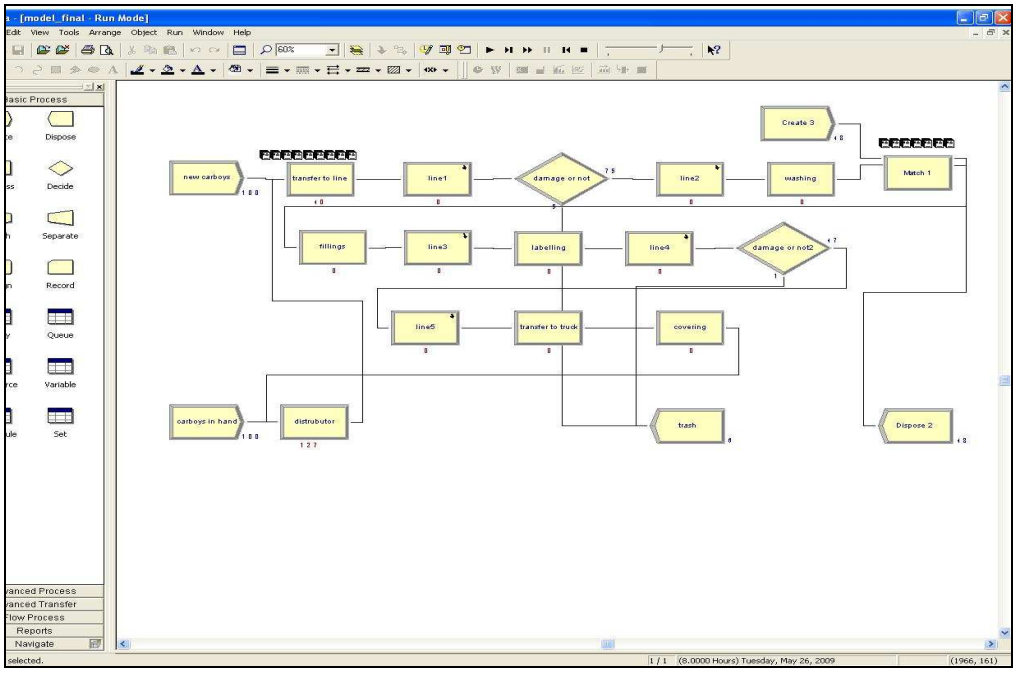


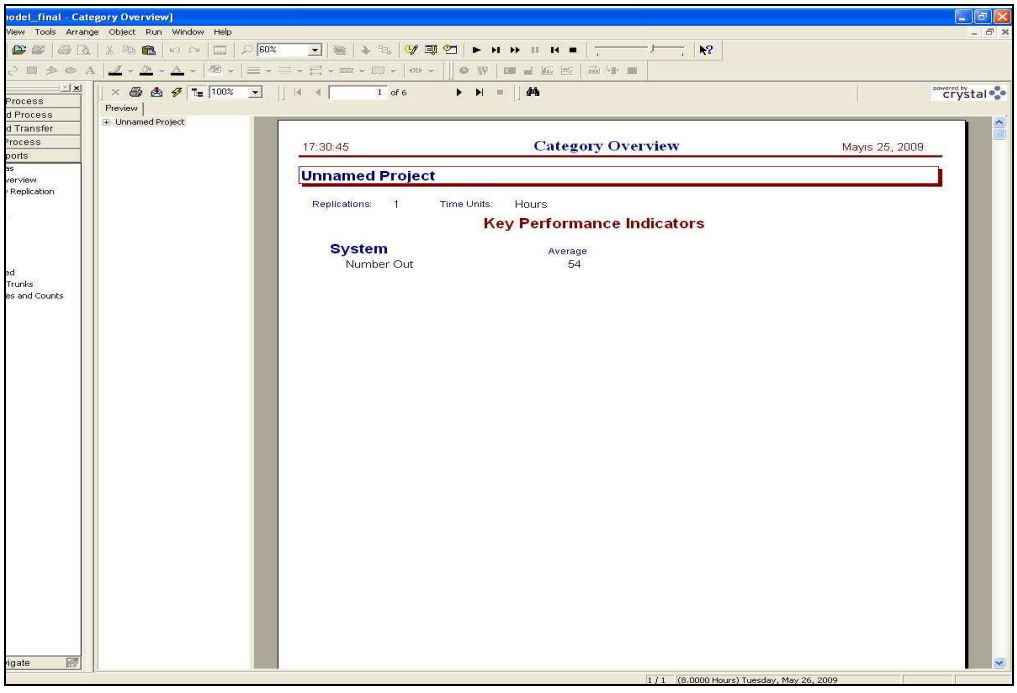
During the second semester, we have revised the model by adding water fountain and matched the process into the the model. And, we have executed it. So, we have explained the main flow, the aim of the project and the highlights of the reports.

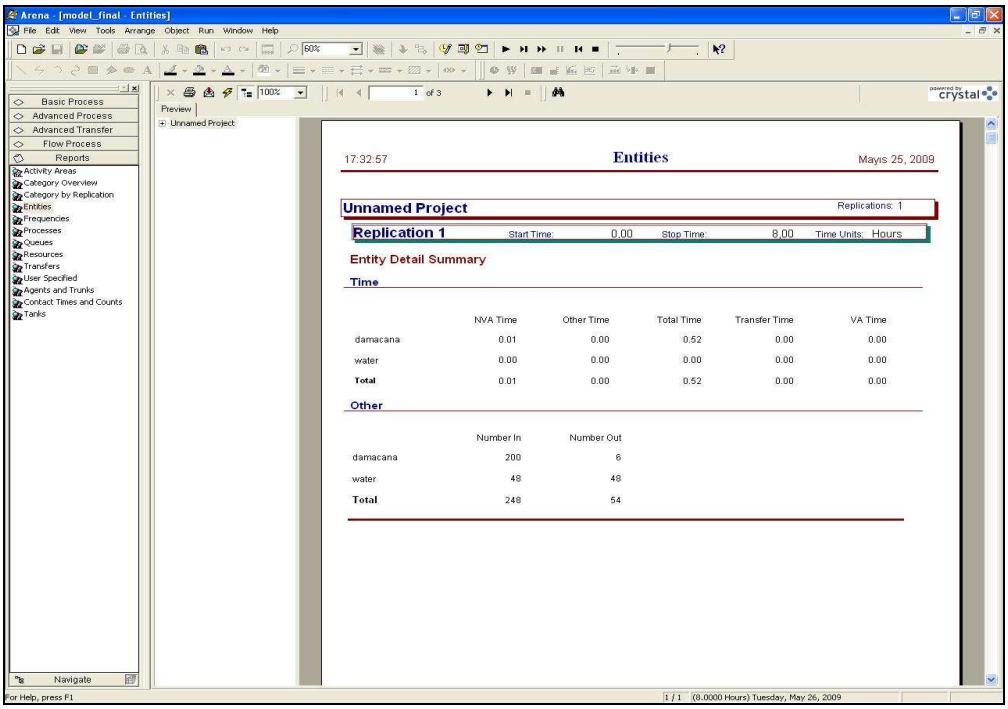
Simulation Expansion and Transformation: Like all computer applications, modeling and simulation was expanding as a result of improvements in computer hardware and software technologies. There was a time when simulation was performed entirely by dedicated personel using expensive, dedicated computer systems. We have reached a point where significant simulations could have been performed on personal computers by experts in a specific field, without the need for a staff of simulation specialists. Research in simulation itself, was leading to an array of new technologies and methods for constructing and using models. Innovations have included formalisms for defining models, interoperability of a diverse set of interactive simulations, metamodeling, human behavior modeling, and concurrent simulation. Later, the manufacturing, research, planning, and training communities have discovered that answers to their questions and insights into their problems could have been obtained economically and quickly from simulation models.

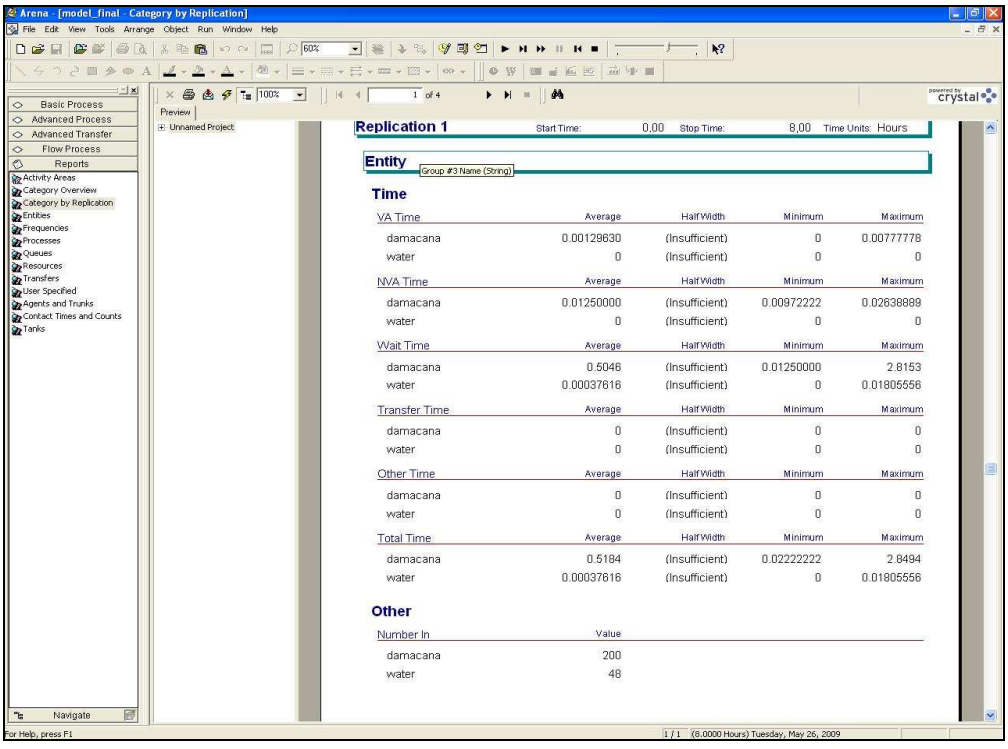
As the world evolves into an information society, more and more business, recreation, and government activities would have been defined in the form of digital data which could have been organized, analyzed, and predicted using simulation. This power would drive the wide adoption of simulation by all forms of business and government.

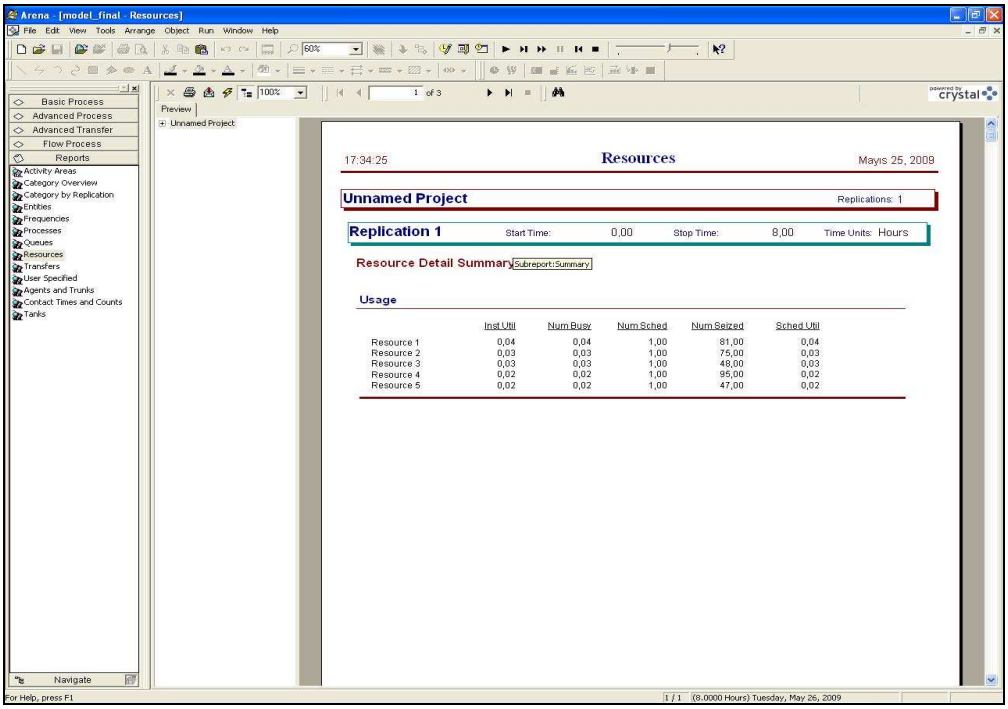
10. APPENDIX

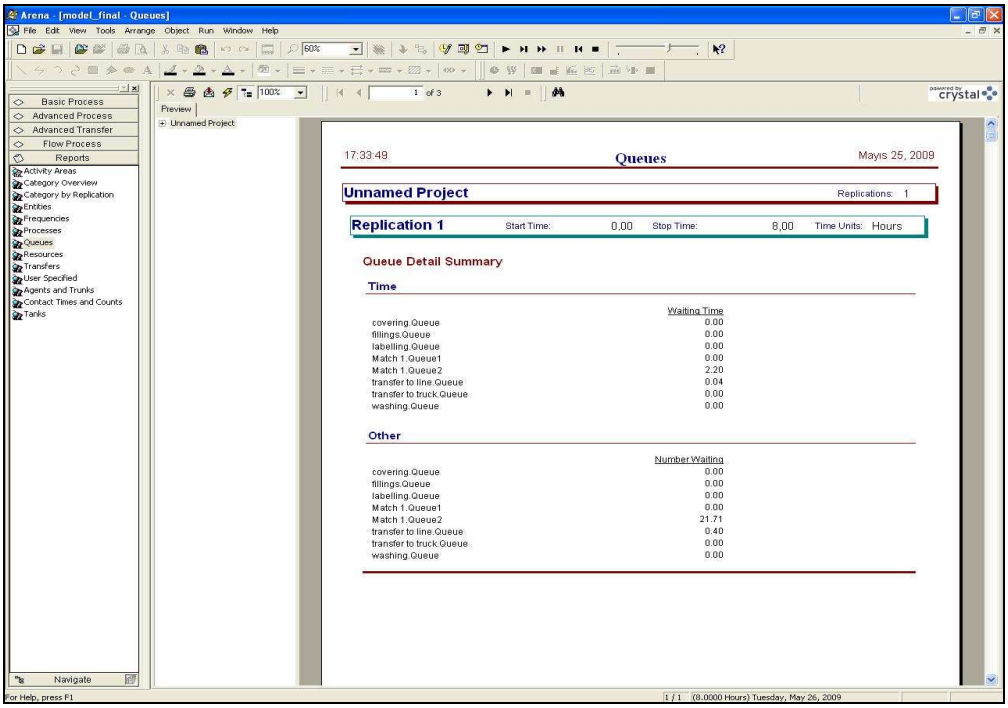

[model_final - Run Mode]
Create 3
new carboys
transfer to line
line1
damage or not
line2
washing
Match 1
fillings
line3
labelling
line4
damage or not2
line5
transfer to truck
covering
carboys in hand
distrubutor
trash
Dispose 2


model_final - Category Overview]
Preview
Unnamed Project
17:30:45
Category Overview
Mayıs 25, 2009
Unnamed Project
Replications: 1
Time Units: Hours
Key Performance Indicators
System
Number Out
Average
54


Arena - [model_final - Entities]
17:32:57
Entities
Mayıs 25, 2009
Unnamed Project
Replications: 1
Replication 1
Start Time: 0,00 Stop Time: 8,00 Time Units: Hours
Entity Detail Summary
Time
NVA Time Other Time Total Time Transfer Time VA Time
damacana 0.01 0.00 0.52 0.00 0.00
water 0.00 0.00 0.00 0.00 0.00
Total 0.01 0.00 0.52 0.00 0.00
Other
Number In Number Out
damacana 200 6
water 48 48
Total 248 54


Arena - [model_final - Category by Replication]
Replication 1
Start Time: 0,00 Stop Time: 8,00 Time Units: Hours
Entity
Group #3 Name (String)
Time
VA Time Average Half Width Minimum Maximum
damacana 0.00129630 (Insufficient) 0 0.00777778
water 0 (Insufficient) 0 0
NVA Time Average Half Width Minimum Maximum
damacana 0.01250000 (Insufficient) 0.00972222 0.02638889
water 0 (Insufficient) 0 0
Wait Time Average Half Width Minimum Maximum
damacana 0.5046 (Insufficient) 0.01250000 2.8153
water 0.00037616 (Insufficient) 0 0.01805556
Transfer Time Average Half Width Minimum Maximum
damacana 0 (Insufficient) 0 0
water 0 (Insufficient) 0 0
Other Time Average Half Width Minimum Maximum
damacana 0 (Insufficient) 0 0
water 0 (Insufficient) 0 0
Total Time Average Half Width Minimum Maximum
damacana 0.5184 (Insufficient) 0.02222222 2.8494
water 0.00037616 (Insufficient) 0 0.01805556
Other
Number In Value
damacana 200
water 48


Arena - [model_final - Resources]
17:34:25
Resources
Mayıs 25, 2009
Unnamed Project
Replications: 1
Replication 1
Start Time: 0,00
Stop Time: 8,00
Time Units: Hours
Resource Detail Summary
Subreport: Summary
Usage
Inst Util
Num Busy
Num Sched
Num Seized
Sched Util
Resource 1 0,04 0,04 1,00 81,00 0,04
Resource 2 0,03 0,03 1,00 75,00 0,03
Resource 3 0,03 0,03 1,00 48,00 0,03
Resource 4 0,02 0,02 1,00 95,00 0,02
Resource 5 0,02 0,02 1,00 47,00 0,02


Arena - [model_final - Queues]
17:33:49
Queues
Mayıs 25, 2009
Unnamed Project
Replications: 1
Replication 1
Start Time: 0,00
Stop Time: 8,00
Time Units: Hours
Queue Detail Summary
Time
Waiting Time
covering.Queue 0.00
fillings.Queue 0.00
labelling.Queue 0.00
Match 1.Queue1 0.00
Match 1.Queue2 2.20
transfer to line.Queue 0.04
transfer to truck.Queue 0.00
washing.Queue 0.00
Other
Number Waiting
covering.Queue 0.00
fillings.Queue 0.00
labelling.Queue 0.00
Match 1.Queue1 0.00
Match 1.Queue2 21.71
transfer to line.Queue 0.40
transfer to truck.Queue 0.00
washing.Queue 0.00

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DESIGN OF DECISION SUPPORT SYSTEMS WITH RFID APPLICATION FOR PINAR SU

Hasan Yonuk, Gökçe Atak, Şerife Tırman

Asst. Prof. Dr. Burcu Adıvar

EXECUTIVE SUMMARY

In this project, the main goal is to propose alternative RFID system designs for Pınar Su. With RFID, Pınar aims to contol the tracing of carboys and pallets, to count how many times a carboy is used, and to reduce the cost from employee mistakes.

To achieve the project goal, our team conducted a research on available RFID Technologies and created several alternatives for Pınar Su. The project was mainly focused on RFID application for a pilot region and the carboys without RFID application. We have also worked on warehouse design system for bottle types and imported goods and analyzed the costs versus benefits with different alternatives, for pilot region application. Our aim was to decide on the usage of single or multiple chips.

Rfid investment have diffrent cost structures depending on the budget, capacity, business processes, needs and expectations from RFID. The main cost structures are hardware, middleware, software, rfid tags, business processes, services, traning and education. Although, RFID is useful for traceability and inventory management, because of its high cost water sector do not prefer to use RFID, in general.

1. INTRODUCTION

1.1. General overview

RFID (Radio Frequency Identification) is relatively a new technology. Similar to barcodes, it is mainly used for automated data collection. RFID could have been easily integrated with barcode technologies to optimize data collection and exchange. Benefits include reduced/eliminated human error, reduced/eliminated labor costs, increased accuracy and visibility at the item level, and opportunities to simplify existing procedures. RFID uses radio frequency waves to transfer data between a reader and a tag. As the tag enters the radio frequency field, the radio frequency signal powers the tag or turns it on. The tag then transmits the ID and the data that has been programmed to the reader. RFID readers translate the radio frequency information into digital information that can be read by software on the host computer. The computer determines the required actions and instructs the reader, which in turn transmits data back to the tag.

RFID interrogators are available in many sizes and shapes, including portable units. All interrogators have the same basic architecture: antenna, decoder, data converter, computer interface, and a power supply.

The tag, which varies in size and appearance, is composed of:

- a chip which houses the "intelligence"
- an inlay which is the antenna
- a unique identifier number (similar to a license plate) to enable item level visibility and tracking, also defined as SID
- read/write data blocks
- optional label

1.2. Motivation:

RFID Decision Support System is an up to date subject at logistics. In selecting this project, our aim was to be informed about RFID technology and related implementations in logistics. RFID technology was widespread in USA and it proved to be useful for some goods especially for meat products and military items. Nowadays, it has started to attract more attention in Turkey as well. Since it is a new technology in Turkey and some of the firms are not even aware of RFID.

This project was also important to create awareness on RFID technologies and emphasize its advantages for those firms. It could be announced as being a new business area for logistics students. RFID technology costs are very high. Therefore, usage area is not wide enough in the world. As other technologies, RFID costs would also decrease by time, when it is known better and used widely. For example, in USA, a chip costs for $2 and in Turkey it could be more expensive as it has not been well known and widely used. Today, time is money. This enhances the importance of RFID technology, especially in logistics industry which requires

faster distribution and higher accuracy. If a Turkish firm could have started to use RFID, it would guide other firms to use it as well.

1.3. Goals:

The aim of the project was to design a system for minimizing the number of carboys lost, to determine carboys' usage while minimizing the mistakes which were mostly aroused from the workers and to apply RFID in the warehouse. Accordingly, we propose a plan to deactivate the barcode system and start using RFID instead. Additionally, examining the reasons of the losses in carboys, defining the real problem behind and finding alternative solutions were the main drivers for the project.

Main goals could have been listed as:

1. Real time tracking of individual items. Every carboy or pallet would have been counted online.
2. The list of the locations which have been visited by the carboy before its arrival to the filling center. If active RFID has been used, it would be possible to follow carboys on line or if passive RFID has been used, it would be possible to understand which carboy has gone to which dealer.
3. Improving operational efficiency through RFID implementation which would fasten the filling center operations and distribution in general.
4. Reducing product scanning costs.
5. Improving inventory management policies.
6. Controlling empty carboy returns better.
7. Decreasing the efforts for productivity through continuous stock counts.
8. Increasing visibility for finding the products through radio frequencies.

1.4. Pınar Su Background

Chronological milestones of Pinar Su are summarized below.

1984: Participated in Yasar Group. Turkey's first Non-Recyclable Packaged Spring Water with Pinar Sasal Brand has been produced. (1,5L PVC Package)
1985-86: Pinar Sasal Water in PVC Packages of 0,33 and 3L have been introduced to the Market.
1990-91: Bottled Water Production has been started in PVC Bottles of 5 and 0.5L.
1995: Annual production volume has been reached up to 100,000 tones. New resources have been started to be searched.
1996: Pinar Madran Facility, the most modern water filling establishment, has been started to be set up.
1997: The first Madran Water in Plastic Bottle of 1.5L has been produced. Turkish Standards Institution has awarded Golden Package with the Plastic Bottle of Madran Memba Water.
1998: Pinar Madran 5L Water in Plastic Bottle, which was Turkey's first Self-Handled Bottle, has been produced.

1999: Water in 5 and 0.5L Plastic Bottles have been started to be produced instead of 5 and 0.5L PVC Bottles; and specially designed 3.78L PVC Bottle has replaced Water in the 3 L PVC Bottle. ISO9002 Quality Management System Certificate has been obtained.
2000: The capacity of production has been doubled by means of new Blowing and Filling Machines for 5L Plastic Bottles purchased in Pinar Sasal and Pinar Madran Facilities. Pinar Madran Water in 8L Plastic Bottle has been launched.
2001: ISO 14001 Environmental Management System Certificate has been obtained. Pinar Madran Water in 2.5L Jag Shapes Bottle has been produced. Pinar Su has been awarded Golden Package Prize. It has become the first and the only Turkish Beverage Company that has been entitled to have the Quality Certificate from NSF based on the USA with its qualified and delicate production.
2002: Pinar Madran's quality has been controlled and approved by Fresenius Institute, which has been based on Germany, an international independent and effective institution controlling the conformity of the Spring Water with the Standards and Regulations of Germany and EU. 19 Polycarbonade Water has been produced.
2003: Pinar Madran Water in glass of 0.33L and 0.75L with one way has been introduced to the Market. Two new Filling Plants in Adapazari and Hendek joined the Family. The Products of these Two Plants have been launched as the brands of Pinar Yasam Pinarim and Pinar Denge.
2004: Pinar Rain, Turkey's first Aromatic Water has been introduced to the Market in four different sorts. Pinar Madran has been approved as "Natural Mineral Water" by the Authorized Officials in Germany.
2005: Clean Room Sytem has been activated in every Pinar Madran Facility. HACCP Food Safety Management Certificate has been obtained.

Facilities of PINAR Su

1.4.1 Pınar Madran Water Filling Facility

It has been established in 1996 in Bozdoğan, Aydın on 64.000m2 of which 14.000m2 is covered. Later, covered area has reached up to 17.000m2 with the additional investments in 2005. Pinar Madran is one of the most qualified waters in Turkey, having sources away from the residents, chemical qualifications not changing during the year and being found out after long researches. Its hardness degree is 1.65 French and it is one of the softest waters that can be drunk easily.

Pinar Su, carrying out filling practices in the filling rooms, where air inflow is prevented and the air is always kept clean, control water in every step of the production from the source to the bottling in physical, chemical and microbiological terms. The facility is also, periodically controlled, as a result of the analysis carried out within the scope of the Regulation by the Ministry of Health.
Pinar Su, producing in the facilities where water is bottled without spoiling the natural structure and changing the mineral balance in it, has put Class 100 Isolator and Clean Room System into practice. Pinar Su has created hygienical environment above the standards by

means of this system. In the Class 100 Isolator and Cleanroom system that Pinar Su has bought, following up the most advanced technological developments in the water sector, the filling machines could carry out filling practices in the sterile environment with laminar flow in the filling rooms, where air inflow has been prevented by keeping sterile air under pressure and the air has always being kept clean. Pinar Su has adopted Class 100 standards in accordance with E.S Federal Standard 209 E and started to bottle its products, having been offered to the consumers in a healthy way with this system up to now, in an ultra-hygienical environment under the surgery conditions.

Filling of 0.33L, 0.5L, 2.5L, 5L and 8L plastic bottles; 0.33L, 0.75L NRB glass bottles and 19L Polycarbonade carboy has been implemented. (Total filling capacity is around 570,000 tone/year)

1.4.2. Pınar Yasam Pınarım/Aadapazarı Water Filling Facility

In this facility, filling of 0.33L, 0.5L, 2.5L, 5L plastic bottles and 19L Polycarbonade carboy has been implemented. (Total filling capacity is 203,500 tones/year)

1.4.3. Pınar Dende/Isparta Water Filling Facility

In this facility, filling of 0.5L, 1.5L, 5L plastic bottles has been implemented. (filling capacity is 40.000 tones/year)

Pinar Su goes on to be Turkey's only leader in exporting packaged spring water. It exports to various countries, in particular, Germany, Turkish Republic of Northern Cyprus, England, Denmark, Poland, Azerbaijan, Kirghizistan, the USA, Canada, Malta, Belgium, Bahreyn, France, Iraq, Qatar, Kuwait, Australia, The United Arabian Emirates and is still a leader in spring water market exported from Turkey to Germany.

2. PROBLEM DEFINITION

Although Pınar Su has implemented prototype RFID chips, it has not received efficient results due to ineffective usage, broken chips and insufficient control systems in their warehouses. On the other hand, existing barcode systems have not worked well enough which resulted in increases in errors.

Besides, the carboys' filling frequency could not have been tracked well. The carboy's life cycle has been determined as filling rotation up to 40 times. Therefore, the company requires to improve the control processes and reach the minimum error rate in warehouse tracking. SAP program has been used in entering the stock data. The barcode system used in their warehouses includes manual card readers, enabling the workers to receive inaccurate information at the warehouse, so resulting in inaccurate forecasts and inventory levels, which at the end lead to ineffectiveness in the company's production and distribution processes. This has a direct negative impact on the company's competitiveness as well. As the control on carboy flow was not controlled well enough, approximately %25 of carboys sent to dealers

have been lost. As a result of the meeting held with Pınar Su's executives, we were supposed to analyze the previous RFID system, find the deficits and at the end, gather enough information to utilize the most suitable RFID chips for their processes.

2.1. Challenges:

- High investment cost as technology has not matured enough (low benefit to investment ratio)
- Uncertainty on whether it could be useful or not.
- Hesitation about information security. The information on chips could have been read by Pınar Su's competitors, if they have been broke down.
- The extent of RFID system design which may or may not include all the functions of Pinar Su supply chain. Only if active RFID chips have been put inside the carboys, process would start from supplier and down to customers by providing coordination in between.
- Exported products are excluded from RFID implementation.
- Replacing the existing technology and applying a new one to a business was a hard and complex process to manage.
- RFID was a new technology which has not been developed well enough in Turkey yet.
- RFID technology requires analysis of business processes with a serious system design.

3. LITERATURE REVIEW

The group has performed an extensive literature review to be informed about RFID technology. RFID is a new technology and have not been applied in Turkey wide enough. Therefore, we have investigated many academic articles, attented to an RFID Symposium[1] which has been organized by ITU and obtained information regarding RFID applications in logistics. Tolga Erkmen[2], who is an expert on RFID applications, has given a review on RFID and helped us to calculate the investment cost of RFID system as well as shared his ideas of how the project should be proceeded.

- RFID investments have different cost structures depending on the budget, capacity, business processes and needs and expectations from RFID. However, the main drivers of the costs are defined as hardware, middleware, software, RFID tags, business processes, services, training and education. Tolga Erkmen has assisted on the cost analysis for Pınar Su.
- Angeles, R., "RFID Technologies: Supply-Chain Applications and Implementation Issues", (2005), *Information Systems Management*, pp.51-65.

[1] II. RFID UYGULAMALARI SEMPOZYUMU, İstanbul Teknik Universitesi, Kasim 2008, http://www.rfid.itu.edu.tr/sempozyum/index.htm

[2] Former CEO of Netsco and current president of ICCE Systems (http://www.iccesys.com)

Innovations, especially technology based innovations, have been very important for the firms aiming to create competitive advantage. Besides, assessing technologies has always been one of the main activities for the firms which have aimed to improve their processes continuously. RFID technology is one of the technologies, which has gained importance in the recent years. In this article, history and infrastructure requirements of RFID technology have been explained in detail. Additionally, advantages and the issues that should have been taken into consideration have also been explained. After presenting the comparison between Barcode and RFID technology, important RFID projects have been outlined. As a conclusion, suggestions related to the RFID technology have been given with the context of technology management.

- Myerson, M.J., "RFID in the Supply Chain: A Guide to Selection and Implementation", (2007), books.google.com, Auerbach Publications

Reasons for transitioning to RFID technology from barcode technology have been summarized and an overview of the RFID market has been given by moving on to the discussion of economic feasibility of rolling out RFID with a focus on supply chain synchronization, customer privacy issues, security challenges, operational and IT challenges, logistical challenges, program management challenges, education and training, standard implementation challenges, and what lessons have been learned. Afterwards, it has been covered that, what RFID technology infrastructure was and should be or the future of Supply Chain Management would be.

- Üstündağ, A., Tanyaş, M., "Radyo Frekanslı Tanıma (RFID) Teknolojisinin Tedarik Zinciri Üzerindeki Etkileri", (2008), *itudergi.itu.edu.tr*

4. APPROACH/ METHODOLOGY

The group has developed RFID System Design. In order to make an effective design, the team has investigated and sought to collect information about filling facilities, production processes, distribution systems, current information technologies and quality control systems.

4.1. Identification of Processes in Nazilli Filling Center

In Nazilli Filling Center analysis, the group has identified the problem areas prior to deploying an RFID establishment. The first part of the analysis has included the RFID components as estimating the needs, reviewing the costs and necessary trainings on using RFID components.

The number of readers required for optimal read response, have been identified along with the number of antennas necessary for Pınar Su warehouses. Besides, the number of tags required for tagging new items, have been identified to determine whether to implement one usage tags or multiple usage tags. If multiple usage tags have been implemented, it should have been considered for returns. Environmental evaluation has allowed for identification of logical zones, such as assembly of the portals in the warehouse.

4.2. Two Different RFID System Designs for Carboys:

The new carboys have been supplied from suppliers and used-emptied carboys have been reversed from distribution centers. They have been gone into the filling center with multiple usage RFID tags. Accordingly, the carboys' data should be transferred to the reader:

- Which carboy has come from which dealer?
- How many days have been passed between exit and entrance of carboys?
- How many times have the carboys been used?

Following the first reading process, carboys have been started to be filled up with water. The carboys to be filled up are resistant to heat and chemical. Besides, tags should also be resistant to heat. In general, the tags have been broken down when they have met with water. For this reason, the group proposed multiple usage chips for carboys, which cost higher than the other alternatives. After the water filling process, below data should be uploaded into the chips.

- Production date of water
- Production time of water
- Shift details
- Carboys' serial number

Tags should be put under the carboys to avoid potential damages. Carboys should be put into big-blue pallets to have the chips been read easily by the dealers. In these big-blue pallets, carboys will be placed side by side and aslope. Those big blue pallets will be mostly used for pilot regions' dealers. Because, when dealers receive carboys from the distribution centers collectively, they could not easily carry the carboys individually as it takes time and is difficult to manage.

Additionally, dealers should enter new data to SAP, to make it visualized clearly by Pinar Su. After the data upload process has been completed, carboys should be loaded into the trucks and sent back to the distribution centers.

Focusing on the pilot region application, carboys arriving to the distribution centers will bee transported to three selected dealers in Konak. Every dealer should have a hand terminal to be able to read the data through and to enter them into SAP system. When the emptied carboys return from the end customer to the dealers, dealers should read the carboys through hand terminal once again. So, they could understand how many days those carboys have been stayed at the end customer.

As a final process, empty carboys have been turned back to the filling center. Tag information will be transferred to the database and to SAP. SAP database system transforms the data for two readers, acts as a core interface between the two. If there has been a problem at RFID system, SAP solves the problem easily and quickly.

The criteria for choosing the dealers for pilot region:

- Fast circulation of the Carboys'

- Clean usage of the Carboys. That is, not causing any damage to the chips which, at the end, return.

4.3. RFID Hardware Location On Warehouse Layout

Pınar Su Nazilli filling center are also used as a warehouse. There were two different product groups: eight types of bottled water and imported goods. After palletizing process, single usage chips should be placed. The reason of preferring single usage chips is their low cost, as they will not be returned after the delivery to the customer.

Two different product groups' data will be read by antennas in the warehouse and transferred to SAP database system. The data that is kept in the database include:

- Stock follow up
- Production date
- Production hour
- Production line
- Serial number of pallets
- Exporting goods' entrance and existing date in warehouse.

There are two exit gates in the warehouse. Two sensors and antennas should be located properly onto the gates. Otherwise, there would be some problems like double reading, or even not reading. Sensors' perceived area should have been modified properly as well. Palletized goods have been read while products leave the warehouse. Thus, Pinar Su would know which product moves where and when. It would provide product visibility and the effective usage of the warehouse as well.

5. DATA COLLECTION

During the first semester, all groups of Pınar Su have attended a meeting and got general information about the company. Second meetings have been organized on group basis, so that we could have learned and discussed Pınar Su's expectations from the RFID project. Following the second meeting, the group has summarized Pınar Su's expectations at the progress report. We have observed Pınar Su's filling center and warehouse at Nazilli and got information about barcode system to be able to make a comparison with RFID. We have constructed the barcode system that have been used at Pınar Su's warehouses as well as the barcode labels, barcode expansion and hand terminals.

During the second semester, the group has met with Murat Ildız and shared with him the business process analyses to receive his feedbacks. The detailed business process analyses have been outlined after visiting Nazilli filling center and receiving information from Murat Ildız during the first semester. Data collection process has been proceeded thorough the internet and related articles. The prices of RFID components and costs of RFID infrastructure have been collected through the internet.

6. IMPLEMENTATION

6.1. Stock Follow-Up:

We should have followed the stocks up, to minimize the problems on the barcode system and to decrease the number of manual operations. While carboys were entering and exiting the line, they should have been counted properly and effectively to be put on depot gates. Thus, we could have counted the products and materials without any mistakes.

6.2. Products' Visibility:

Both for carboys and bottles, we should have focused on batch numbers, which were written under the expiration date. It was necessary for tracking which product has exited from which warehouse and in which dealer they have been sent. The carboys have not been stocked in the warehouse as their trucks were a kind of moving warehouse.

Lost carboys are important problem for Pınar Su. Actual versus registered stocks were different. Through RFID, the number of lost carboys would have been decreased as well as the stocks and related costs.

6.3. Materials Traceability:

Batch follow up is one of the main challenges of the material warehouses. Following up the type of the cap and mould was an important task for Pınar Su. When the caps and moulds have entered the center, they should have been read by the computers. For example, in case of a complaint about the caps of a bottle, the information regarding the caps, like the name of the supplier or date of production, should have been tracked. Through RFID system, we would have got all the related information on a bottle instead of following up the cap and mould details. Therefore, barcode-RFID system could have been proposed to decrease the cost.

6.4. Boxer RFID:

This concept has been used by Murat Ildız. It is a counter to know how many times a carboy has been used. Carboys should have been used maximum for 40 times for the customers' health. Pınar Su could have implemented boxer RFID into the filling center. Thus, carboy would have been wasted automatically by the 51st time.

6.5. Evaluating the Dealers:

Pınar Su has required receiving the carboys back in clean and undamaged condition. Therefore, we should have developed a dealer evaluating system. For example, to be able to know which carboy has been sent to which dealer, the related license-tag should have been recorded. As soon as the carboys have been returned back to the filling process, they have been read and in case of damage detection, it could have been understood from which dealer they have come from. Therefore, license-tag was important to be recorded and dealer name was important to be followed up.

Through RFID system, it could have been understood that which dealers were damaging the carboys and decreasing their sustainability. Sometimes, carboys have been carried by

motorcycles which results in higher damages. Pınar Su was warning these dealers and invoicing the cost of the damages to the dealers. Through RFID, it could also be traced that which trucks were causing damage to the carboys. Pınar Su could have controlled all activities of a dealer during a month through the dealers' code and name.

6.6. Create Awareness:
Through RFID, Pınar Su would be able to create awareness. Also, by using bags on the carboys, they could have managed their demands better. Besides, customers' health is of highest priority for Pınar Su.

7. RESULTS AND ANALYSES

The decision to implement RFID technology in a company is a business decision, not a technology decision. For this reason, it is vital that the decision to implement RFID should be justifiable in terms of its economic value to the company. A cost-benefit analysis could assist a company in analyzing the impact of an RFID implementation to its business and activities. It is critical that a company could take an enterprise view, since every agreed decision would have an impact on future deployments and net ROI. An enterprise system requires the multiple and variable performance criteria to be met simultaneously and effectively.

In this analysis, we have considered certain attributes to clarify the fundamentals towards success. We have coined the expression "absolute truths" for such findings. If we were to use RFID tags with reserve logistics, we could have decreased the costs. In the recent years, mobile reader's performance was increasing, so dependency on immobile system was decreasing. Therefore, information on different points could have been collected easily and quickly. And fixed costs of RFID's main components were decreasing like reader, antennas and printers. Annual tag consumption was the variable costs.

There is a legal necessity about reverse logistics of carboys for at least 45%. As a result, Pınar Su has made an agreement with a firm which collects the 0.5lt, 1.5lt and 5lt bottles. This would cost a lot.

<u>COST versus BENEFIT ANALYSES</u>
Hardware $15000
Antennas
5 Readers
Middleware & Software $7000
Tag
As an example, the given data:
# of Carboys: 50.000/month
# of Months: 8

ALTERNATIVE SINGLE USAGE 1
Single usage chip: $0,1
50.000*$0.1= $5.000/month for single usage
Cost: 5.000*8=$40.000 for 8 months period

ALTERNATIVE SINGLE USAGE 2 (THREE TIMES IN A MONTH)
Single usage chip: $0,1
50.000 *$0.1= $5.000/month for single usage
If 50.000 carboys have been used for 3 times a month, total number of single chips required in a month is 50.000x3=150.000
150.000x0.1$=15.000
15.000x8=120.000
Total cost = $15.000+$7.000+$120.000+$10.000+$3.000+$5.000= $160.000

ALTERNATIVE SINGLE USAGE 3 (TEN TIMES IN A MONTH)
Single usage chip: $0,1
50.000 *$0.1= $ 5.000 /month for single usage
If 50.000 carboys have been used ten times a month , total number of single chips required in a month is 50.000x10=500.000
500.000x0.1$=50.000
50.000x8=400.000
Total cost = $15.000+$7.000+$400.000+$10.000+$3.000+$5.000=$440.000

ALTERNATIVE MULTIPLE USAGE 1 (5 TIMES IN A MONTH)
Multiple usage chips: $1 (40 times usage)
Cost: 50.000 *$1=$ 50.000 first putting chips on carboys
If we assume that a carboy is turning back 5 times in a month,
40/5=8 months - we won't change chips within 8 months

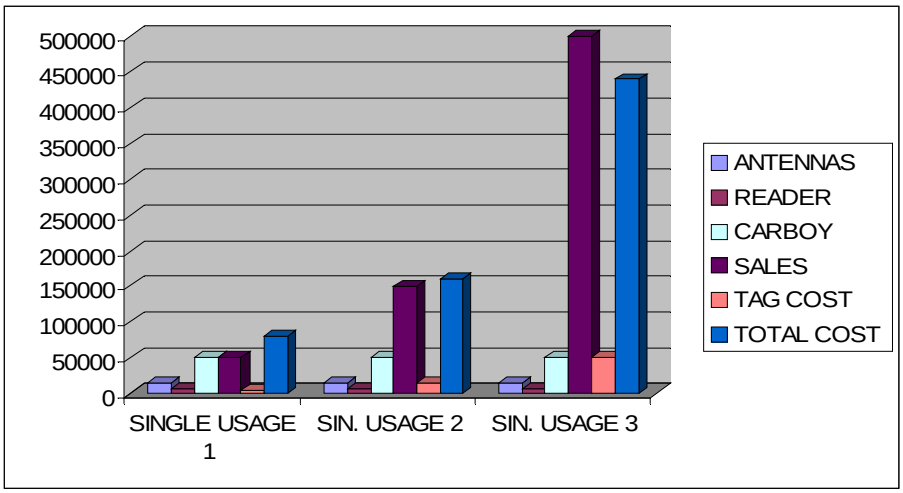
ALTERNATINE MULTIPLE USAGE 2 (THREE TIMES IN A MONTH)
Multiple usage chips: $1 (40 times usage)
Cost: 50.000 *$1=$ 50.000 first putting chips on carboys
If we assume that a carboy is turning back 3 times in a month,
40/ 3 = 12 months - we won't change chips within 12 months
Total cost = $15.000+$7.000+$50.000+$10.000+$3.000+$5.000=$90.000
The same price at "5 times in a month"

ALTERNATINE MULTIPLE USAGE 3 (TEN TIMES IN MONTH)
Multiple usage chips: $1 (40 times usage)
Cost: 50.000 *$1=$ 50.000 first putting chips on carboys
If we assume that a carboy is turning back 10 times in a month,
40/ 10 = 4 months - we won't change chips during 4 months
We have 4x2=8 months so chips change two times

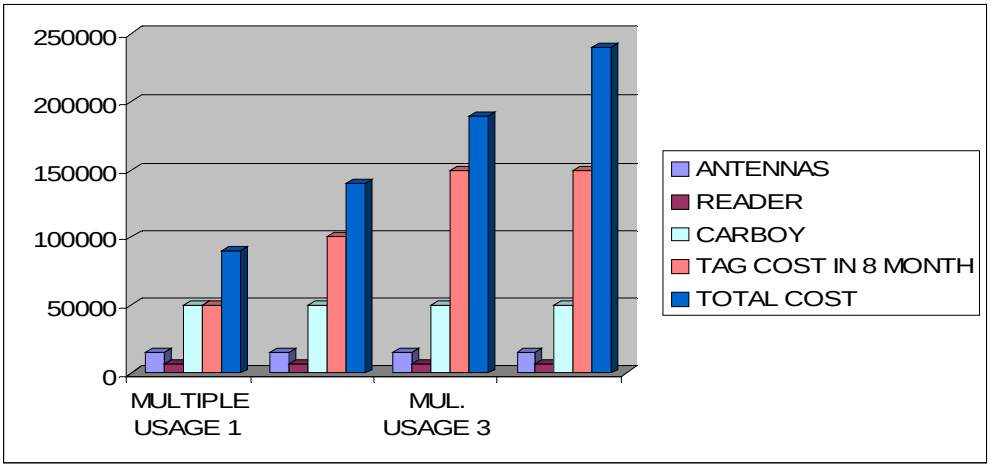
50.000x2=100.000
Total cost = $15.000+$7.000+$100.000+$10.000+$3.000+$5.000=$140.000

ALTERNATINE MULTIPLE USAGE 5 (TWENTY TIMES IN A MONTH)
Multiple usage chips: $1 (40 times usage)
Cost: 50.000 *$1=$ 50.000 first putting chips on carboys
If we assume that a carboy is turning back 20 times in a month,
40/ 20 = approximately 2 months - we won't change chips during 2 months
We have 8/2=4 so chips change four times
50.000x4=200.000
Total cost = $15.000+$7.000+$200.000+$10.000+$3.000+$5.000=$240.000

	MULTIPLE USAGE 1	MUL. USAGE 2	MUL. USAGE 3	MUL. USAGE 4
ANTENNAS	15000	15000	15000	15000
READER	7000	7000	7000	7000
TAG COST PER UNIT	1	1	1	1
CARBOY	50.000	50.000	50.000	50.000
USAGE TAG NUM.	1	2	3	4
TAG COST IN 8 MONTH	50.000	100.000	150.000	150.000
TOTAL COST	90.000	140.000	190.000	240.000



	MULTIPLE USAGE 1	MUL. USAGE 2	MUL. USAGE 3	MUL. USAGE 4
ANTENNAS	15000	15000	15000	15000
READER	7000	7000	7000	7000
TAG COST PER UNIT	1	1	1	1
CARBOY	50.000	50.000	50.000	50.000
USAGE TAG NUM.	1	2	3	4
TAG COST IN 8 MONTH	50.000	100.000	150.000	150.000
TOTAL COST	90.000	140.000	190.000	240.000



Business Process:	$10000
Services:	$3000
Training and Education:	$5000

TOTAL COST FOR ALTERNATIVES:

Single usage costs

$15.000+$7.000+$40.000+$10.000+$3.000+$5.000=$80.000

$15.000+$7.000+$120.000+$10.000+$3.000+$5.000=$160.000

$15.000+$7.000+$400.000+$10.000+$3.000+$5.000=$440.000

TOTAL COST FOR ALTERNATIVES

Multiple Usage Costs

$15.000+$7.000+$50.000+$10.000+$3.000+$5.000=$90.000

$15.000+$7.000+$100.000+$10.000+$3.000+$5.000=$140.000

$15.000+$7.000+$150.000+$10.000+$3.000+$5.000=$190.000

$15.000+$7.000+$200.000+$10.000+$3.000+$5.000=$240.000

After the cost analysis, the group has decided to apply multiple usage chips for pilot region application. When the group has calculated the total cost, it has shown that single usage was not suitable. In the short term (1 or 2 months period), single usage chips were more suitable than multiple usage chips. But the group has realized that in 8 or 12 months period, multiple usage chips' costs have become more suitable than single usage chips.

8. PROJECT EVALUATION

8.1. Project Outcomes

During the first semester, the group has worked on expectations of Pınar Su from RFID. Upon this, six types of methodology have been improved. These were, stock follow up in the warehouse, raw material traceability, products' visibility, boxer RFID, dealer evaluation system and creating awareness for Pınar Su.

During the second semester, we have prepared business process analysis for carboys and other products in the warehouse. In Izmir, Çigli has been chosen as the pilot region area for carboys' application. The group has studied for deciding whether multiple usage chips were effective enough for Pınar Su or not, on the selected pilot region. We have worked on cost-benefit analyses through assumptions for both multiple and single usage chips according to business process analyses. Accordingly, the group has proposed to apply single usage chip application for Pınar Su's warehouse and multiple usage chip application for Pınar Su's carboys. At the end of the project, the goals could have been reached. RFID System Design has been set up in the warehouse and pilot region application has also reached its goals regarding carboys.

8.2. Contribution to the Company

In general, the project has focused on RFID system design on warehouses, as the group has also found RFID System Design advantageous to the warehouse for Pınar Su Company.
Studying on benefits of RFID was a challenging task for the group. Because RFID is an information technology and it should have been known better nowadays. As a result of all our studies, we have concluded that the usage of RFID is more advantageous than the usage of barcode system, as it is a more developed system.

Prior to starting the operations, structuring the business process analyses is a key activity for a firm. If business process analyses have been figured out clearly, the firms' operations could have been faster, profitable or the human caused errors could have been reduced or solved quicker.

The group's contributions for Pınar Su could have been summarized as preparing the business process analyses for distribution and recycling of carboys and other warehouse applications. Besides, RFID has been applied to these business processes and it has provided a more effective flow. Although RFID was an expensive system, it has provided more benefits for the long term, compared to the barcode system.

By the application of RFID technology, products' traceability could have been increased. Firms could have received detailed information about carboys' location, where and when they have left and how many times they have been used. Besides, the problems would have been reduced by applying RFID as well.

8.3. Contribution to Our Group

Studying on this project has created awareness for us on the importance of information technologies and accordingly we have learned how to apply RFID to the operations of a firm. It also has stimulated us to work with a firm that applies RFID technology. Because RFID application in the warehouses were not well known in Turkey and it was recently developing as a new area in logistics firms. The contributions of RFID technology to the group could have been listed as:

- developing methodology on RFID,
- learning RFID technology in details,
- having information about infrastructure of RFID and chip prices,
- preparing business process analyses and preparing those processes' cost benefit analyses,
- applying RFID to the warehouses or to the business processes.

This project has also experienced us the real business life. We have learned how to prepare professional reports and presentations and how to present them. After observing Nazilli filling center and talking to the administrators, we have understood how to analyse business processes. Besides, we have learned how to behave, speak or sent formal correspondences.

8.4. Performance of Team

During the first semester, the group was consisted of five members. There was a division of work system. But during the second semester, number of group members decreased to three. The effective group work has also continued. All the members have known all the processes, but on the other hand, the workload per member has increased. Even tough, everyone has worked equally and effectively. The decisions have been taken all together.

During the first semester, we have focused on the literature research, but during the second term, group members' brainstorming has generated different ideas. At the end of the first semester, considering the literature researches like chip prices and infrastructure prices, we have applied those prices into the Pınar Su warehouses and business processes. During the first semester, we have visited Nazilli filling center and analyzed the pilot region application for RFID warehouse design and distribution channels. Business process analysis has been figured out by group members and RFID system design application has been applied accordingly.

8.5. Performance of the Company

Murat Ildız has helped us a lot. We have shared the business process analysis and received his feedbacks. Business process analysis has been outlined after the visit to Nazilli. At the beginning of the second semester, we have sent our activity plans to Murat Ildız. He directed and assisted us a lot on how to proceed regarding the project.

8.6. Performance of Academic Advisor

The group's advisor meetings were more regular and effective in the second semester. The group has met with Muhittin Demir when the academic advisor was not available. Having a second advisor and meeting with him has also been very beneficial for us in receiving different advices. The academic adviser has directed us to draw business process charts, given some articles to understand the stages better and proposed to search some web sites about RFID.

9. CONCLUSION

The company would have controlled warehouse activities more effectively than the barcode system. If RFID chips could have worked effectively, the company would have provided more information for the identification of the goods. The company would be able to control the usage of empty carboys; to determine how many times the carboys have been filled again. Also, the company would be able to increase recycling ratio with using the RFID chips on the carboys. The company can also collect information from customer's houses with active RFID chips.

Additionaly, RFID system might have been helpful for distribution planning, like which carboys have been loaded and where the goods have been taken from Pınar Su. If we use RFID tags with reserve logistics, we can decrease total cost.

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CUSTOMER RELATIONSHIP MANAGEMENT AND MARKETING ANALYSIS AT SCHENKER ARKAS

Benedikt Schröder, Yiğit Pir, Halil Kahramanoğlu, Serhan Güloğlu

Asst. Prof. Dr. Burcu Adıvar

EXECUTIVE SUMMARY

In thıs project, specific ideas and strategies fitting to the company profile of Schenker-Arkas have been produces. In the context of customer relationship management framework, we specically dealt with customer services including complains management, campaigns, lost customer system and call center; past and future CRM projects, benchmarking, discounts, and promotion management.

By this project the team members have had the opportunity to gain work and project management experience at Schenker-Arkas and the opportunity to develop and improve business skills. Advised by academic and industrial professionals the team has worked as junior consultants for Schenker-Arkas.

1. INTRODUCTION

1.1. General overview

During the last 3-month period, CRM methods and activities at Schenker-Arkas have been observed and analyzed. This report aims to close the project by analyzing the outcome as well as all aspects regarding this project. It addresses the Industrial Advisor (Schenker-Arkas) as well as the Academic Advisor (Asst. Prof. Dr. Burcu Adıvar) of the group to assess the success of the project, identify best practices for future projects, resolve all open issues, and formally close the project.

This project is created to accomplish the following goals:

- Review and validate the milestones and success of the project.
- Confirm outstanding issues, and recommendations.
- Outline tasks and activities required to close the project.
- Identify strength and weaknesses of our project management

The project is closed due to the fact that two of the team members (Benedikt Schröder, Serhan Güloglu) are Erasmus students from Vienna, Austria. They have to go back to Austria at the end of the Fall Term 2008/2009. This fact has allowed the team just to work for three months on this project.

1.2. Motivation

The background of this project has been a new established bench between the Izmir University of Economics and several companies situated in Izmir. By this project the team members have had the opportunity to gain work and project management experience at Schenker-Arkas and the opportunity to develop and improve business skills. Advised by academic and industrial professionals the team has worked as junior consultants for Schenker-Arkas.

1.3. Project Highlights and Best Practices

Project Highlights:

- Eco-driving
- Campaigns
- Website Benchmarking
- Lost Customer Program
- Customer Complaint Management

2. PROBLEM DEFINITION

According to the project proposal, the scope of the project had been set as to:

- Develop a catalogue of ideas of how to improve customer service especially designed for the needs of Schenker-Arkas.

- Provide Schenker-Arkas with the ability to predict the needs of their customers before the customer has to come to Schenker-Arkas.
- Other objectives had been defined as to help Schenker-Arkas with already started CRM-related projects, for example
- Lost customers program
- Handling complaints
- CRM Application project

Compared to goals and objectives in the project proposal, the team members have worked on all topics mentioned above. The team has offered a catalogue of ideas and campaigns that the team could have dealt with and Schenker-Arkas has guided the team to several topics and directions to work on, like Complaint Management and Lost Customers program.

According to Schenker-Arkas the project has been a success. They have been pleased to work with the team members and have found the ideas and developments of the team useful. The time the team has spent in the office has been useful and effective for both sides. The team has learned a lot about the company and of course the topic, and on the other hand the team has been able to provide Schenker-Arkas with ideas and systems on how to improve their Customer Relationship Management. Furthermore, from the team members' point of view, most of the criterias have been successfully achieved.

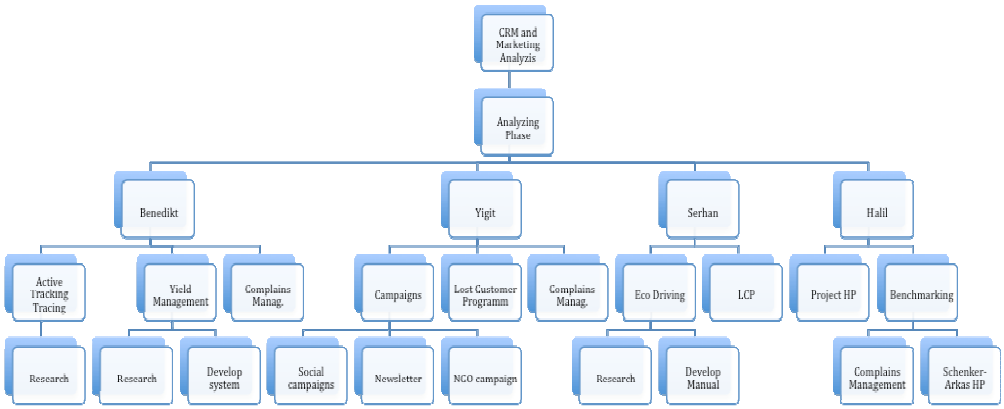

Figure 1. Work breakdown structure for the project

3. LITERATURE REVIEW

The resources which have been used in the project were:

- University Databases and Literature
- Internet
- Documents provided by Schenker-Arkas
- Meetings and input from the Industrial and Academic advisors

The use of all these recourses has been intense and helpful. Literature and documents from the database have helped the team get a solid background about the topic CRM. These kinds of recourses also have also been used to compare and evaluate the systems used by Schenker-Arkas like, Customer Complaint Management or Lost Customer program.

Documents provided by Schenker-Arkas were:

- Customer Complains Flow Chart
- International and Local CIP Flow Chart
- Screenshots of the Database
- Customer Surveys and CIP statistics
- Customer Complains entry form

These documents have helped the team understand the way how certain systems and business processes work at Schenker-Arkas.

In this project, the team has had to shift recourses in a way that the team members have concentrated more and more on the documents and information provided by Schenker-Arkas. In the beginning it was very important for the team members to use the database and literature to gain knowledge, however, the more our project preceded the more the team had to shift in order to work very close on the systems used by Schenker-Arkas.

4. APPROACH/ METHODOLOGY

About the main topics the team has had to work on, the team has filed reports and presented them to Schenker-Arkas. Reports have been filed about following topics:

- Campaigns and Lost Customer Program
- Website Benchmarking
- Customer Complains Management

Lost Customer Program (LCP)
Schenker-Arkas recently stopped the LCP. Detailed information will be provided from Schenker-Arkas within the next week.

Complains Management
Schenker-Arkas provided us with the current Complains Management structure (hard copy). The customer calls his contact person at Schenker-Arkas. A standard formula with all necessary data is filled out.

- Complains topic (delay, damaged goods)
- Customer data
- Responsible branches
- Transport type

This paper is send to the responsible department manager. He develops a solution and analysis this solution. If the solution is acceptable it will be send to the customer, otherwise it will be revised. Schenker-Arkas monitors the next three shipments of this customer and calls if everything was handled to his satisfaction.

Customer Satisfaction survey

A questionnaire was developed to measure customer satisfaction. For applying the survey Schenker-Arkas chooses random customers from their database. These customers are called and asked predefined questions. Since 3 weeks, this operation is performed once a week by 2 employees. Before that this procedure was performed just once a year.

It shall be an opportunity for their customers to make suggestions, comments, complains about the services Schenker-Arkas provides.

Eco Driving

Eco driving is about driving in a style suited to modern engine technology: including smart, smooth, safe driving techniques. It's a way of driving that reduces

- Fuel consumption
- Greenhouse gas emissions
- Noise level
- Accident rates
- Vehicle repair and maintenance costs
- Driver (and passenger) stres

Results of implementing eco driving educations across urban bus drivers in Athen are given below:

Driver	Fuel consumption (l)			Driving time (min)		
	Tour #1	Tour #2	Difference (%)	Tour #1	Tour #2	Difference (%)
1	18.9	16.4	−13.23	37	34	−8.11
2	19.1	15.7	−17.80	33	32	−3.03
3	16.9	17.2	+1.78	27	38	+40.74

Milestone and Deliverables Performance

The team has done all works just in time. Before going to Schenker-Arkas the team has always sent pre-information to industrial and academic advisors. The milestones of the team had been predefined in the first steps of the project but during the meeting in Schenker-Arkas, the team has always had some changes because Customer Relationship Management was a wide-range topic. For example, the team had focused on some social campaigns. The competitors have applied such activities and it is also beneficial for the company. But industrial advisors did not implement.

5. PROJECT EVALUATION

5.1. Resource Management

The team has also concentrated on and used the inputs given in personal meetings with the academic advisors Asst. Prof. Dr. Burcu Adıvar. The knowledge gained during the project is kept in

- Team meeting reports
- Schenker-Arkas meeting reports
- Project proposal, Progress report

At the end of this project a book with all written information will be created.

5.2. Issue Management

Due to the fact that two team members were Erasmus students, the team has planed its project in a way that it could have finished it at the end of the Fall Term 2008/2009.
Therefore, no outstanding issues have been faced.

5.3. Risk Management

Project Risks Mitigated: Time risk:
The biggest risk in the project has been the time limit of three months because there was no chance for continuance after this three-month period.

5.4. Quality Management

In order to assure the customer Schenker-Arkas the best quality, the team has internally measured quality after these steps:

- Quality Targets to be met by our team
- Defined how those quality targets will be measured
- Actions needed to measure quality
- Identify quality issues and improvements

In order to proof the quality of the work that has been done, quotes from literature and the University Database have been used in the reports. Another method of quality measurement has been the direct feedback from the customer, Schenker-Arkas as well as the academic advisors. All the findings have also been checked and controlled by the team during the team meetings if they fit to the profile of the company.

5.5. Communication Management

The communication ways have been:

- E-Mail
- Telephone
- Meetings

Communication channels have showed no problems during the whole project. Answers of the company, Schenker-Arkas have always been on time. Also the communication during the group meetings has been very good. No problems occurred. Main communication has been

done in English, at some points, topics have been discussed in Turkish or German and afterwards translated in English.

The communication between the company and the team (as well as internally) has been very good and successful regarding the response time and information flow.

5.6. Customer Expectation Management

- The customer Schenker-Arkas gave the team the feedback that the team had succeeded their expectations. Schenker-Arkas had concluded to be satisfied with the ideas and findings of the group.
- From the feedbacks of the second “customer”, Izmir University of Economics, the team has also fulfilled their expectations.

5.7. Contribution to the Group and Lessons Learned

The lessons the team has learned are:

- Discipline
- To succeed in business and in projects, it is necessary to keep up a certain high level of discipline.
- Business communication
- Communication in business has several stages. It is always formal but can change from a very formal style of communication at the beginning to a personal and very friendly style when relations grow in a positive way.
- Business behavior in a company
- The behavior is often very formal and shows some diplomatic attitudes. Also dress code is very formal.
- Work atmosphere in a company
- The atmosphere in a company depends very much on the people working there. All in all, we felt that there was a very good atmosphere at Schenker-Arkas.
- Acting and succeeding as an international team
- Working in an international team has been one of the most interesting experiences. Not only that different types of characters meet the first time and have to work together but also cultural differences have to be solved.
- Project management
- The topic of project management in theory may sound logic and easy. When it comes to conversion from theory into practice the team has often had to create and find its own solutions.
- Team work
- The teamwork was one of the most interesting tasks. In the end, the team members have learned that a team works well if personal relations are good. Personal relations can also vanquish cultural differences. A major point in our teamwork has been communication. Being able to communicate and solve problems with the recourse of three languages (Turkish, English, German) has been a major advantage for the teamwork.

- Time Management
- Also time management is a major point in succeeding in a project. It is very important to solve given tasks in time.
- Cultural experience
- Some points are mentioned above however, working in an international team gave the team members experiences, which will be very useful for the future.

6. CONCLUSION

Due to a narrowed time schedule of the project, the team could not have completed its work on the topics of Yield Management and Database Analyses. These topics were very time intensive and especially the Database needed a lot of attention, research and work hours at Schenker-Arkas, which the team could not provide at the necessary amount.

Industrial and academic advisors were mainly responsible for measuring progress. Besides that, the team measured progress on its own using project management.

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PINAR SU DISTRIBUTION OPTIMIZATION

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Asst. Prof. Dr. Burcu Adıvar

EXECUTIVE SUMMARY

The aim of this project report was to show, what we have done to optimize the distribution network of PINAR SU in the project process. During the optimization process, the distribution network, sources, location of the facilities have been investigated in detail. In order to find the optimal distribution plan for Pınar Su, we have built a mathematical programming model. Given the product, site, demand, source-machine-storage capacities and holding cost and the constraint data as input, we aimed to minimize total transportation cost plus storage cost depending on these constraints. We had minimum costs, optimal product flow and minimum inventory amount as output.

This project has also showed minor or major problems at the company which they have faced or would have been facing. This has brought an opportunity to resolve the problems and reconsider the determinations in some issues. Due to our success on the optimization of network; company expenditures would have decreased and as a result, profits have been maximized.

1. INTRODUCTION

1.1. General Overview of the contents

This project aims to optimize the distribution network of Pinar Su Sanayi ve Ticaret A.S (Pinar Su). The report includes information about the project development, company, the group's studies and problem solving statements. The report highlights what we have done during the two semesters regarding the problem statements, researches, analysis, methodologies and evaluations.

1.2. Motivation

We have started the project at the beginning of the fall semester and we have started to draw a framework for our project. First, the nominal view of the project seemed to be straightforward. However, when we have started to go into detail and practice, we have seen that the problem has too many dimensions to be coped. From this point of view, we have agreed that, this problem needs high consistency and we have decided to consult to our advisors for their ideas and learned what they would recommend us regarding the problems in order to find a solution.

1.3. Goals

With this project our goal was to assist PINAR SU for the optimization of company's distribution network. Initially, articles and literature research have been conducted in order to find how distribution network would be optimized in large scale water companies. There were two ways to start, first was LP (Linear Programming) and second was MIP (Mixed Integer Programming). We have found that MIP would have been more appropriate method for the project. On the other hand, our concerns have been based on modeling the process and determining an appropriate modeling method (single or two echelons) for using in practice. As a result, a decision has been made as single echelon for the start but two echelon models have also been created as a future work. According to the advisors it would have been a hybrid model between single and two echelons. Difficulty showed up while we were creating a hybrid model.

1.4. Company Background

Pinar Su Sanayi ve Ticaret A.S. is a Turkish company which runs business into the bottling and distribution of natural spring water. The Company offers its products under Pinar Yasam Pinarim brand. Additionally, it provides products for water disinfection. Pinar Su operates three manufacturing plants, located in Aydin, Isparta and Sakarya. It exports its products to Germany, France, the United Kingdom, Iraq, Malta, the United States, Australia, Cyprus, Qatar, Kuwait, Bahrain, the United Arab Emirates, Denmark, Saudi Arabia, Italy, Romania, Malta and Azerbaijan. The Company is a subsidiary of Yasar Holding A.S. Yasar Dis Ticaret A.S., a Yasar Holding company, which markets Pinar Su products globally, whereas Birmas Tuketim Mallari ve Ticaret A.S., a subsidiary of Pinar Su, markets and distributes the Company's products domestically.

2. PROBLEM DEFINITION

Article research has started and followed by five different models' creation by each group member, separately. In the leadership of the academic advisors, a new multi-period model has been created according to the received data which has been gathered from the company, by using five different models. As a result, problem has been modeled and it has become a LP. As a large scale, problem has had different variables, which were, types of products, production facilities, source capacities of production facilities and demand amounts. The choice of which facility would have been served in which city was another variable. Wideness of variables has obliged us to use software. Problem has needed to be computerized instead of solving manually. GAMS software has been chosen to solve the problem. Firstly, model was integrated to the software. Then, model has been run with unrealistic data. Some errors have been occurred but results were satisfying. The hardest part was importing data from Excel to GAMS software. After that model has been run with real data and there have been so many errors occurred. These errors have been corrected one by one until optimal solution has been found. Some changes should have been made to find the optimal solution. Company has been informed about the changes and they have had additional requests. Finally, an optimal solution has been found and presented to the company and to the academic advisors. The results were satisfying.

The greatest and the most important step was importing the mathematical model to the software. After that step, model has needed to be run. Real data should have been requested from the company. These data must have consisted of source capacity, machine capacity, demand points and which production facility would have served which demand points, in order to be used in software, during the solution process. For this purpose, a special meeting has been arranged with company responsible and models have been represented. Finally, we have received the real data from the company which we have requested. The data have been imported to the software. Solution has had some infeasible points at the summer period due to excess demand and the limited source capacity. In order to find the total cost and solve the problem, we have obliged to increase the source capacity. Correspondingly, we have contacted with the industrial advisor at Pinar Su to represent the solution and discuss the change that we have done in source capacity. During the meeting, company's response was realistic. They have said that source capacity could not have been increased in summer time. Based on this information, we have asked for the advices of academic advisors. As a result, two new constraints have been proposed to be put into our model, one was holding capacity, other was holding cost. Correspondingly, we have requested the relevant data from the company. While we were waiting for data, model has been changed. After the data have been received from the company, we have uploaded the data to the software. At the very beginning of the process, 'holding step' has been eliminated. In present form, the model has consisted of 'holding step' as well. As a result, the inventory holding cost has been integrated to the problem. This has resulted in an increase in total cost. However, problems have already been solved and project has been achieved to success.

3. LITERATURE REVIEW

Our project was about Pınar Su's distribution optimization. During the optimization process, the distribution network, sources, location of the facilities would have been investigated in details. We have tried to find improvements in the chain and searched for more effective ways for increasing the profits of the company and satisfying the customers more. Until now some companies have made some investigations and optimization projects about distribution networks. Procter and Gamble was one of these companies which have made studies about distribution optimization of market chains. The scope of the project was described as developing a tool that has aimed to improve P&G Turkey's National Account customers' distribution network for the purpose of minimizing cost and maximizing service level. As a result of these studies they have converted their manual system to computerized and systematic way by using simple graphical program. Through this program, they have reached to have an opportunity to make the transactions in a short period of time and in a more corrective way. Outputs of the studies for the company were reduced costs and expenditures through optimization of vehicle routing, facilitating through maintaining information about vehicle numbers, loading volumes of vehicles, arrival and departure times of vehicles and routing.

Another company which has conducted a research in network optimization and design of the network was Coca-Cola Company. In this study, a distribution system was designed for the sales of water in Ankara. With this aim, the sales potential of HOD-Demijohn water has been forecasted and also the locations of vendors as well as their service areas, capacities, numbers of workers and vehicles requirements have been determined. In this project cost analysis modeling and map studies were the frameworks of projects. Retailer analyzing, survey of retailer conditions and demands were another key search points in this project.

In our project we have benefited from these two successful studies and methods. We have tried to minimize the time cost in distribution network, and also we have tried to reach whole customers all around Turkey. By using the survey of market analysis results, we have had weekly or monthly demand data of retailers. By this way, the company was ready to meet whole orders also they could have maintained new customers from other regions. This would have resulted in a competitive advantage in the water market for the company. This has led to an increase in income of the company, furthermore, as a result of optimization of the network, expenditures of company have been decreased and thus profits have been maximized. As a result we have put the algorithms into simple computer programs about distribution network by that way; a fast, modern and systematic working environment has been created in the company.
First, we have reviewed the articles that we have analyzed before in order to make sure there have been no mistakes and/or gaps within the models which we have set up in the last semester. It has been also helpful for the selection of new articles to read. New articles have been also read and analyzed. According to the requirements of Pınar Su some new models have been set up and also existing models which we have already been set, was improved.

We have seen that improved models should have required new information and techniques. The new articles have had a vital importance in that point of understanding, applying, and exposing the information.

According to the requirements of Pınar Su, we have chosen our models to be improved; whether it was cost or satisfaction based. In addition, by considering the importance of costs, we would have given rates for costs. After we have determined what has been needed for the models we have begun to research for the sources. All the articles which were related with the subject and chosen models have been memorized and clearly understood. The articles, which have been listed in the references section, have had a vital role in gathering the new information and techniques.

4. APPROACH / METHODOLOGY

We have tried to minimize the transportation and storage cost in the distribution network, in order to reach whole customers all around Turkey. The monthly demand data for each product type have been provided by Pınar Su. We have observed that, the data has enabled the company to meet whole orders and also supported to maintain new customers from other regions. By that way, company has gained competitive advantage in the water market. Due to our success on the optimization of network; company expenditures would have decreased and as a result, profits have been maximized.

The problems of the firm should have been examined in order to support the best decision .As a result, we have put the algorithms into GAMS computer program about distribution network to understand whether GAMS solutions would have given the best result to keep the current situation and whether it would have been logical or not. In the existing distribution system of Pınar Su, they have made the dispatching from their three production plant to retailers and retailers to customers. The distribution up until that point has been named as ‘long-haul transportation’. Long-haul freight transportation is the movement of goods over relatively long distances between facilities by truck, rail, ship or combination of these. The retailers have dispatched the products to the point of sale and the sellers have dispatched the products to the customer. That part of the distribution has been named as ‘short-haul freight transportation’. Short-haul freight transportation is the movement of goods usually by truck between pick up and delivery points in the same area.

The models have been created in a flexible way due to the needs of Pınar Su; the model was allowed for the changes in demand, possible amount of the demand points in the future and also for the changes in costs. Also the model was able to show the optimum routes between “Plant-Retailer” with the minimum cost while considering the storage, either.

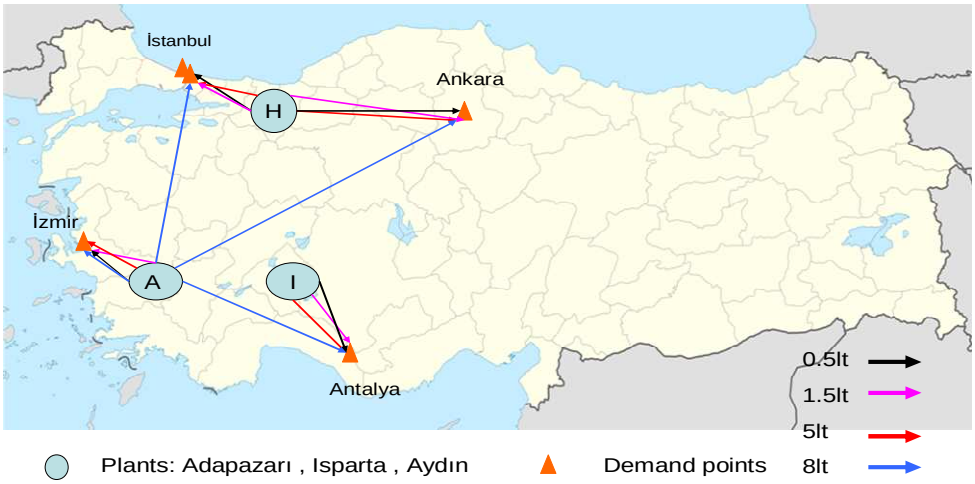


Figure 1. Distribution Network of Pinar Su on a Turkey Map

This figure illustrates the network elements sources, plants, demand points in a single-echelon supply chain. We construct a network structure that is based on time period. The sources, plants, demand points represents the supply chain sites. We represent each site as a node in the network and we connect these nodes with links called network arcs. We have built two different models. The Model 1 includes demand satisfaction, cource capacity, and machine capacity constraints. The Model 2 includes capacity constraints, demand satisfaction constraint, inventory balance constraint and also takes storage cost and transportation cost into account. Both problems are modeled as minimization of total cost.

The Model 1 is multi-product, multi-period and single echelon. We have four product types and time horizon is divided by months. Also interaction is between plants and demand points. In this model our aim is to minimize the sum of the cost of transportation of product flows. The cost is proportional to distance. We have used three types of constraints:

1. Demand satisfaction constraint; each demand point has a demand for each product types and the demand should be satisfied on time period t by plants.
2. Source capacity constraint; amount of product shipped between facilities should not exceed capacity of source.
3. Machine-product capacity constraint; amount of product shipped between facilities should not exceed machine capacity.

NOTATION FOR MODEL 1:

Sets:

i , plants (Bozdoğan , Hendek , Isparta)
j , demand points (120 points)
k , product types (0.5lt , 1.5lt , 5lt , 8lt)
t , time period (12 months)

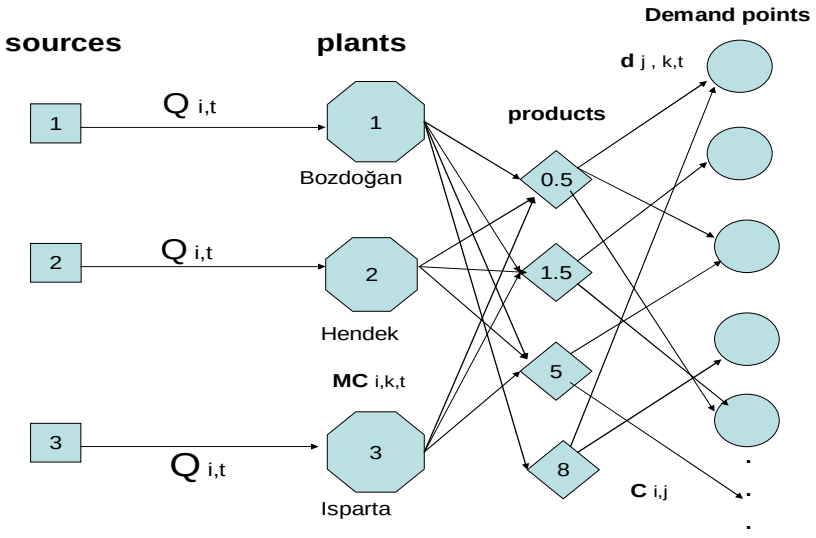


Figure 2. Network structure for Model 1

Parameters:

$d^{k}_{j,t}$: demands on point j for product type k in time period t

$Q_{i,t}$: source capacity for plant I in time period t

$MC^{k}_{i,t}$: machine capacity on plant i for product type k in time period t

Decision Variables:

$C_{i,j}$: transportation cost per ton from plant I to demand j

$X^{k}_{i,j,t}$: amount of product k shipped from plant i to demand j in time period t

$a_{i,j}$: { 1 if plant I can serve demand point j; 0 otherwise }

MODEL 1

Minimize Total Cost = $\sum_{i}\sum_{j}\sum_{k}\sum_{t} C_{i,j} X^{k}_{i,j,t}$

subject to:

Demand Satisfaction Constraint $\sum_{i} a_{i,j} X^{k}_{i,j,t} = d^{k}_{j,t}$ *for all j, t ,k*

Source Capacity Constraint $\sum_{k}\sum_{j} X^{k}_{i,j,t} \le Q_{i,t}$ *for all i , t*

Machine-Product Capacity Const. $\sum_{j} X^{k}_{i,j,t} \le MC^{k}_{i,t}$ *for all i ,k , t*

Nonnegativity Constraint $X^{k}_{i,j,t} \ge 0$ *for all i ,j, k, t*

After getting the feedback of our industrial advisor for Model 1, we decided to build the second model. In Model 2 our aim is to minimize the total cost but we considered two types of cost. First one is the transportation cost; it is proportional to distance. Second one is the storage cost. We have changed the objective function to decide how much to order in each time period in such a way that the sum of transportation cost plus storage cost is minimized. The demand satisfaction constraint and machine product constraints are same. We have a constraint for amount filled at each source cannot exceed source capacity. We added storage capacity constraint to provide that amount of inventory at plant should not exceed storage capacity of this plant. Finally we added inventory balance constraint that says that the amount of inventory in the next time period must equal the current inventory plus what is produced minus what is sold. Network structure of the Model 2 is presented in Figure 3, which is followed by notation and model formulation.

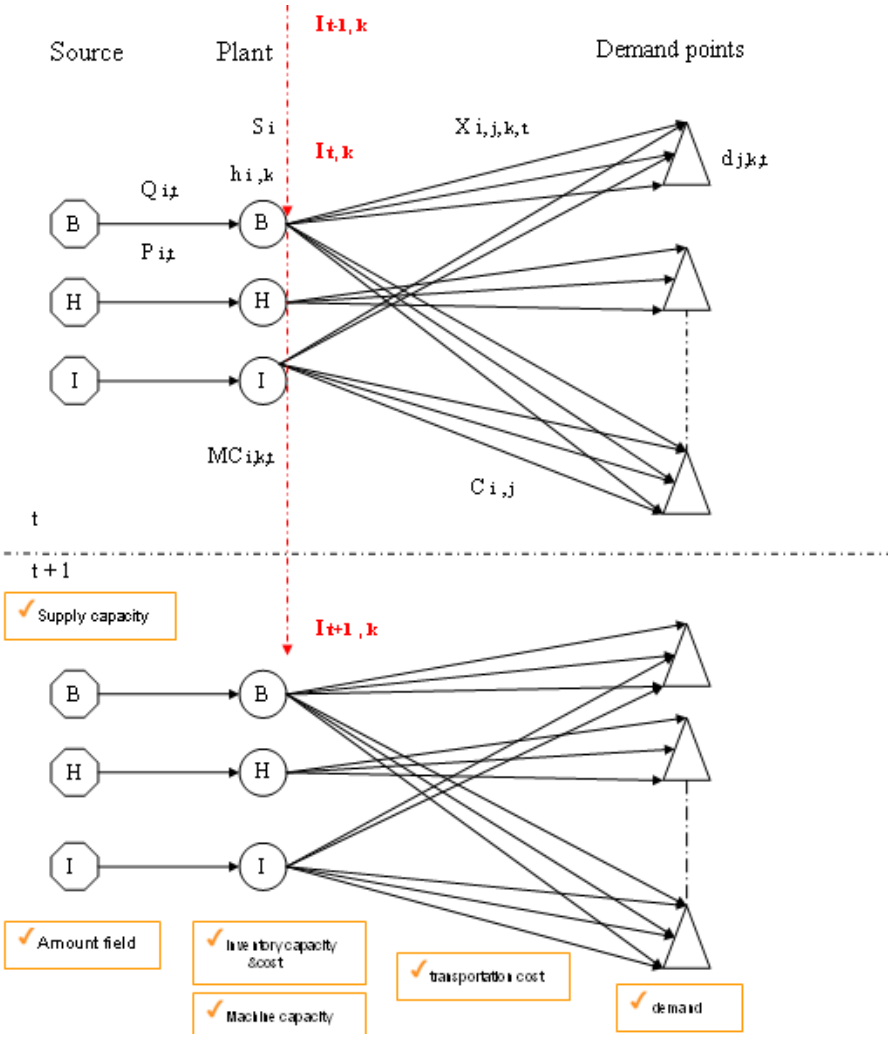


Figure 3. Network structure for Model 2 which is based on time period

Figure 3 illustrates the network elements sources, plants, demand points in a single-echelon supply chain. We have constructed a network structure that was based on time period. Given sources, plants, demand points have represented the supply chain sites. We have represented each site as a node in the network and we have connected these nodes with links called network arcs. This model has included capacity constraints, demand satisfaction constraints, inventory balance constraints. Storage and transportation costs also have been taken into account. This problem has modeled as minimization of total cost.

NOTATION FOR MODEL 2

Sets:

i , plants (Bozdoğan , Hendek , Isparta)
j , demand points (120 points)
k , product types (0.5lt , 1.5lt , 5lt , 8lt)
t , time period (12 months)

Input Parameters:

$d^{k}_{j,t}$: demands on point j for product type k in time period t

$Q_{i,t}$: source capacity for plant i in time period t

$MC^{k}_{i,t}$: machine capacity on plant i for product type k in time period t

h^{k}_{i} : holding cost at plant i for product k

S_{i} : storage capacity at plant i

Decision Variables:

$C_{i,j}$: transportation cost per ton from plant i to demand j

$X^{k}_{i,j,t}$: amount of product k shipped from plant i to demand j in time period t

$I^{k}_{i,t}$; amount of inventory at plant i at the beginning of period t

$P_{i,t}$; utilization amount of resource on time period t

$a_{i,j}$; { 1 , if plant i can serve demand point j
0, otherwise }

MODEL 2

Objective Function :**added total storage cost*

Minimize Total Cost = $\sum_{i}\sum_{J}\sum_{k}\sum_{t} C_{i,j} X^{k}_{i,j,t} + \sum_{i}\sum_{k}\sum_{t} h^{k}_{i} I^{k}_{i,t}$

Subject to:

Demand Satisfaction Constraint	$\sum_i a_{i,j} X^k_{i,j,t} = d^k_{j,t}$	*for all j, t ,k*
Machine-Product Capacity Const.	$\sum_j X^k_{i,j,t} \le MC^k_{i,t}$	*for all i ,k , t*
Storage Capacity Const.	$\sum_k I^k_{i,t} \le S_i$	*for all i ,t*
Inventory Balance Constraint	$P_{i,t} = \sum_k \sum_j X^k_{i,j,t} + \sum_k I^k_{i,t} - \sum_k I^k_{i,t-1}$	*for all i,t*
Source capacity constraint	$P_{i,t} \le Q_{i,t}$	*for all i ,t*
Nonnegativity constraint	$P_{i,t}, I^k_{i,t}, X^k_{i,j,t} \ge 0$	*for all i, j,k, t*

5. DATA COLLECTION & ANALYSIS

To solve the models that we have created, we have collected data from Pınar Su. We have already known sources, demand points, product types from our researches. In addition to these, we have needed data that contained monthly demand, demand point by product types, transportation costs by plants, holding costs at plants by product types. In order to add some restrictions by considering Pınar Su's requisitions, we have needed more data of machine capacities of plants, water capacity of plants and storage capacity of plants. Also we have restricted the service area of plant Isparta by considering Pınar Su's needs. We have received all data from Pınar Su in the following format and we have put them into models to get an optimal solution.

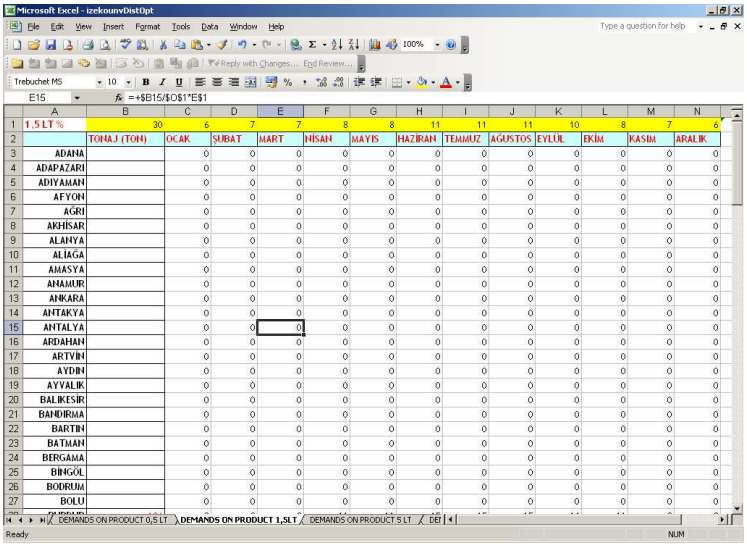


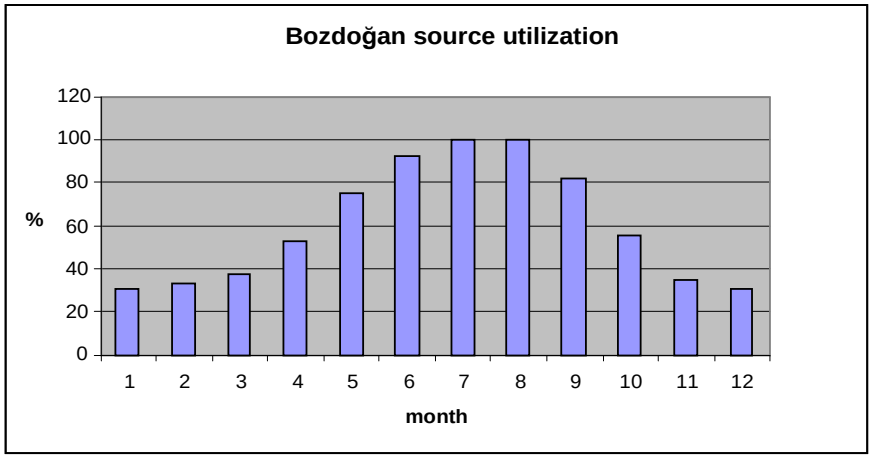
Figure 4. Screenshot of the data format received from Pinar Su

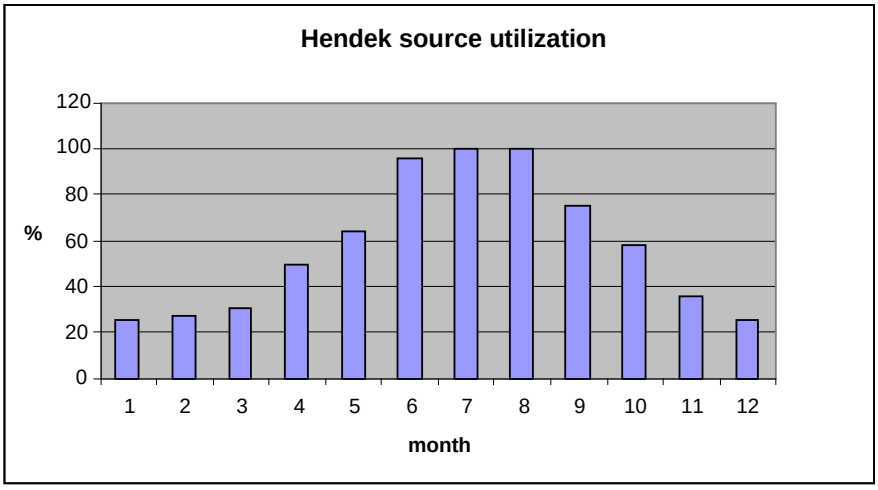
6. IMPLEMENTATION & RESULTS

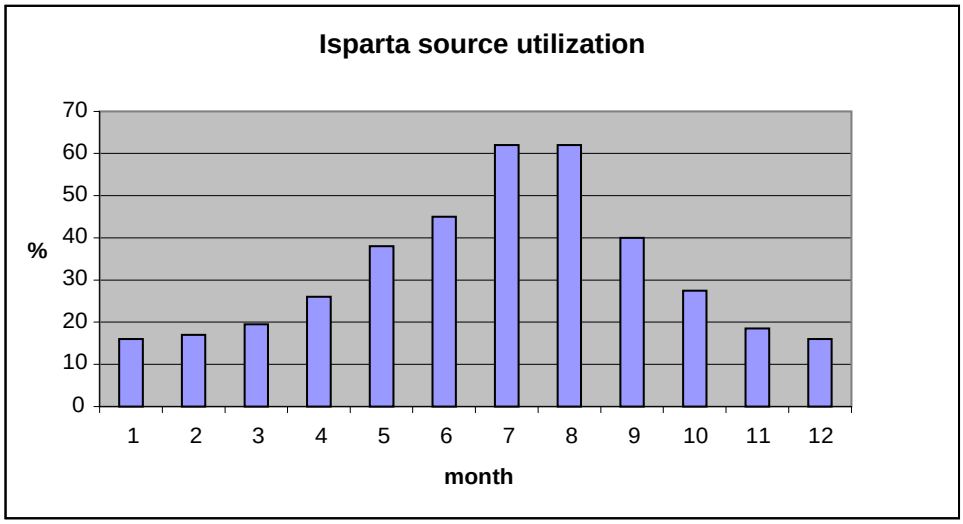
After the data processing, the second mathematical model has been solved by using GAMS software. In the final LP model, there were 17,461 variables, 57,229 parameters and 4093 contraints. CPU time required by GAMS to produce the solution was less than a minute. After the optimal solution is obtained, solution analysis is performed and presented in the next sections.

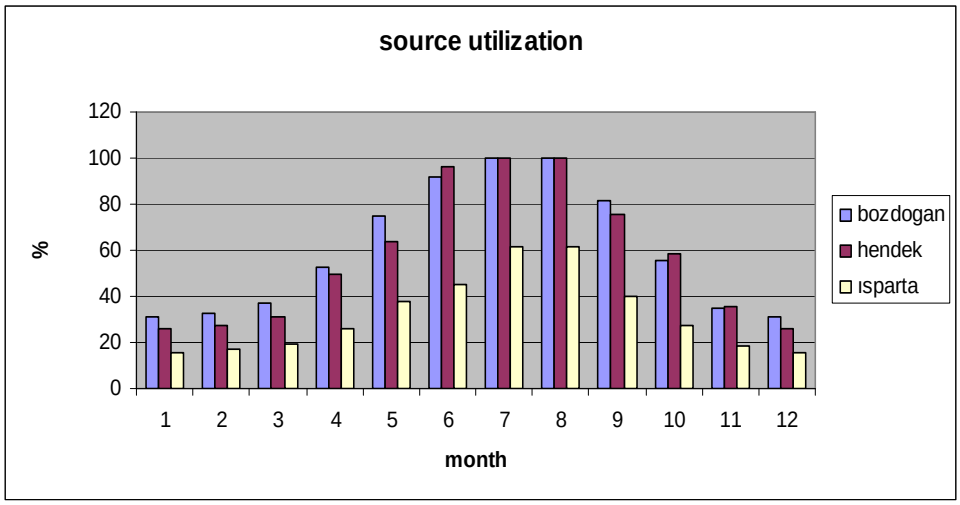
SOURCE UTILIZATION

According to the optimal solution, Bozdogan, Hendek and Isparta's source utilization have shown big augmentation in summer months. We have seen that, most of the utilization have been located in the Bozdogan, because of higher demand. Also we have understood from the figure, the source utilization was exceeding in June. Hendek's source utilization has shown full usage in July and August. For Isparta, we have clearly seen the source utilization was the highest in July and August.



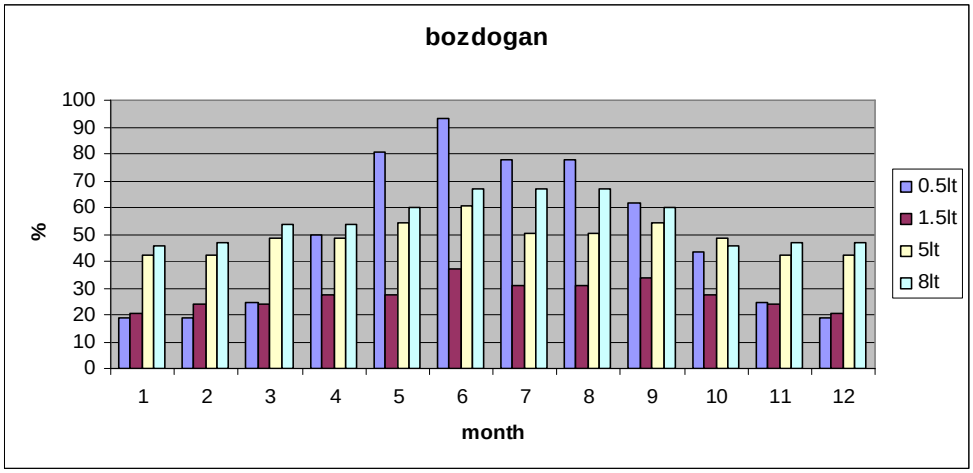


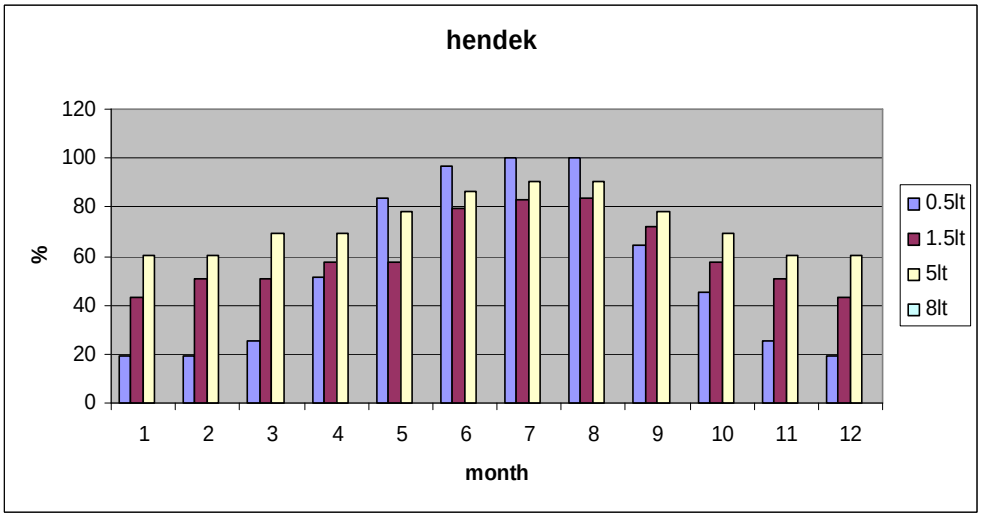


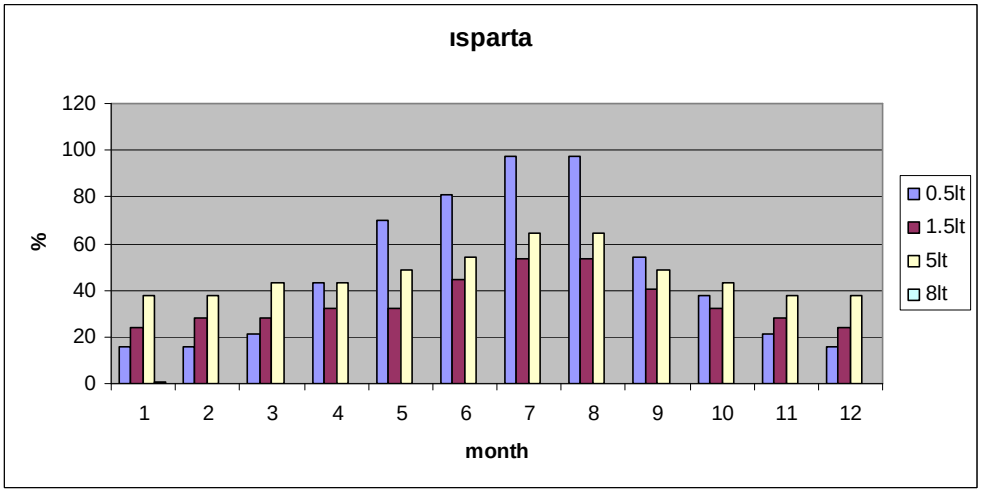


MACHINE UTILIZATION

According to this figure, we have seen the machine utilization and how much it has been used. Each figure has shown that, 0.5 Lt was the most- demanded product by customers. Once again, demand was increasing in summer months and also every product usages have increased simultaneously in June, July and August. For Hendek and Isparta there was not any demand for 8 lt.

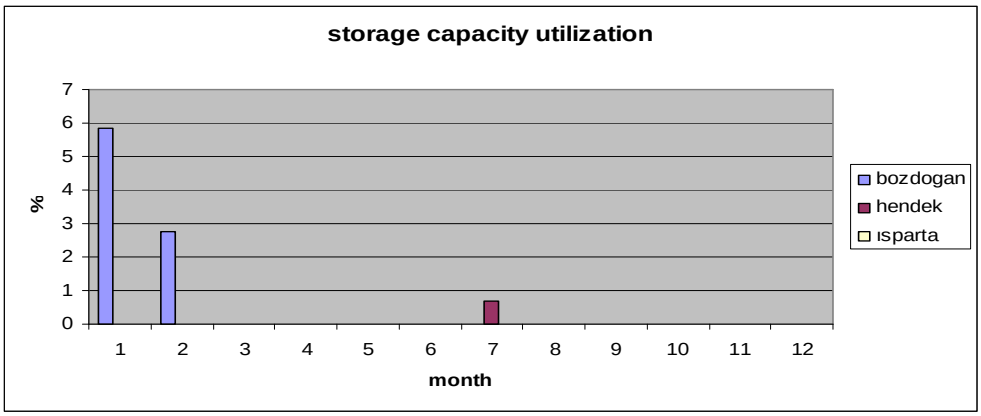

bozdogan
%
month
0.5lt
1.5lt
5lt
8lt


hendek
%
month
0.5lt
1.5lt
5lt
8lt

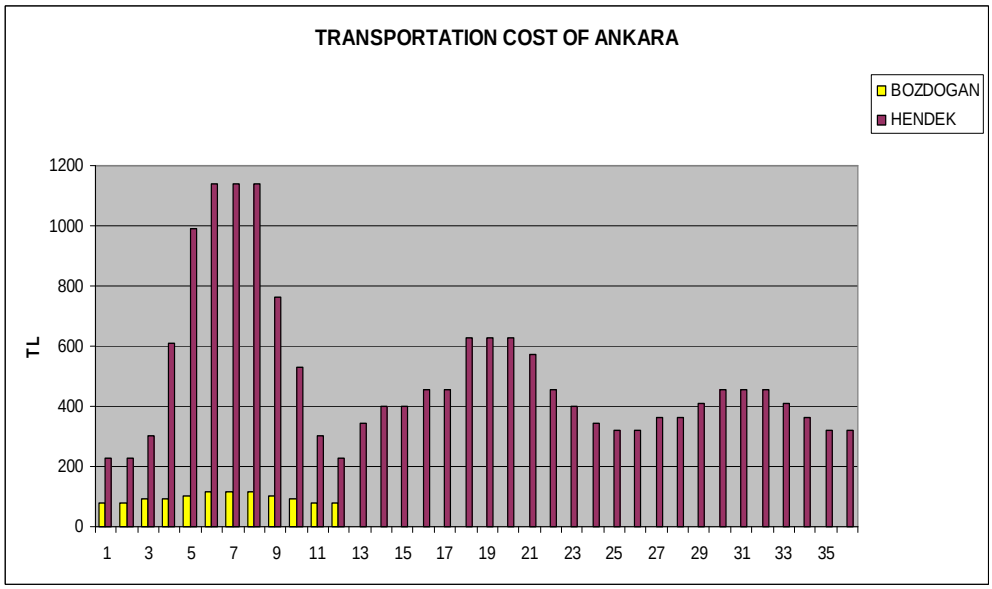

ısparta
%
month
0.5lt
1.5lt
5lt
8lt

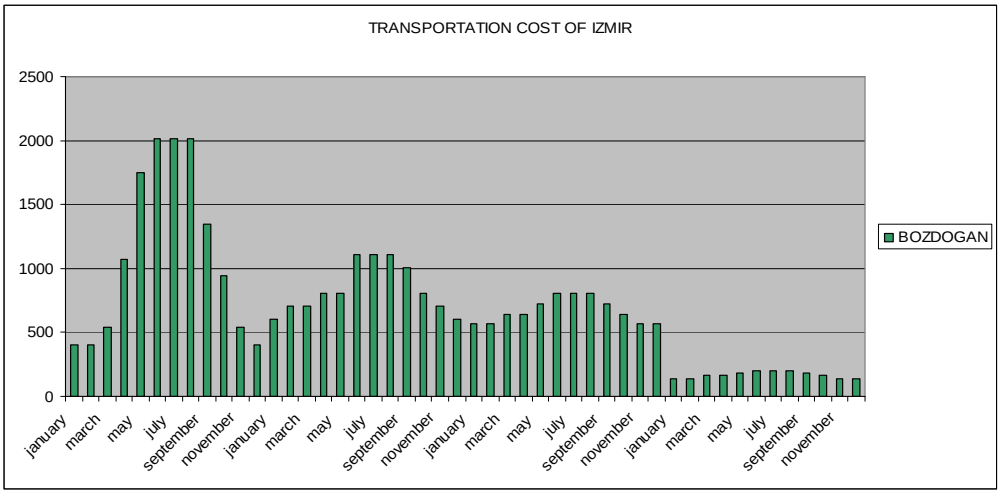
STORAGE UTILIZATION

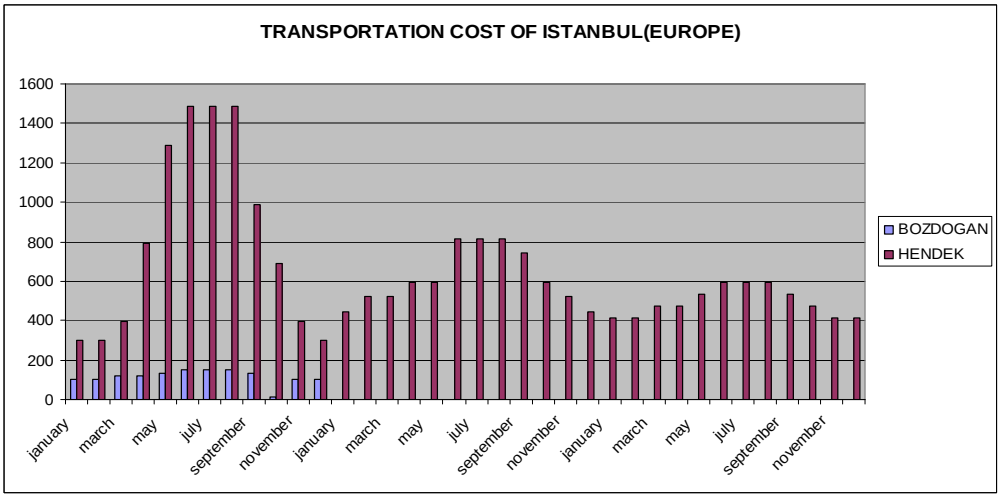
Storage utilization was very important for companies because they have had to satisfy the customers whenever they have demanded the product. If company has made right strategy for storage utilization at the right time, this would have been beneficial in every area for company. This figure has shown us the storage capacity utilization. As seen, in Bozdogan, storage utilization has increased in winter months. Not only in Bozdogan but also in Hendek, storage utilization has been made in July. As we have known, demand was exploding in summer months. In order to cover demand, Pınarsu has made storage utilization in winter months.

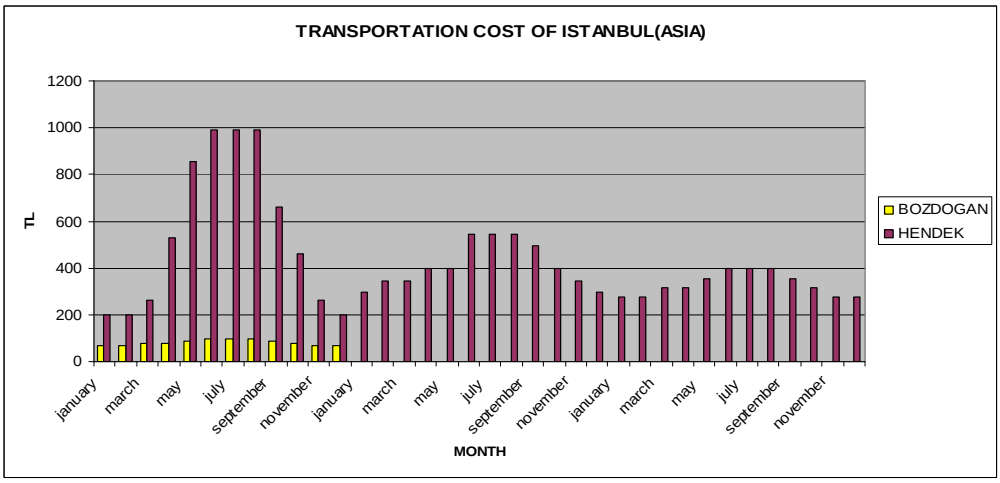


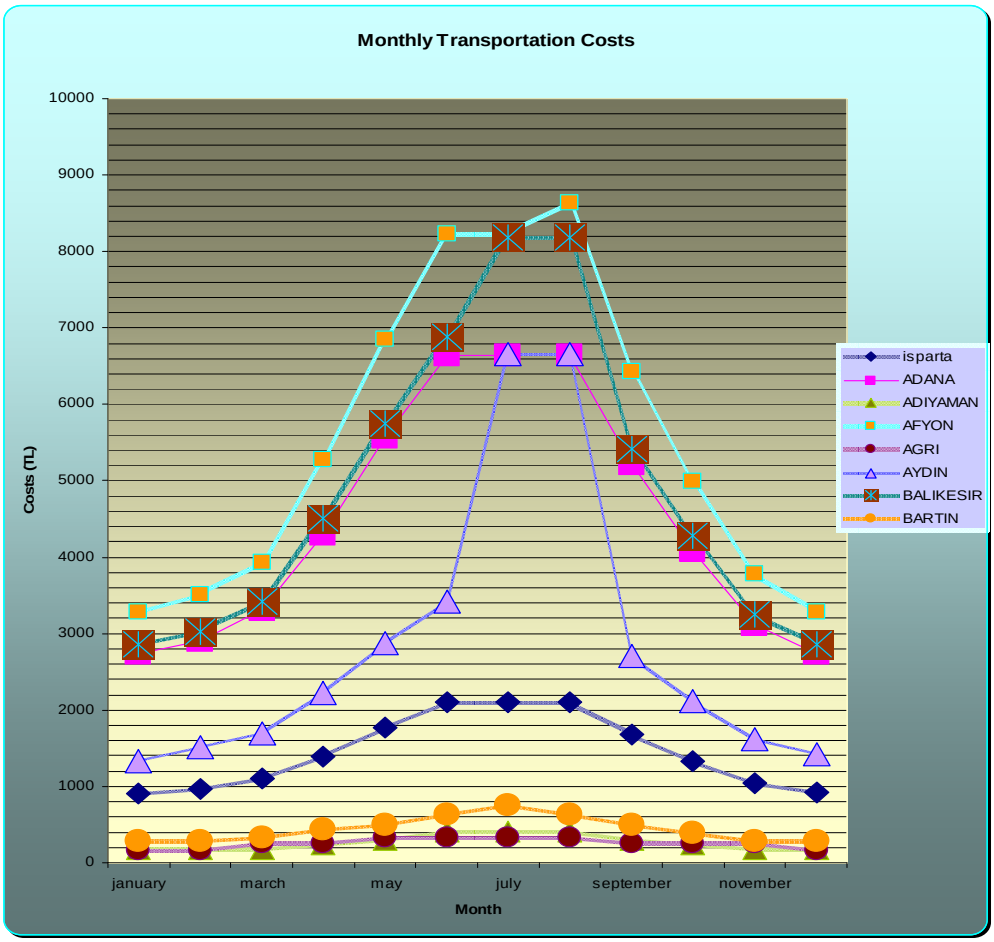
TRANSPORTATION COST




TRANSPORTATION COST OF IZMIR
2500
2000
1500
1000
500
0
BOZDOGAN
january
march
may
july
september
november

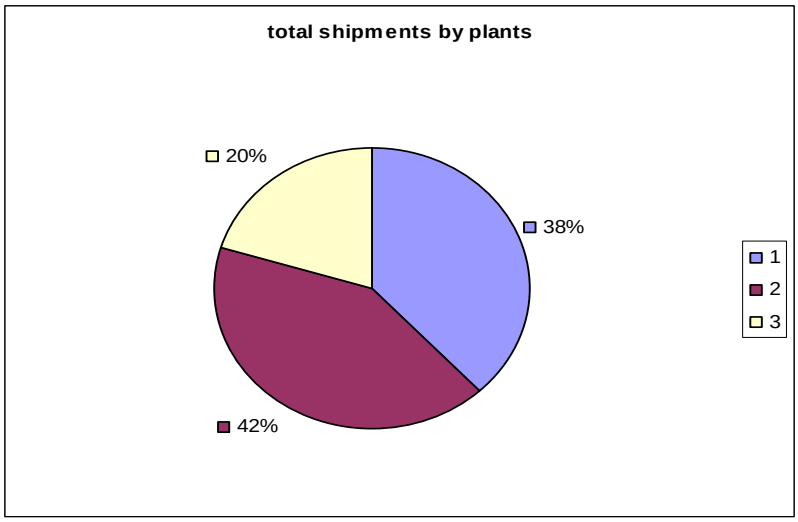

TRANSPORTATION COST OF ISTANBUL(EUROPE)
1600
1400
1200
1000
800
600
400
200
0
BOZDOGAN
HENDEK
january
march
may
july
september
november

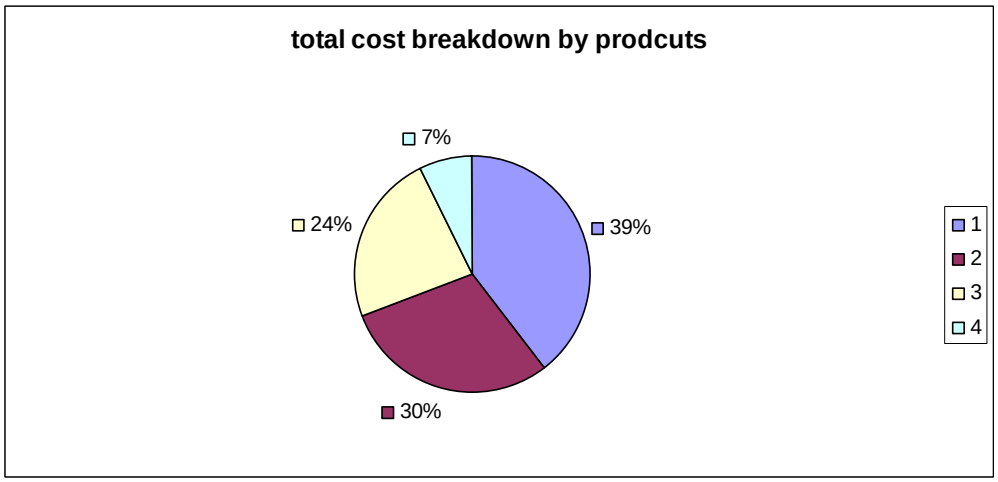

TRANSPORTATION COST OF ISTANBUL(ASIA)
1200
1000
800
600
400
200
0
TL
BOZDOGAN
HENDEK
january
march
may
july
september
november
MONTH

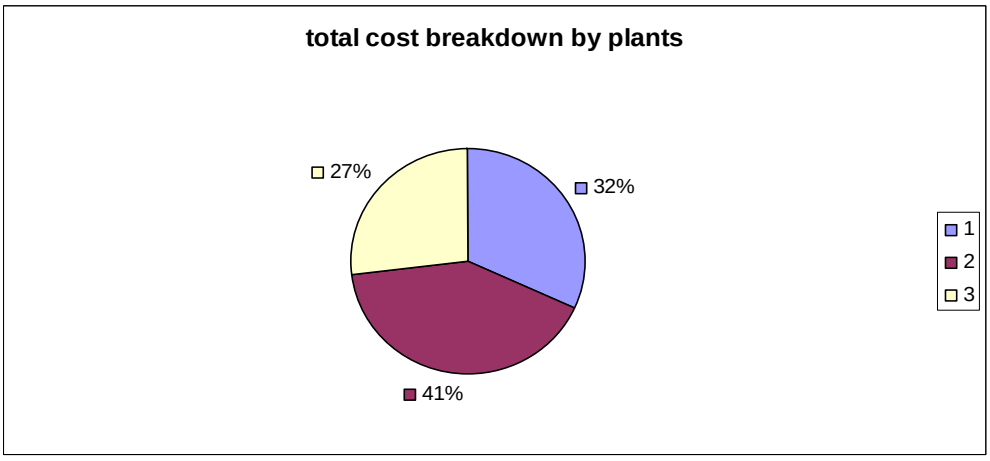


TOTAL SHIPMENTS AND TRANSPORTATION COST

total	shipments	in tons	from	Bozdogan	Hendek	Isparta	source to retailer
				62616	68603	33294	
total		TRANSPORTATION COST PER TON					22

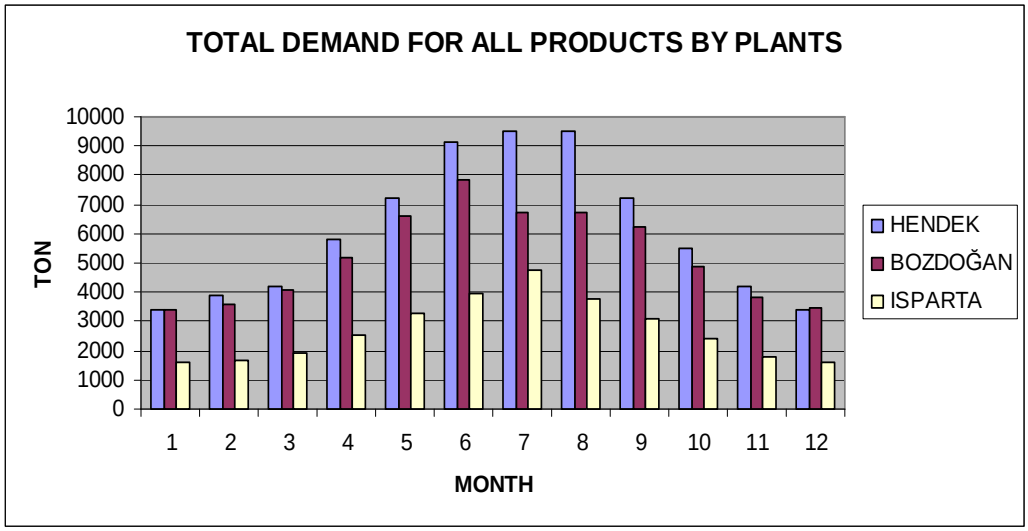


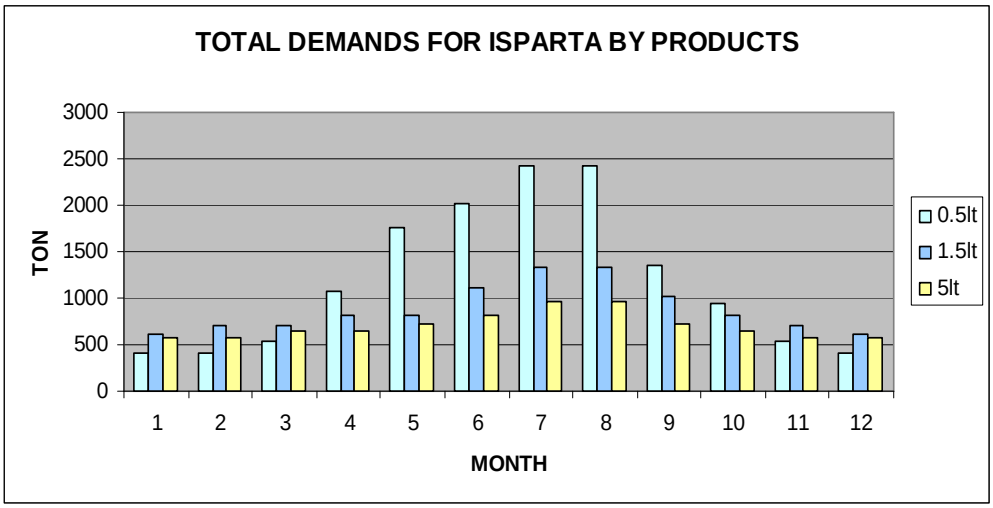


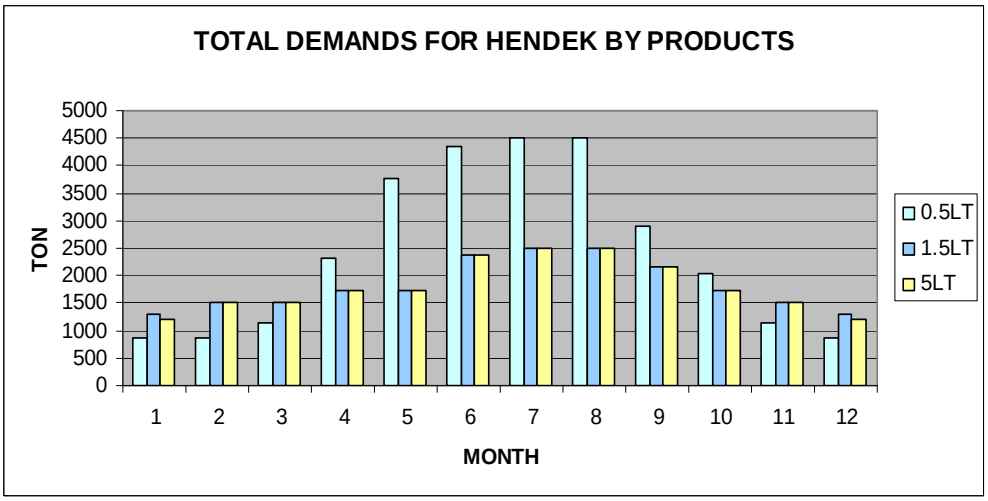


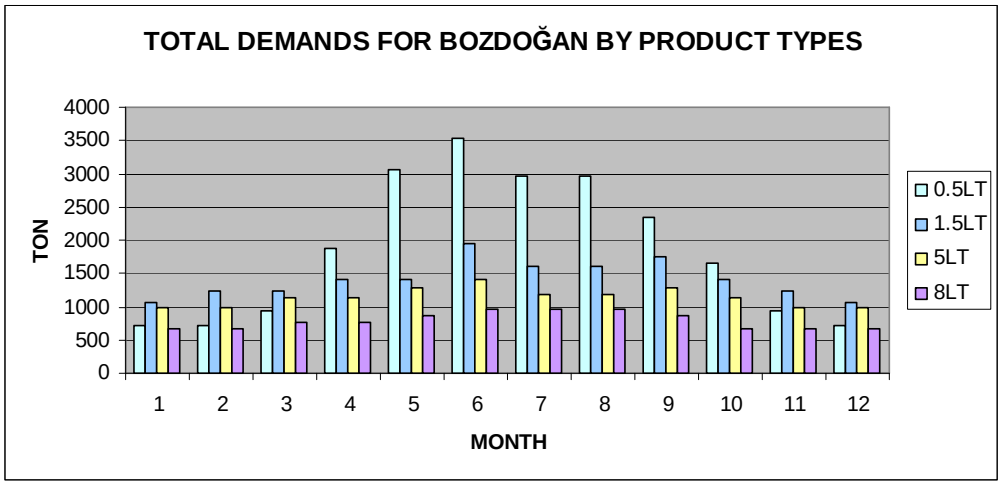
Total demand met in the optimal solution

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HENDEK	1	2	3	4	5	6	7	8	9	10	11	12
	3383	3900	4189	5776	7219	9111	9476	9504	7226	5487	4189	3383
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
BOZDOĞAN	1	2	3	4	5	6	7	8	9	10	11	12
	3421	3609	4084	5205	6612	7860	6724	6710	6259	4860	3841	3431
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ISPARTA	1	2	3	4	5	6	7	8	9	10	11	12
	1575	1677	1899	2537	3292	3945	4744	3772	3086	2405	1815	1575




TOTAL DEMANDS FOR ISPARTA BY PRODUCTS
TON
3000
2500
2000
1500
1000
500
0
1
2
3
4
5
6
7
8
9
10
11
12
MONTH
0.5lt
1.5lt
5lt


TOTAL DEMANDS FOR HENDEK BY PRODUCTS
TON
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1
2
3
4
5
6
7
8
9
10
11
12
MONTH
0.5LT
1.5LT
5LT



7. PROJECT EVALUATION

7.1. Project Outcomes

The project which we have been involved in, has contributed greatly in achieving the expected outcomes. With the support of advisors from both academic and company circles, we have learned a great deal in formulating the outcome of our project in the manner which has suited all. Now that we have reached the final stages of our project, we proudly congratulate ourselves on the achievements we have obtained. The result has made us to manifest our determination in the best possible way.

7.2. Contribution to Company

Initially, the company, which we had prepared the project for, has requested us to prepare such a project. The outcome has satisfied with the end result. The contribution of technological information and other forms of it have helped a lot during the formulation of our project to the satisfaction of the company.

7.3. Contribution to Student

Preparing and working with various advisors from both company and academic circles, has contributed greatly to us, the students. To begin with, we have learned how to use and implement planning programs such as GAMS which has led us to formulate correct solutions and which were most acceptable to the management of the company we have worked for. On the other hand, this project has given us the opportunity to work as a team whereby each of us on this team has had a specific job to perform. With the help and understanding the significance of programs such as GAMS, we have understood how technology could have helped us in collecting the proper data to reach the proper solution.

7.4. Performance of Team

Working together meant that, each group member should have known the exact role he or she had to play. If we have been succeeded in bringing about a satisfactory conclusion to this project, it was because of the teamwork we have demonstrated. A word of praise should have gone to the leader of our team who was successful in coordinating the functions of each member of our team.

7.5. Performance of Company

Those in charge of our work project in Pınar Su have known the importance of the project that we were involved in. To help us in reaching the required solution for the problem, they have encountered us and also they have provided us with all the necessary data without any hesitation. Their behavior has encouraged us to work hard and made us use all the technological information system that we have learned during this final year in our lessons. Our success would not have happened without their active participation in our work.

7.6. Performance of Academic Advisor

Without the active guidance of our academic advisor, completing the project in its present form would not have happened. It was because of her knowledge and experience that we were able to overcome problems associated with preparing such a project. Her in-depth knowledge of the work we have involved in has helped us greatly in performing well on this project and consequently gaining the trust and admiration of those in charge of the company we worked for.

8. CONCLUSION

We have introduced two types of models about the network optimization. At the first glance we have wanted to use first model and we have had optimal solution. But this model has not been sufficient for Pınar Su distribution problem. We have changed the model according to Pınar Su’s requirements. With consideration of holding inventory, we have prepared a network structure for each type of product that has been demanded from demand points on time period.

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DEMAND MANAGEMENT FOR DRINKING WATER PINAR SU

Mert Salkı, Güven Balcı, Yağız Sezersan, Pınar Eligür, Sinan Kitapçı

Asst. Prof. Dr. Burcu Adıvar

EXECUTIVE SUMMARY

Water is so important for people and it was very interesting for us to work on such an important topic. Besides, forecasting was an important subject for Pınar Su as well as a challenging task for us. If the production could have been planned effectively, customer sales and so the profit could have been increased accordingly. Besides, better planning would provide a better demand management as well

1. INTRODUCTION

We need it to live!

Have you ever known that our bodies are made up of water mostly? Water is essential for us to use in daily lives. Approximately 75 percent of our body is water. To function properly, the body requires one to seven liters of water per day to avoid dehydration; the precise amount depends on the level of activity, temperature, humidity, and other factors. Most of this is ingested through foods or beverages other than drinking water directly. It is not clear that how much water intake is needed by healthy people, though most advocates agree that 6–7 glasses of water daily is the minimum to maintain proper hydration. One can live without food but living without water is impossible. So, water is the most important need of humanity.

After describing the importance of water, it is important to describe water market as well. During the last years, water resources have become so important for everyone, as resources have started to be decayed day by day due to the increase in population. Other reasons could have been classified as;

- Global warming
- Unconscious consumption
- Lack of resources

Global Warming:

As you have already known, in the last decades, global warming has aroused in the world. Accordingly, the temperatures have increased, whereas rainfall rates have decreased rapidly. The precipitations have started to go down and people have started to consume from the reserves.

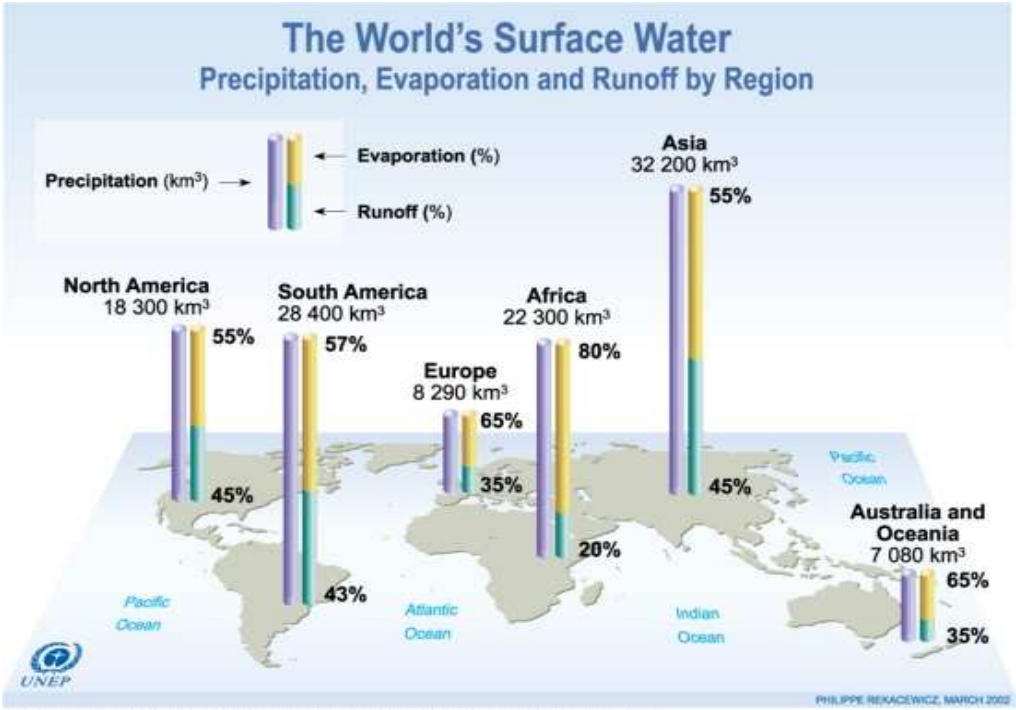
Unconscious Consumption and Lack of Resources:

People mostly think that water could have been reached easily or found everywhere. However, it is not that much easy. Because, only around %50-60 of it has been kept, rest has been evaporated. So, careful consumption is of much importance for long term standing for the coming years. All of these factors affect water market directly.

Water Industry

The water industry provides drinking water and waste water services to households and industry. Water supply facilities include, for example, water wellholes' cisterns for rainwater harvesting, water supply network, water purification facilities, water tanks, water towers, water pipes including old aqueducts. Besides, atmospheric water generator is in development. Drinking water is often collected at springs, extracted from artificial borings in the ground, or wellholes. Building more wellholes in proper places is thus a possible way to produce more water, assuming the aquifers could supply an adequate flow. Other water sources could have been identified as rainwater and river or lake water. This surface water, however, must have been purified for human consumption, like removal of undissolved substances, dissolved substances and harmful microbes. Popular methods are filtering with sand which only

removes undissolved material, while chlorination and boiling kill harmful microbes. Distillation does all three functions. More advanced techniques exist, such as reverse osmosis. Desalination of abundant ocean or seawater is a more expensive solution used in coastal arid climates.



Source: Peter H. Gleick, *Water in Crisis*, New York Oxford University Press, 1993.

Figure 1. Water evaporation by region

The distribution of drinking water has been done through municipal water systems or as bottled water. Governments in many countries have programs to distribute water to the needy at no charge. Others argue that the market mechanism and free enterprise are better to manage this scarce resource and to finance the boring of wellholes or the construction of dams and reservoirs.

Reducing waste, by using drinking water only for human consumption, is another option. In some cities such as Hong Kong, sea water is extensively used for flushing toilets citywide in order to conserve fresh water resources.

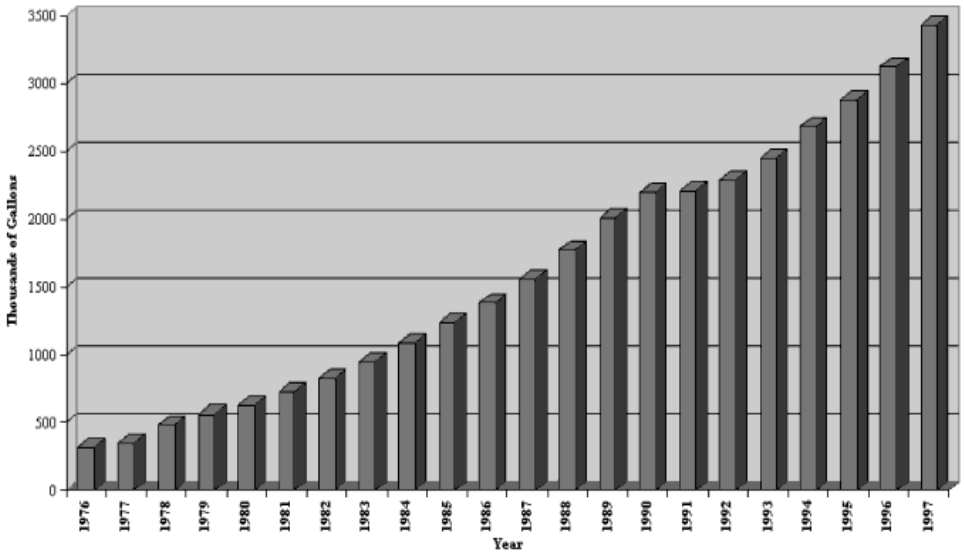


Figure 2. Amount of water bottled

Why Has Water Been Put In Bottles?

After water has gained more importance, some companies have entered into this market. They have sold their product in bottles as water has a fluid structure. Thanks to this, people could have used and consumed it easily and companies could have sold their products more effectively. Besides, bottled water is healthier for humanity, especially the glass bottles. However, today, companies in the world are using plastic bottles as it is cheaper than the glass bottle. This is the same for Turkish companies; the leaders of the water companies; Pınar Su, Erikli, Nestle Danone, Saka as well as the other small enterprises are using the plastic bottles. As a result, nowadays water is much more important for people than the past. It has to be consumed more carefully.

1.1 Motivation

We have chosen this subject, because water is so important for people and it was very interesting for us to work on such an important topic. Besides, forecasting was an important subject for Pınar Su as well as a challenging task for us. If the production could have been planned effectively, customer sales and so the profit could have been increased accordingly. Besides, better planning would provide a better demand management as well. Also, working for a company like Pınar Su could have been a good experience for us.

1.2 Goals

By this project, we could have developed ourselves in teamworking, forecasting, some software programs, and some methods. The project was regarding the demand management problems of Pınar Su and we have worked on finding appropriate solutions to the related problems.

Firstly, we have made a research about the demand management in Pınar Su and tried to understand the factors effecting water sales directly or indirectly. Accordingly, it has been outlined that one of the most important factors affecting the sales of water was temperature. Therefore, we have focused mainly on past years' temperature and sales data relations and investigated methods for relating temperature and sales data. As a result, a software program named SPSS has been found as suitable for the project, therefore we have focused on SPSS to determine how this software program could have been of use for the project. However, SPSS has not effectively met the requirements of the project, so we have investigated more and found SAS ARIMA as another alternative which has seemed to be more suitable for the forecasting studies.
All of the researches about demand management and forecasting have added value to the group members as it has encouraged team working. Besides, it has helped us in finding alternative solutions as well as using different programs or being informed about water industry and demand management.

2. PROBLEM DEFINITION

In economics, demand management is the art or science of controlling economic demand to avoid a recession. In natural resources management and environmental policy more generally, it refers to policies to control consumer demand for environmentally sensitive or harmful goods such as water and energy. Within manufacturing firms, the term is used to describe the activities of demand forecasting, planning and order fulfillment.

Demand management is the supply chain management process that balances the customers' requirements with the capabilities of the supply chain. With the right process in place, management can match supply with demand proactively and execute the plan with minimal disruptions. The process is not limited to forecasting. It includes synchronizing supply and demand, increasing flexibility, and reducing variability.

In this project, we have described the demand management process in detail to show how it could have been implemented within a company and managed across firms in the supply chain. Increasing complexity and uncertainty in supply chains, partially explain the root causes of these significant challenges to supply chains, but the environment alone does not explain all of the challenges. Demand management is concerned with these questions and the core "disconnects" between the traditional supply chain management activities and the demand generation and management processes. The challenge is to develop integrated demand -supply management processes, involving the matching of supply and demand over all time frames - during planning, as well as in real-time as demand materializes.
An effective demand management system guarantees:

- improved service levels; accurate demand planning allows for better response to market demands.
- lower stock levels and inventory costs; lowers safety stocks at every level of the distribution chain.

- improved purchase planning with subsequent reductions in procurement cost.
- improved use of production assets.
- improved promotion and assortment planning, with positive effects on sales.

Demand management of water refers to a tool to optimize sectoral performances prior to looking for new water sources for development and thereby allows for prioritizing investments in the water sector. Money, thus saved, could have been invested in other productive sectors of the economy. WDM also ensures sustainability of qualified water services and a good return of investments in the sector as well.

2.1 Challenges

The project scope had many challenging subjects some of which has been inquired by asking the following questions:

- ✓ How do they manage the demand management process?
- ✓ How do they determine the demand?
- ✓ Do they use any special software program to determine the demand?
- ✓ In which season\ months are their demand get increase or decrase?
- ✓ What are the main reasons that affect the production?

These questions were the guideline for us because demand management for this company is uncertain. The production quantity is changing with the natural water supply. If in the winter there is an efficient level of snow the volume of the production will be increase automatically. So this is about the seasons. In general, this firm produces the most of the water products in the autumn and winter season and stocks these. Then in the spring and the summer seasons they sell from their stocks. Especially the quantity of the sales is three times higher than the other seasons/months. In the company, they are using the MRP and SAP software programmes for the demand management and demand forecasting. Also they keep the datas about the past years. The historical data is considered to be so important for forecasting. In the project, the most difficult, but on the other hand, important part was collection of the data and usage of the software. Related data which was necessary for the project was, for instance, monthly and yearly temperature and rainfall data for each city. It was difficult to reach the data regarding the information about cities' monthly temperatures and rainfall volumes. The data that we could have found from the internet was average values of temperatures or rainfall for cities. However, this was not the data that we have required. Another challenge for us was the usage of the software. This program was not available in the university's laboratory and has been sold for over $5000. So, we have used the academic advisor's program instead.

3. LITERATURE REVIEW

In statistics and econometrics, and in particular time series analysis, an autoregressive integrated moving average (ARIMA) model is a generalization of an autoregressive moving average or (ARMA) model. These models are fitted to time series data either to better understand the data or to predict future points in the series. They have been applied in some cases where data show evidence of non-stationarity, where an initial differencing step

(corresponding to the "integrated" part of the model) could have been applied to remove the non-stationarity.

The model generally refers to ARIMA (p,d,q) model where p, d, and q are integers greater than or equal to zero and refers to the order of the autoregressive, integrated, and moving average parts of the model respectively. ARIMA models form an important part of the Box-Jenkins approach to time-series modeling. The ARIMA approach was first popularized by Box and Jenkins, and ARIMA models are often referred to as Box-Jenkins models. The general transfer function model employed by the ARIMA procedure was discussed by Box and Tiao (1975).

The ARIMA procedure analyzes and forecasts equally spaced univariate time series data, transfer function data, and intervention data by using the autoregressive integrated moving-average (ARIMA) or autoregressive moving-average (ARMA) model. An ARIMA model predicts a value in a response time series as a linear combination of its own past values, past errors (also called shocks or innovations), and current and past values of other time series.
The ARIMA procedure supports seasonal, subset, and factored ARIMA models; intervention or interrupted time series models; multiple regression analysis with ARMA errors; and rational transfer function models of any complexity. It provides a convenient framework which allows an analyst to think about the data, and to find an appropriate statistical model which could have been used to help answering relevant questions about the data. The analysis performed by PROC ARIMA is divided into three stages, corresponding to the stages described by Box and Jenkins (1976).

1. In the identification stage, you use the IDENTIFY statement to specify the response series and identify candidate ARIMA models for it. The IDENTIFY statement reads time series that are to be used in later statements, possibly differencing them, and computes autocorrelations, inverse autocorrelations, partial autocorrelations, and cross-correlations. Stationarity tests can be performed to determine if differencing is necessary. The analysis of the IDENTIFY statement output usually suggests one or more ARIMA models that could be fit.
2. In the estimation and diagnostic checking stage, you use the ESTIMATE statement to specify the ARIMA model to fit to the variable specified in the previous IDENTIFY statement and to estimate the parameters of that model. The ESTIMATE statement also produces diagnostic statistics to help you judge the adequacy of the model.
3. Significance tests for parameter estimates indicate whether some terms in the model might be unnecessary. Tests for white noise residuals indicate whether the residual series contains additional information that might be used by a more complex model. The OUTLIER statement provides another useful tool to check whether the currently estimated model accounts for all the variation in the series. If the diagnostic tests indicate problems with the model, you try another model and then repeat the estimation and diagnostic checking stage.

4. In the forecasting stage, you use the FORECAST statement to forecast future values of the time series and to generate confidence intervals for these forecasts from the ARIMA model produced by the preceding ESTIMATE statement.

4. METHODOLOGY

Before selecting the project methodology, we first analyzed the factors affecting the demand. These are:

- status of the economy in general
- customer plans and attitudes
- time of year
- competitors' prices and efforts
- advertising and sales promotions
- reputation for service
- design of products
- quality

In the project, first we have chosen SPSS to solve the problem. However, this program could not have supported the size of the data. The proposed solutions through SPSS were complex, incomprehensible and uninterpretable. In SPSS, we have tried to make a factor analysis and investigated the effects of temperatures on the sales and production, rainfall on the production and capacity. These researches and studies were meaningful only if the data was smaller. As soon as we have realized that SPSS could not have provided the effective solution for the problem, we have restarted searching for a better method. The academic advisor has suggested a software program called SAS-ARIMA, and we have concentrated on this method accordingly. Through this method and software, we could have reached to more meaningful solutions. This method was more complicated than SPSS, as it does not accept the data at the time it has been uploaded. First, it has to be changed and accordingly a formula should have been created to reach a proper solution.

An example about the formula could have been explained as follows. Suppose SALES is the variable that has required to be forecasted. The following example illustrates ARIMA modeling and forecasting by using a simulated data set, TEST, that contains a time series SALES generated by an ARIMA(1,1,1) model. The output produced by this example has been explained in the following sections.

```
proc sgplot data=test;
scatter y=sales x=date;
run;
```

Accordingly, the output chart displayed in Figure 3 is obtained. The following sections contain similar graphs and solutions for the project.

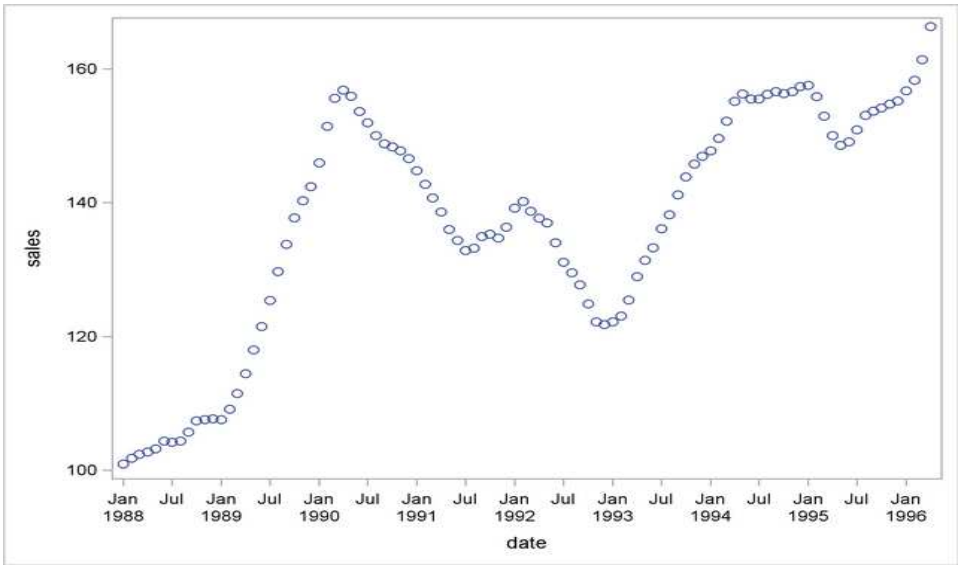


Figure 3. Output chart of the ARIMA example

5. DATA COLLECTION AND ANALYSIS

Data collection was the most difficult part of the project. The data related to Pınar Su Company's "SALES and PRODUCTION" was huge as well as other related data effecting the sales and production like; "TEMPERATURES, RAINFALL" for each city in Turkey, on month and year basis. Our industrial advisor, Mr. Murat ILDIZ, has helped us to reach the sales and production data of Pınar Su. However, this was not enough to find a proper solution. Because, the research results have shown that environmental situations were also affecting the sales and production directly like temperatures and rainfall. To reach a solution, we have to find all the related data for each region or city on month and year basis. Therefore, we have contacted twith the Department of Meteorology. They have prepared the required data and sent to us.

Analyzing the data was not a very complicated process as all the available data was clear enough. The examples of the data related to the "Sales, Production, Temperatures and Rainfall" were as follows;

YEAR	MONTH	(Demand=Sales)	
2005	1	4,062,860	KG
2005	2	3,814,355	KG
2005	3	4,309,642	KG
2005	4	4,773,779	KG
2005	5	5,238,072	KG
2005	6	6,227,948	KG
2005	7	8,851,274	KG
2005	8	9,363,632	KG

2005	9	6,870,125	KG
2005	10	5,907,380	KG
2005	11	5,569,000	KG
2005	12	5,933,472	KG

YEAR	MONTH	AMOUNT (Demand=Sales)	
2007	January	5,732,859	KG
2007	February	5,516,202	KG
2007	March	6,472,857	KG
2007	April	6,273,051	KG
2007	May	7,976,715	KG
2007	June	9,658,726	KG
2007	July	10,655,761	KG
2007	August	10,444,463	KG
2007	September	7,440,818	KG
2007	October	6,708,892	KG
2007	November	5,834,710	KG
2007	December	5,552,231	KG

Monthly Total Rainfall (mm)

STATION NAME/NO: IZMIR / 17220

YEAR/ MONTH	1	2	3	4	5	6	7	8	9	10	11	12
2004	228.5	27.9	21.3	30.3	11.3	3.7	1.2	0	0.0	1.7	100.0	77.7
2005	124.0	287.4	90.5	17.3	35.8	21.0	0	0.2	6.6	22.8	155.9	67.5
2006	77.5	93.4	180.9	29.4	0.2	10.0	0	0	167.2	114.5	63.1	9.1
2007	33.1	22.6	29.7	19.3	44.1	0.3	0	0	0.0	107.7	111.6	118.8
2008	30.1	9.0	60.0	62.3	4.9	0.4	0	0	55.0	12.0	92.6	101.0

Monthly Total Rainfall (mm)

STATION NAME/NO: IZMIR / 17220

YEAR/ MONTH	1	2	3	4	5	6	7	8	9	10	11	12
2004		9.2	12.7	16.5	20.2	25.7		27.4	24.0	21.1	14.8	11.2
2005	10.0	8.8	12.1	16.3	21.3		28.5	28.4	24.1	18.0	13.1	11.6
2006	7.1	9.7		17.2	21.1	25.7	27.9	29.1	23.8	18.9	12.6	9.8
2007	10.6	10.4	13.1	16.1	22.4	27.4	30.0	29.0	24.4	19.6	13.9	9.0
2008	7.5	9.3	15.2	18.0	21.0	26.9	28.5	29.2	23.8	19.6	15.6	11.5

Finally, after collecting the necessary data, we have started to upload them to the software program.

6. IMPLEMENTATION

As explained before, we have changed the methodology due to the size of the data. In SAS-ARIMA method, we have had to create a formula to solve the problem, which was called modeling. We have identified the data to the software as a formula and ARIMA have used this formula to reach the most proper solution. However, this formulation was not so easy to build up. Although ARIMA has had formulations in it, we have had to revise these formulations and identified the years and cities one by one to solve.

An example of the sales data that we have reached about Pınar Su was as follows;

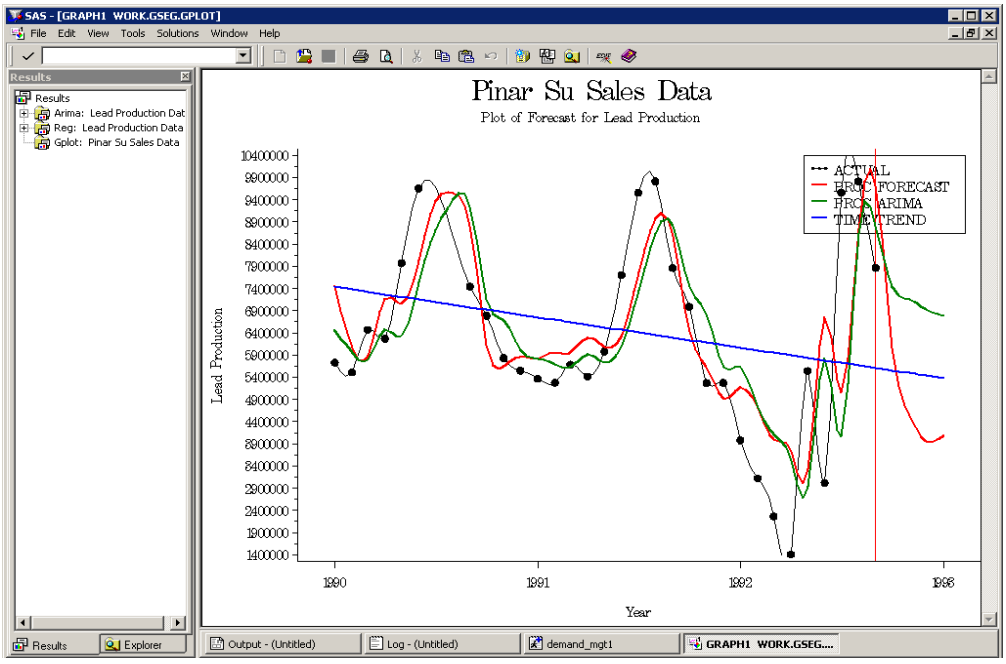


Figure 4. SAS ARIMA forecast for Pinar Su

7. RESULTS AND ANALYSIS

The solutions to the forecasting problem of Pınar Su have been described below. In the graph, 3 different solutions have been summarized; the actual sales of Pınar Su, procurement forecast and forecast of Arima.Arima has concluded that, in the coming season, the sales would have declined as it will be winter and beginning of spring, March. During the winter season, sales have been generally low due to the effect of temperatures. However, as the

temperatures have started to be warmed up, the sales would have raised accordingly. It could also have been observed in past years statistics session on the graph. After, these solutions have been improved and the effect of the temperatures and rainfall have been investigated, the differences between the months, seasons and the effects of the natural conditions' on the sales and production could have been observed clearly. For this process, we have used below formulas to reach the related solutions;

Sales formula;

Factor 1: 1 - 0.54087 B**(1) - 0.17562 B**(2) + 0.35712 B**(3)
+ 0.07555 B**(4) - 0.22888 B**(5) + 0.36828 B**(6)

Temperature formula;

Ankara

Autoregressive Factors

Factor 1: 1 + 0.13012 B**(1) - 0.50046 B**(2) + 0.14894 B**(3)
+ 0.08082 B**(4) + 0.33422 B**(5) + 0.51949 B**(6)

Moving Average Factors

Factor 1: 1 + 0.86662 B**(1)

Isparta

Autoregressive Factors

Factor 1: 1 - 0.93153 B**(1)

Moving Average Factors

Factor 1: 1 + 0.53897 B**(1)

Izmir

Autoregressive Factors

Factor 1: 1 - 0.99437 B**(1)

Moving Average Factors

Factor 1: 1 + 0.76618 B**(1)

Sakarya

Autoregressive Factors

Factor 1: 1 - 0.79877 B**(1)

Moving Average Factors

Factor 1: 1 + 0.55085 B**(1)

Aydin

Autoregressive Factors

Factor 1: 1 - 0.8278 B**(1)

Moving Average Factors

Factor 1: 1 + 0.64852 B**(1)

Istanbul

Autoregressive Factors

Factor 1: 1 - 0.62527 B**(1)

Moving Average Factors

Factor 1: 1 + 1 B**(1)

Rainfall formula;

Sakarya

Factor 1: 1 + 0.39347 B**(1) - 0.01878 B**(2) - 0.09784 B**(3)
- 0.04938 B**(4) + 0.07447 B**(5) + 0.24996 B**(6)

Aydin

Autoregressive Factors

Factor 1: 1 - 1.20439 B**(1) + 0.3822 B**(2) - 0.23105 B**(3)
+ 0.20337 B**(4) + 0.1433 B**(5) - 0.08764 B**(6)

Isparta

Autoregressive Factors

Factor 1: 1 - 0.73586 B**(1) + 0.18323 B**(2) - 0.1181 B**(3)
+ 0.15641 B**(4) - 0.01929 B**(5) + 0.13929 B**(6)

Moving Average Factors

Factor 1: 1 - 0.54881 B**(1)

Multi – variate demand forecasting formulas;

The SAS System 1
Using PROC GLM for Multivariate Linear Regression
The GLM Procedure
Number of observations 48

The SAS System 2
Using PROC GLM for Multivariate Linear Regression
The GLM Procedure

Dependent Variable: y1 Sales

Source	DF	Sum of Squares	Mean Square	F Value
Model	2	1.5264484E14	7.6322419E13	86.15
Error	45	3.9864516E13	885878128193	
Corrected Total	47	1.9250935E14		

Source	Pr > F
Model	<.0001
Error	
Corrected Total	

R-Square	Coeff Var	Root MSE	y1 Mean
0.792922	13.07189	941211.0	7200269

Source	DF	Type I SS	Mean Square	F Value
z1	1	2.9232481E13	2.9232481E13	33.00
z2	1	1.2341236E14	1.2341236E14	139.31

Source	Pr > F
z1	<.0001
z2	<.0001

The SAS System 3

Using PROC GLM for Multivariate Linear Regression

The GLM Procedure

Dependent Variable: y1 Sales

Source	DF	Type III SS	Mean Square	F Value
z1	1	1.6771634E13	1.6771634E13	18.93
z2	1	1.2341236E14	1.2341236E14	139.31

Source	Pr > F
z1	<.0001
z2	<.0001

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	-21143428.18	5534970.807	-3.82	0.0004
z1	1411.18	324.327	4.35	<.0001
z2	224984.39	19061.631	11.80	<.0001

The SAS System 4

Using PROC GLM for Multivariate Linear Regression

The GLM Procedure

Dependent Variable: y2 rainfall

Source	DF	Sum of Squares	Mean Square	F Value
Model	2	1.0618794E13	5.3093972E12	0.86
Error	45	2.7905272E14	6.2011716E12	
Corrected Total	47	2.8967152E14		

Source	Pr > F
Model	0.4316
Error	
Corrected Total	

R-Square	Coeff Var	Root MSE	y2 Mean
0.036658	40.89894	2490215	6088703

Source	DF	Type I SS	Mean Square	F Value
z1	1	9.4005498E12	9.4005498E12	1.52
z2	1	1.2182446E12	1.2182446E12	0.20

Source	Pr > F
z1	0.2246
z2	0.6597

The SAS System 5

Using PROC GLM for Multivariate Linear Regression

The GLM Procedure

Dependent Variable: y2 rainfall

Source	DF	Type III SS	Mean Square	F Value
z1	1	1.0064697E13	1.0064697E13	1.62
z2	1	1.2182446E12	1.2182446E12	0.20

Source	Pr > F
z1	0.2092
z2	0.6597

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	24426918.64	14644185.45	1.67	0.1023
z1	-1093.19	858.09	-1.27	0.2092
z2	22353.23	50432.44	0.44	0.6597

The SAS System 6

Using PROC GLM for Multivariate Linear Regression

The GLM Procedure

Multivariate Analysis of Variance

E = Error SSCP Matrix

	y1	y2
y1	3.9864516E13	-2.098755E13
y2	-2.098755E13	2.7905272E14

Partial Correlation Coefficients from the Error SSCP Matrix / Prob > |r|

DF = 45	y1	y2
y1	1.000000	-0.198987
		0.1849
y2	-0.198987	1.000000
		0.1849

The SAS System 7

Using PROC GLM for Multivariate Linear Regression

The GLM Procedure

Multivariate Analysis of Variance

H = Type III SSCP Matrix for z1

	y1	y2
y1	1.6771634E13	-1.299236E13
y2	-1.299236E13	1.0064697E13

Characteristic Roots and Vectors of: E Inverse * H, where

H = Type III SSCP Matrix for z1

E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 y1	y2
0.42457069	100.00	0.00000015	-0.00000001
0.00000000	0.00	0.00000005	0.00000006

MANOVA Test Criteria and Exact F Statistics

for the Hypothesis of No Overall z1 Effect

H = Type III SSCP Matrix for z1

E = Error SSCP Matrix

S=1 M=0 N=21

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.70196587	9.34	2	44	0.0004
Pillai's Trace	0.29803413	9.34	2	44	0.0004
Hotelling-Lawley Trace	0.42457069	9.34	2	44	0.0004
Roy's Greatest Root	0.42457069	9.34	2	44	0.0004

The SAS System 8

Using PROC GLM for Multivariate Linear Regression

The GLM Procedure

Multivariate Analysis of Variance
H = Type III SSCP Matrix for z2

	y1	y2
y1	1.2341236E14	1.2261584E13
y2	1.2261584E13	1.2182446E12

Characteristic Roots and Vectors of: E Inverse * H, where
H = Type III SSCP Matrix for z2
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 y1	y2
3.27614901	100.00	0.00000016	0.00000001
0.00000000	0.00	-0.00000001	0.00000006

MANOVA Test Criteria and Exact F Statistics
for the Hypothesis of No Overall z2 Effect
H = Type III SSCP Matrix for z2
E = Error SSCP Matrix
S=1 M=0 N=21

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.23385527	72.08	2	44	<.0001
Pillai's Trace	0.76614473	72.08	2	44	<.0001
Hotelling-Lawley Trace	3.27614901	72.08	2	44	<.0001
Roy's Greatest Root	3.27614901	72.08	2	44	<.0001

```
DATA stuff;
INPUT          z1:monyy5. z2 @@ y1 @@ y2 @@  ;
Format         z1 monyy5.;
LABEL  z1='Times'
z2='Temprature'
y1='Sales'
y2='rainfall';
CARDS;
```

Jan05	10	4062860.25	5732858.6
Feb05	8.8	3814354.5	5516201.6
Mar05	12.1	4309641.75	6472857.3
Apr05	16.3	4773778.5	6273051.4
May05	21.3	5238072	7976714.9
Jun05	25	6227948.25	9658726
Jul05	28.5	8851273.5	10655760.5
Aug05	28.4	9363632.25	10444463.4
Sep05	24.1	6870124.5	7449118
Oct05	18	5907380.25	6791892.4
Nov05	13.1	5568999.75	5834710
Dec05	11.6	5933472	5552231.3
Jan06	7.1	5634464.25	5371473.28
Feb06	9.7	5427269.25	5278352
Mar06	11.2	5994262.5	3982162.88
Apr06	17.2	6171204.75	3125251.328

May06	21.1	7435707	5689274.88
Jun06	25.7	8899737.75	5416659.84
Jul06	27.9	10046193	5983690.68
Aug06	29.1	11441111.25	7706533.76
Sep06	23.8	7452892.5	9560690.56
Oct06	18.9	6416789.25	9818725.76
Nov06	12.6	5995146	7866902.96
Dec06	9.8	6247755.75	6991394.88
Jan07	10.6	6142348.5	5276199.68
Feb07	10.4	5910216	5277929.52
Mar07	13.1	6935204.25	3982162.88
Apr07	16.1	6721126.5	3125251.328
May07	22.4	8546480.25	3125251.328
Jun07	27.4	10348635	2268339.776
Jul07	30	11416886.25	1411428.224
Aug07	29	11190496.5	5545160.672
Sep07	24.4	7972305	3023940.88
Oct07	19.6	7188099	9560690.56
Nov07	13.9	6251475	9818725.76
Dec07	9	5948819.25	7866902.96
Jan08	7.5	6294695.25	5276199.68
Feb08	9.3	6185568.75	5277929.5
Mar08	15.2	6667119	3982162.88
Apr08	18	6347648.25	3023940.88
May08	21	7012040.25	2268339.776
Jun08	26.9	9031094.25	1411428.224
Jul08	28.5	11203934.25	5545160.672
Aug08	29.2	11506319.25	5545160.672
Sep08	23.8	9218054.25	9818725.76
Oct08	19.6	7123119	9818725.76
Nov08	15.6	6183046.5	7866902.96
Dec08	11.5	6184101	6991394.88

```
PROC GLM DATA=stuff;
MODEL  y1 y2= z1 z2/;
MANOVA H=z1 z2/PRINTE PRINTH;
TITLE4  'Using PROC GLM for Multivariate Linear Regression';
RUN;
```

8. PROJECT EVALUATION

This project was a challenging effort for us in improving the skills. The most important value adding part of the project was team working and brainstorming. This project has also contributed the firm on creating awareness regarding the new demand management and forecasting methods. Pınar Su could have improved their forecasting method through the proposed method prior to estimating the production or demand.

As the Demand Management Project Team, we have experienced the support of Mr. Murat ILDIZ, in all areas. Although he was very busy, he has answered the questions and provided the necessary data on time.
Besides, the academic advisor Asst. Prof. Dr. Burcu Adıvar has also assisted us a lot during all steps of the project.

9. CONCLUSION

The project outcome was based on a proposal for improving the demand management and forecasting of Pınar Su. The method has been presented successfully and improvements on the results have been summarized accordingly. Besides, this project could have been developed through adding other criteria like environmental factors related to the effect of the humidity on the production stage or the effects of flow rate in production. Besides, a research could have been made regarding the people using tab water or customers point of view of to Pınar Su Company.

10. REFERENCES

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FEASIBILITY STUDY OF IZMIR LOGISTICS VILLAGE

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EXECUTIVE SUMMARY

This project is about feasibility study of logistics villages in Agean region in Turkey. Area of logistics is too wide so it is hard and complex. Logistics is the efficient flow and storage of goods from their point of origin to the point of consumption. Although logistics has short definition, it has not short phases. It includes many relevant parts. Our secondly need is definition of logistics village. Logistics Village is a defined area within the all activities relating to transport, logistics and distribution of goods, both for national and international transit are carried by various operators.

This study emphasizes on both manufacturing and services firms. Also, logistics firms will be included in the analysis by conducting questionares. Both sectors have disadvantages and problems due to not been in the logistics villages. In addition following questions will be answered that ”What kind of services(customs, warehouses etc.) do logistics firms provide? What modes do freight villages use for trade? What types of products they produce or distribute? How many consumers do they have? Do they have own warehouses or long term leases?”

1. INTRODUCTION

This study is a feasibility study of Izmir Logistics Village. We have tried to measure the need for a Logistics Village in Izmir, of both manufacturing and logistics firms.

1.1 Overview

We have collected general information to assist us in doing a feasibility study of Izmir Logistics Village and have answered some basic questions. In our method, we have handled the related information starting from more general and making our way up to more specific subjects as we progressed. For this reason, we have compared general, basic and useful information with our observations. To see if the information we have gathered were in accordance with the real life situation, two different questionnaires were applied, one for manufacturing and one for logistics companies, as they have had different characteristics. Questionnaires were sent to approximately 1300 firms. But the response rate has been very low with this method, around 2%. That's why we have planned site visits to fill the questionnaires through face to face interviews as these answers would have shaped our decisions about the general view towards logistics villages and the success of the feasibility study at the end. Also we have believed that conducting face to face interviews would have helped us in testing the efficiency and effectiveness of our questionnaire questions. Before the interviews, we have made some revisions to the questionnaires in order to get more general information from the firms about their thoughts regarding Izmir and logistics. We have included these general aimed questions in both questionnaires. To conduct the interviews, we have formed two groups. Then, we have started the pilot questionnaire application with 5 firms. We have taken appointment from these 5 companies that we have selected from Izmir and around Izmir, and finally we have gone to these companies to conduct face to face interviews. After this pilot questionnaire application, we have seen that our questions were well prepared and we haven't needed to revise them. So, we have proceeded by continuing our questionnaires via telephone interviews.

1.2 Motivation

In this project, we have made a study in order to see whether forming a Logistics Village around the city of Izmir having a big trade volume, could have made sense and have tried to clarify some points like; whether there was really a need for it or not, where it should have been located or what advantages this village would have provided to logistics and manufacturing firms. We have analyzed some locations which could have been alternative locations for the village and outlined some suggestions accordingly. There was also a study that has been carried out with the coordination of the University of Economics and Izmir Chamber of Commerce for building a Logistics Village in the best suited area which was close to strategically most important areas. The most important motivation for us, as group members, has been the poor number of logistics village projects in the near future for Izmir. Logistics villages have provided an advantage for planning, creating and recommending some alternatives to the companies for overcoming the problems they would have possibly faced in

logistics operations. Thus, this study would also be analyzed related to the market researches of both logistics and manufacturing firms' demand for a logistics village.

1.3 Goal

When we have first started the project, we have decided to investigate “What geographical and weather conditions we have experienced in the Aegean region?”. Until this time, geographical and weather conditions have affected all type of decisions about logistics and site selection of logistics villages in the world. Therefore, we should have considered geographical rules that could have helped us in answering questions such as “What type of logistics decisions about constructions were being made according to these rules?”, ”What type of studies were made in the last five years?”; ”What did the last studies find out about the Aegean region?”, “What were the last studies proposed for special areas such as the Aegean region?”, “Which areas were found as suitable places for logistics villages in the studies?”, “What were the common suitable places?”. Besides these subjects, "What have been made by logistics investigators?”.

During the research time period, we have tried to find the answers to these questions as well: “What we could have done?”;”Why we should have made it?”. We have known that if the most essential structures have been built, it would have had a very positive effect. For the cost side, if the project was to be planned effectively, it would have been more beneficial. If we were able to plan our project successfully, the other steps could have been more easily executed. “Which strategies did we need to select? Should we have constructed new plants, designed support services or new channels for transportation?” And so on. We have decided that a logistics village should have been built and this village should have provided sufficient, suitable and efficient support services.

When we have concluded our research phase, we have tried to know the Aegean Region in a more detailed way, especially paying attention to its geographical properties, which could have affected the location selection process for the logistics village. The findings of this research have helped us in selecting an area in the region.

1.4 Institution Background

IZMIR CHAMBER OF COMMERCE

Izmir Chamber of Commerce was founded in 1885. Between the years of 1885 and 1917, the Chamber has prepared daily market reports and export-import statistics using customs records, specified market prices and provided the European tradesmen with the necessary information and references about the Turkish businessmen while introducing our products to foreign markets as well. Between the 1st World War and Turkish War of Independence, the Chamber was unable to carry out its functions.

After the year 1922, when the Independence War has ended, the Chamber has restarted its above mentioned services. Along with the history of the Turkish Republic, the Chamber has

caught a gradually progressing trend aiming to maximize the quality of the services rendered. Izmir Chamber of Commerce has more than 55.000 registered members and is the second largest Chamber in Turkey. It is an obligation to be a member of the Chamber for every established company. According to the statistics conducted by the State Institute of Statistics, the Aegean Region and Izmir have the highest increasing rate of newly founded businesses. So, this leads to a gradual increase in the number of the members of the Chamber.

2. PROBLEM STATEMENT

2.1 Problems

In the beginning, we have thought about the most likely potential problems that could have been faced, and planned our actions accordingly. However, there were more problematic issues than we have expected. First of all, we have believed that data could have been researched with various methods like literature reviews, parallel analysis and other sources. Normally, we have experienced many research stages and when our research results have not helped much, we have sought other methodologies that could have helped us.

The first method we have applied was the questionnaires. In the questionnaires, we have developed some general and some logistics village related questions. Questionnaires have been sent to approximately 1300 logistics and manufacturing firms. However, the response rate was only 23 firms. The scope of the project was large and the necessary information was missing; more than 1200 firms have not filled essential parts.

Our second method was visiting the firms and filling in the questionnaires through face to face interviews. Like the first experience, we weren't able to gather enough information. This problem was mainly caused by the low participation and interest in our questionnaire by the participating firms.

The third and last method we have relied on was the telephone interviews. Nearly 50 logistics and manufacturing firms have been called within four weeks. This process wasn't successful as well, as only 12 firms have agreed to participate in our questionnaire. Besides, the firms who have replied the questionnaires did not want to give real data and results. Therefore, this process was ineffective as well. Global problems have affected most manufacturing and logistics firms. Many firms were affected negatively from the global economic crisis, 4 of the 12 firms have gone bankruptcy. Firm's managers have told us that the reason of not being able to help us in our project was due to the bankruptcy problems that they were dealing with. So, lack of participation was the main cause of our problem. Other causes were that the firms have shrunk, by which their marketing, planning, operational strategies have been changed. In addition, managers have not required explaining the firms' strategic conditions and related units at all. Although we have presented our title and mentioned that our interview was for a university research project, some managers, who were called via telephone, were very reluctant to answering our questions.

3. LITERATURE REVIEW

We have examined some examples of logistics villages, in order to be able to understand the results of building logistics villages and its advantages.

It was appropriate to give the example of Dubai Logistics Village, which eventually would have spanned almost 140 square kilometers, featuring logistics, aviation, commercial, residential, educational, recreational, technology and entertainment facilities. Dubai Logistics village would have been a free trade zone and a preferred location for businesses which have required, or offered, logistics and multi-modal transport services to/from wider Middle East, India, Africa (a market of more than 2 billion consumers). This was the world's first truly multi-modal facility for air, sea and road services combined into an integrated common logistics platform. All transport modes, logistics and value-added services, including assembly and value-added manufacturing would have been located in a single customs bonded and free trade zone environment. Dubai Logistics village would have allowed companies to integrate their regional manufacturing, sales and support infrastructure and organization into their global networks. Other important issues were as follows:

* It was designed to handle more than 12 million tons of air cargo annually, up to 16 air cargo terminals and it was built next to the Jebel Ali Free Zone and port, which has been further extended to handle 15 million TEU (container units) per annum within more than 100 square kilometers.
* This important initiative would have allowed Dubai International Airport to focus on the development of passenger traffic without suffering from congestion caused by freight and logistics operations.
* Dubai Logistics Village would have provided: Land plots for dedicated industrial businesses, trading companies, distributors and logistics service providers; shared facilities, such as warehouses and offices as well as modern air cargo handling facilities. It has had its own unique, dedicated, modern road system which would have separated professional logistics from public traffic to ensure clients could have provided a quality and speedy service to their customers. All Dubai Logistics Village's customers would have directed access to Jebel Ali Port without having to leave the free zone. An ocean container could have been transferred from the port's container terminal to the airport's cargo terminal without going through customs clearance and without any delay. This would have maximized the freedom to do business.

Trade and industry customers could have had the option to build their own facilities, including distribution centers and regional headquarters, on serviced sites with long term leases or lease space in advanced business units with offices and warehouses provided by Dubai Logistics Village. Alternatively, companies could have outsourced operations to contract logistics service providers that have provided both services and facilities. Official transportation plans have included the development of a 160 km network of main roads within Jebel Ali Airport City to support public traffic and a unique system dedicated to the specific needs of Dubai Logistics Village and Jebel Ali Airport measuring a total of 90 km.

Phase one of the 140 square kilometers Jebel Ali Airport City - the size of Manhattan – has been completed in September 2007. It has included a 4,500meter runway for DLC, a cargo terminal, a small passenger terminal and executive jet facilities. DLC has had its own unique, dedicated, modern road system which would have separated professional logistics maximizing the freedom to do business. There were also recommendations for a major ring road which circumvents Jebel Ali International Airport (JXB) and an elevated dual three-lane road erected between DLC and Jebel Ali Free Zone (JAFZ). A major artery linking the different Jebel Ali Airport City components with major roads were constructed.

Plans have also included an 11 km extension of the Dubai Rail project from the free zone to Jebel Ali Airport and 55 km express railway link between port and Dubai International Airport to handle both passengers and cargo. Dubai logistics village was the key in Dubai's plans to attract 12 million tons of cargo into the Jebel Ali Airport, a target that was nearly four times the amount handled in Memphis International, the home of FedEx and the world's busiest cargo airport, last year. The free zone has been designed to become a platform for both third party logistics providers and distribution centers for other companies. These were the only types of businesses that were able to operate within it; other operations instead have had to look for premises in Dubai's other large free zones.

Another example could have been given as the Aqaba Logistics Village (ALV). ALV project has aimed operating and managing logistics complexes, container freight station operations and supply chain movements on an international scale. ALV was a prime integrated logistics facility for successful business, economic and social outcomes for the benefit of all stakeholders of the project which has included the industrial, commercial and public sectors in Jordan. The Aqaba Logistics Village has offered services that have been developed such as container freight station (CFS), distribution center (DC), exhibition and trade show center in open space or inside a special exhibition hall, cold store and specialized warehousing for hazardous cargo, a logistics training institute for life-long learning and upgrading of skills, a dedicated auction area, and a container repair facility. The total cost of the Aqaba logistic village has been approximately US$ 60 million. Of course, there have been some projects still in progress in Turkey. It has been estimated that the logistics villages that would have been built in Turkey, would have cost approximately 200 million dollars, which were known as the modern place of transportation. After 2008, thirteen logistics village projects were considered to be built. From the city centers, facilities such as warehouses would have been moved to the centralized area provided by these logistics villages. Therefore, both the traffic congestion would have been reduced and also transportation activities would have been faster. With the advantages gained by operating in the logistics village, the Turkish products would have had a better standing in the global marketplace.

The Turkish State Railways (TCDD) would have signed logistics village projects in eleven cities in Turkey, including Samsun, Balikesir, Eskisehir, Istanbul, Kayseri, Adana, Izmit, Erzurum, Konya, Usak and Denizli. Besides the rail way, these logistics villages would have integrated the road, sea and air modes, enabling companies to make use of intermodal

transport. And these villages were planned to be built near large and important economical and industrial areas and important railway lines.

4. DATA COLLECTION AND ANALYSIS

To define the appropriate specifications of a possible logistics village and to assess firms' need for a logistics village in Izmir, two types of questionnaires were prepared. With the questionnaires we have conducted, we have tried to see if there were any criteria that have affected a firm's need for a logistics village and the services that would have been meaningful for the logistics village to provide, that we might have missed. The questionnaires have had different characteristics for the manufacturing and logistics companies, as the operation processes of the manufacturing and logistics firms were very different from each other. In the questionnaire for logistic firms, we have tried to learn about these subjects:

- General information about the firm
- Logistics activities that they have provided to their customers (inventory management, bonded warehouse management, purchasing, transportation services, refrigerated transport, dangerous goods transportation, order management, materials handling …)
- Their servicing areas in Turkey and foreign countries
- Sectors that they have provided services to
- How much of their operations have been realized in the domestic or foreign market
- Which transport modes have been used to perform their activities
- Type of their loads
- Utilized warehouses and their properties
- Fleet information
- The annual average volume of cargo handling

In the questionnaire for manufacturing firms, we have tried to gather information about the following subjects:

- The sector of the manufacturing firms
- Their main product groups
- The cities that they have been served
- The activities that they have provided for their customers (by themselves or by the use of 3PLs)
- The activities that have been directed to the domestic and the foreign market
- Percentage of the firms' manufacture that has been produced for exporting
- Transport modes that have been used
- Utilized warehouses and their properties
- The services that the companies have outsourced
- Fleet information
- The annual average volume of cargo handling

We also have included some general aimed questions in both the logistics and manufacturing firms' questionnaires. And these questions were:

- What are the problems that you experience during your logistics activities? How much of these problems can be associated with Izmir's logistics infrastructure?
- What are your solutions for the problems that you have?
- What are the logistics problems in Izmir?
- Where will Izmir be in the terms of logistics in the future?
- What are the strengths and weaknesses of Izmir?

5. IMPLEMENTATION

After creating the questionnaires, it was the time for applying them to firms. Before applying the questionnaires to the firms, we have created a list which has required contact information of firms. We have been able to gather nearly 1300 contacts. We have tried to reach the firms via e-mail. But we have received only 23 replies. Because of the insufficiency of replies, we have decided to continue applying the questionnaires via telephone and sometimes via face to face interviews with our contacts both from logistics and manufacturing firms. Firstly, we have started a pilot survey application with 5 firms. We have taken appointment from these 5 firms that we have selected from Izmir and around Izmir, and finally gone to these companies in order to conduct face to face interviews. Because of time constraints, we have decided to stop the face to face interviews and continued with telephone interviews. Most of the firms have not responded to our questionnaire, because according to them the questionnaires have included some questions that has asked for some confidential information. As a result, we have been able to accumulate 56 responds to questionnaires, distributed equally between the logistics and manufacturing firms.

Some of the logistics firms that have responded are;

- Terra Uluslararası Tasımacılık ve Dıs Tic.Ltd. Sti.
- Kapıtrans Ulus Tas. Tic. LTD.
- Unimar Lojistik A.S
- Kıta Ulastırma Hizmetleri A.S
- Balnak Lojistik Grubu
- Omsan Lojistik A.S.
- Genel Transport
- Karmer Uluslararası Nakliyat
- Ekol Lojistik A.S.
- Gefco Tasımacılık ve Lojistik A.S

Some of the manufacturing firms that have responded are;

- Batıcim Batı Anadolu Cim. San. A.S.
- Hugo Boss Tekstil Sanayi LTD.
- Flavortech

- Elda Içecek
- Idol Organik Gıda
- Cms
- Taris
- Bmc Sanayi ve Tic. A.S
- Sumer Blok A.S
- Mastas A.S

6. RESULTS AND ANALYSIS

As a result of the questionnaire applications, we have reached certain conclusions from the 56 responses. Logistics firms that we have interviewed were active in their sector from 10 to 35 years. The respondents have been operation managers and sales managers from the logistics firms. And we have seen that, the activities that they have provided to their customers mostly were: inventory management, bounded warehouse management, purchasing, transportation service, refrigerated transport, dangerous goods transportation, order management, materials handling, packing, labeling, logistics communication and information systems, recyclable materials handling, departing transportation, customs clearance, arrival transportation, agency, freight control, dry docking, reversible logistics, carrier selection, order management, pricing, fleet management, distributing control, customer service, 4PL services, inventory ownership and supply chain management integration. Also all of the firms we have contacted were servicing in the Aegean Region. The sectors that the firms were mainly active in included textile, food, machinery, construction, furniture, electronic, servicing, medicine, chemistry, plastics and automotive. The activities of the firms were mostly directed to the foreign market. The firms have used all the transport modes except the firms which have provided only road transport. The firms sometimes have preferred to integrate modes. Road and sea transport integration was the most commonly used intermodal transportation type. Types of the bulk cargo and their amount have shown diversity from firm to firm. For example, Karmer has transported general cargo (3000 tons), hazardous goods (1000 ton) and pallet bulk (18000 ton), where, Genel Transport has preferred to transport cargo (%25), container (%65), dry bulk (%5) and hazardous goods (%2). C. M. Canmar has transported cargo (%80), hazardous goods (%5) and others (%15). All firms have had their own warehouses. But only some of the firms have had bonded and frozen warehouses. Most of the firms, who were making use of bonded warehouses, have outsourced this function. They have thought that their need for warehousing within five years would have increased by around 21–30%. In addition, all the logistics firms we have interviewed have had their own fleets. But they have also outsourced vehicles when some extra have been needed.

Most of the manufacturing firms that we have contacted were in the food and automotive sector. Their manufacturing products were raki, wine, felloe, commercial vehicles, and so on. They were mostly serving to Izmir and Middle Anatolia, Mediterranean, Aegean, Black Sea and Marmara regions also. They have been servicing in the sector between 4-44years. Most of them were old and very successful companies. We have conducted the questionnaires with

planning managers, manufacturing managers and import-export managers. The processes that the firms have insourced and outsourced have differed. For example, CMS has insourced the inventory management, bonded warehousing management, purchasing, order management, material handling, assembling/packing/labeling, logistics communication and information systems, reversible materials handlings, fleet management, order management, purchasing, primary production management, branding and labeling, pricing, inventory management and information technologies. Also, CMS has outsourced the bonded warehousing management, transportation management, waste processing, departing transportation, customs clearance, arrival transportation, customs broker, freight consolidation and consulting services. With the results of the questionnaires, we have seen that Elda Icecek has insourced the inventory management, bonded warehousing management, purchasing, order management, materials handling, packing, labeling, logistics communication and information systems, reversible materials handling, return and repair, distributing control and customer service; but they were outsourcing the transportation management, dangerous good transportation, customs broker, agency, freight control, reversible logistics, carrier choose and fleet management. When we have taken a look at Idol Org, we have seen that they have insourced inventory management, purchasing, transportation management, order management, packing, labeling; moreover they were outsourcing the bounded warehousing management, logistics communications and information system, reversible material handling, customs broker, and so on. When we have generalized the activities of the firms to the market, we have seen that their activities were mostly directed to the domestic market. Generally, they have not preferred to use several modes (intermodal transportation) within the same operation. But some of the firms have combined the land and sea transportation. The amount of cargo handled has varied from firm to firm, depending on the type of the bulk. Some examples of bulk could have been given as, Elda Icecek transporting the goods as liquid bulk and Idol Org. as cargo. The firms have had their own warehouses. But considering the future need was also important in a feasibility study. When we have examined the responses, we have seen that the warehousing capacity needs would have been increasing at a rate around 0–10 % in the next five years. The average volume of cargo handling and average fleet for Elda Icecek was 15 trucks/month and 45 trucks/ month for Idol Org.

There were many problems in the logistics sector, according to the companies. They have found infrastructure and storage availabilities inadequate. They have had problems in the topics of technical personnel, partners, and technological opportunities. Many logistics firms in Izmir were the firms whose headquarters have been located in Istanbul. The firms in Izmir have not operated as effectively as their headquarters in Istanbul. They were usually smaller firms that have covered and operated the Aegean region operations. Because Izmir's industrialization has not been developed enough, this has become a disadvantage for the companies located in Izmir.

7. POSSIBLE ALTERNATIVE SITES FOR THE IZMIR LOGISTICS VILLAGE

In this project we have researched on the need for a logistic village around Izmir having a big trade volume. If there has been a need, where it should have been located? What were the advantages of these villages to logistics and manufacturing firms? We have analyzed some locations with alternatives and supported these alternatives with our suggestions.

First of all, Organized Industrial Zones were analyzed as the location of these specialized areas has become important, while trying to select the best possible location for the logistics village. During the research stage, we have been careful about some basic rules like logistics village should have been at least 250 decares (that is 2,500,000 m2). Organized industrial zones should have had access to the city center, and multiple transportation systems. Also the logistics village should have provided services which have had the potential to grow and develop in terms of both development level and quality. More specifically, the village should have been able to provide maximum service level with minimum time and cost with maximum capacity.

While determining the possible areas, distances between special areas, such as organized industrial zones, and all transportation ways were taken into consideration. While distances were calculated, we have tried to answer some questions such as: "Why was this area selected?" Each area's advantages and disadvantages have been determined. We have also made a classification of these options, by the advantage-disadvantage balance – depending on which one was greater.

The areas that we have taken into consideration were as follows:
Aliaga: Aliaga is located at 60 km north of Izmir. Aliaga hasn't had enough space (398 km2), so we could have not selected this area. In addition, there was not much transportation way that has gone through Aliaga, although there have been some ports. Besides this information, Aliaga has had petroleum reserves, so these reserves have had a much higher importance than logistics. Therefore, we have eliminated this area.
Kinik: Kinik has had 436 km2 of available space. It is located at 120 km north from Izmir. According to its geographical conditions, just like Aliaga, it was not possible to build railway. Kinik has also been eliminated according to these observations.
Kemalpasa: The available space was 655 km2. It is located at 29 km west of Izmir. Geographical conditions have seemed to be appropriate for this project. Its mountains lie from western to east, which has had positive effects on the ability to utilize any kind of transport mode. Kemalpasa was our initial alternative for the logistics village.
Torbali: The available space was 600 km2. It is located at 45 km east from Izmir. Torbali has had access to main transportation ways and on top of that, the geography was suitable. On the other hand Torbali hasn't had enough space for a large investment such as the logistics village. So Torbali was also eliminated.

Kiraz: The available space was 586 km2. It is located quite far away from Izmir, with a distance of 142 km. Kiraz was suitable for only railway systems. Although geographical conditions have allowed railway system developments, Kiraz is too far away from the centre of the Aegean region, Izmir, just like Soke. So investors, producers, suppliers would not have required to locate their operations in this location. For these reasons, this alternative was eliminated.
Bergama, Bayindir, and Odemis were also considered but all turned out to have unsuitable geographical conditions for any transportation way to connect these areas to Izmir, which has made them inappropriate alternatives for being a location to set up a logistics village in. Therefore, these alternatives have been eliminated.

Considering all our comments on these alternatives, our suggestions have been: Logistics Village A1, Logistics Village B1, Logistics Village B2, Logistics Village C, Logistics Village K, these locations could have been seen in the map provided in Appendix-3. In these five points, we have established type of a triangle schedule. Our future ideas would have been shaped according to these places' characteristics.
Proposal of Logistics Village A1 was near Foca.
Second alternative was Logistics Village M1. M1 was near Mordogan. We have believed, if this alternative was selected, there might have been a need to fill the sea in order to be able to utilize sea transportation, but other than that, railway could have been used in this area without any difficulty.

Another alternative was Logistics Village B2. This area was near Balikliova. Balikliova has had a harbor, which could have been an advantage of the area. If railway system was to be set up in Mordogan, this region would also have benefited from this, since these two areas have been located very close to each other. If this was not the case, Balikliova could also have been reached by highway, which would have supported the logistics village's road transportation needs.

One of the best alternatives, in our opinion was Logistics Village C. According to this research, Logistics Village C, was an area that could have been determined as long as it was at a point between Izmir and Cesme highway. The reason why we have favored Logistics Village C was because the area of this place was appropriate for constructing a logistics village. Besides, Logistics Village C has not only had access to motorway but also it was near the sea, which has proved to be an important property for logistics village locations.

Finally, the last alternative we have proposed was the area of Logistics Village 3K. This area was similar to the Logistics Village C. This place was near Kemalpasa. As we have mentioned before, Kemalpasa's distance from Izmir is 29 km. It was located near large and important industrial areas and important railway lines that have been built by Turkish State Railway lines in 2007 and the traffic always flows there, because of this industrial density.

8. PERFORMANCE EVALUATION

Outcome approach

The success of our project could have been determined using the outcomes approach. The answers to the following questions would have built the comments on how successful this project has been.

8.1 Outcomes

We have decided that focusing on the following questions would have been useful when identifying and evaluating the project's outcomes:

• Are your outcomes relevant to the activities your project will provide?
• Do you know how you will measure your outcomes?
• How will you know your project is making a difference?
• Are your outcomes specific and realistic?
• Can you achieve your outcomes within the lifetime of the grant?
• Are your project outcomes relevant to the need of the project?

The difference our project has created was that the recommendations presented in the following section about what the logistics village should have provided the firms with;

- Multi-modal facility for air, sea and road services combined into an integrated common logistics platform. Therefore all transport modes, logistics and value-added services, including assembly and value-added manufacturing must have been located in a single customs bonded and free zone environment.
- The village in Izmir should have allowed companies to integrate their regional manufacturing, sales and support infrastructure and organization into their global networks.
- All logistics village's customers should have had a direct access to Port without having to leave the free zone. And ocean containers should have been transferred from the port's container terminal to the airport's cargo terminal without customs clearance and without any delay. Therefore, maximizing the freedom to do business of course. This has led us defining the need for a cargo aimed airport that has needed to be located in the logistics village.
- This logistics complex would have been attracting firms to do their business here and to stay here. The focus must therefore have been on trading, as if a distributor of spare parts makes the decision to come to Izmir, all of the service providers and forwarders would also have come and they would have stayed here as long as there has been a business for them.
- Warehouses located in the city centers or close to the city centers, should have been transferred to the centralized area of the logistics village, so the city-center traffic congestion could have been reduced and also transportation activities could have been faster.

8.2 Contribution to the Students

The project has provided us awareness on the dynamics of working in a team, the opportunity to have experience in working on a large-scale project, to have better awareness of the responsibilities and duties pertaining to industry roles, and to gain experience of exchanging ideas and inspiring others to work together.

The project also has helped us to gain the discipline of demonstrating professional behavior such as showing up on time, taking responsibility, delegating as necessary and meeting deadlines.

8.3 Contribution to Advisor

We have thought that the project has helped our advisors to have a better understanding of each student's ability to work as a team under pressure, which has reflected the real-life demands of the job market, to allow the advisor to observe students, both collectively and individually, as we have exchanged and clarified information among ourselves.

8.4 Performance of the Team

Generally, it was true to say that we have had very limited time to reach all the firms we have intended to contact. But still, we have tried to do our best and therefore the performance we have exhibited at the end has been good enough to have a general idea about the current situation of the general information we have asked for.

9. CONCLUSION

Applying the questionnaires has taken nearly a month. Making appointments with firms was more difficult than we have expected. Most of the firms have said "confidential information is being asked for in the questionnaires". However, we have been able to receive some information from the firms that we have contacted. Of course, these data were not enough for measuring the need for a logistics village in Izmir, since such a generalization could only have been made if the majority of the key firms in the area have participated in our research. We have believed that, the project of feasibility study of Izmir Logistics Village has not been completed yet. If more firms could have been contacted, the responses gathered from these questionnaires then would have been meaningful, as in being able to reflect the degree of need for a logistics village in Izmir.

As for the conclusions for the location selection for the logistics village, according to our research, Logistics Village C and Logistics Village 3K were the best suitable areas. Logistics Village C has had great opportunities for advancement with all transportation modes. In addition, Logistics Village 3K was located near large, important industrial areas and important railway lines that have been built by the Turkish State Railway lines.

10. APPENDIX

Appendix-1 Questionnaire for logistics firms

1. What is the company's name? (optional)

…….

2. What is your main business area?

…….

3. Which cities do you operate in?

…….

4. How long have you been operating your business?

…….

5. How many employees do you have?

…….

6. What is your position in your firm?

…….

7. Which of the following logistics activities do you provide your customers?

- □ Inventory management
- □ Warehousing and bonded warehousing
- □ Purchasing
- □ Transportation activities
- □ Refrigerated transportation
- □ Hazardous goods transportation
- □ Order management
- □ Materials handling
- □ Assembly
- □ Packaging
- □ Labeling
- □ Logistics communications and information systems
- □ Parts and service support
- □ Return goods handling
- □ Waste Processing
- □ Departing transportation
- □ Customs clearance
- □ Arrival transportation
- □ Customs brokerage
- □ Agency services
- □ Freight controlling
- □ Pooling
- □ Freight Consolidation
- □ Consultancy services
- □ Reverse logistics
- □ Carrier selection

- Main production activities
- Branding and Labeling
- Pricing
- Returns and repairing
- Information technologies
- Fleet management
- Order activities
- Distribution controlling
- Customer services
- 4PL services
- Factoring
- Supply chain integration
- Other (please indicate):

8. How many companies do you provide services to? How many of these customers are located in the Aegean Region?

……
……

9. Which of the sectors below do you serve and by what percentage (%)?

- Textile
- Food
- Machine
- Construction
- Furniture
- Electronics
- Service
- Defense sector
- Pharmaceuticals
- Chemistry
- Plastics
- Automotive
- Leather
- Other

10. What portion (%) of your activities are carried on directed to the domestic/international market?

- Domestic Market .....
- International Market .....

11. Which transportation modes do you utilize during your operations (road/air/sea/railway)? What are the usage percentage of each one you utilize?

- Road % .....
- Air % .....
- Sea % .....
- Railway % .....

12. Do you utilize more than one transportation mode in one single operation (intermodal transportation)? What are the mode combinations that you usually use?

……
……

13. Could you please indicate the most frequently utilized departure and destination terminals for your operations?

	Departure Terminal	Destination Terminal
Road		
Railway		
Sea		
Air		

14. Please indicate the transported volumes for each load type:

□ Break bulk: …….
□ Liquid bulk: …….
□ Cargo: …….
□ Container: …….
□ Hazardous goods: …….
□ Other: .....

15. Does your company own any warehouses/ refrigerated warehouses / bonded warehouses? Please indicate their quantities, areas (m2), capacity usage rates, and locations.

	Quantity	Area(m2)	Capacity Usage Rate	Location
□ Warehouse				
□ Refrigerated Warehouse				
□ Bonded Warehouse				

16. Which of the following services does your company outsource?

□ Warehouse
□ Refrigerated Warehouse
□ Bonded Warehouse
□ Other

17. How much does your company outsource services of warehouses/ refrigerated warehouses / bonded warehouses?

		Warehouses	Refrigerated Warehouses	Bonded Warehouses
a.	100 m2 and less	□	□	□
b.	101 – 300 m2	□	□	□
c.	301 – 500 m2	□	□	□
d.	500 - 1000 m2	□	□	□
e.	1001 m2 and more	□	□	□

18. By how much do you foresee your warehousing needs will increase in the next 5 years?

		Warehouses	Refrigerated Warehouses	Bonded Warehouses
a.	% 0-10	□	□	□
b.	%11-20	□	□	□
c.	% 21-30	□	□	□
d.	%30 and more	□	□	□

19. Do you own your own fleet? Please indicate quantities and volumes.

□ Truck:
□ Refrigerated vehicle:
□ Ship:
□ Plane:
□ Wagon:

20. Please indicate the quantities and volumes of the vehicles you lease from other firms?

□ Truck:
□ Refrigerated vehicle:
□ Ship:
□ Plane:
□ Wagon:

21. Do you own your own container stocking area in the port? Please indicate the area (m2).

…….

22. Do you own your own container stocking area outside of the port?

…….

Appendix-2 Questionnaire for manufacturing firms

1. Which of the sectors do you operate in?

- Textile
- Food
- Machine
- Construction
- Furniture
- Electronics
- Service
- Defense sector
- Pharmaceuticals
- Chemistry
- Plastics
- Automotive
- Leather
- Other

2. What are the main product groups that you manufacture?

……
……

3. What is your firm's name? (optional)

…….

4. Which cities do you operate in?

……
……

5. For how many years has your firm been operating?

…….

6. How many employees does your firm have?

…….

7. What is your position in your firm?

…….

8. Which of the activities mentioned below do you insource/outsource?

	Insource	Outsource
Inventory management	□	□
Warehousing and bonded warehousing	□	□
Purchasing	□	□
Transportation activities	□	□
Refrigerated transportation	□	□
Hazardous goods transportation	□	□
Order management	□	□
Materials handling	□	□

Assembly	□	□
Packaging	□	□
Labeling	□	□
Logistics communications and information systems	□	□
Parts and service support	□	□
Return goods handling	□	□
Waste Processing	□	□
Departing transportation	□	□
Customs clearance	□	□
Arrival transportation	□	□
Customs brokerage	□	□
Agency services	□	□
Freight controlling	□	□
Pooling	□	□
Freight Consolidation	□	□
Consultancy services	□	□
Reverse logistics	□	□
Carrier selection	□	□
Main production activities	□	□
Branding and Labeling	□	□
Pricing	□	□
Returns and repairing	□	□
Information technologies	□	□
Fleet management	□	□
Order activities	□	□
Distribution controlling	□	□
Customer services	□	□
4PL services	□	□
Factoring	□	□
Supply chain integration	□	□
Other (please indicate):	□	□

9. What portion (%) of your activities are carried on directed to the domestic/international market?

□ Domestic Market .....

□ International Market .....

10. What portion of your production is made for imports/exports?

□ Imports .....

□ Exports .....

11. Which transportation modes do you utilize during your operations (road/air/sea/railway)? What are the usage percentage of each one you utilize?

□ Road % .....
□ Air % .....
□ Sea % .....
□ Railway % .....

12. Do you utilize more than one transportation mode in one single operation (intermodal transportation)? What are the mode combinations that you usually use?
……
……

13. Could you please indicate the most frequently utilized departure and destination terminals for your operations?

	Departure Terminal	Destination Terminal
Road		
Railway		
Sea		
Air		

14. Please indicate the transported volumes for each load type:
□ Break bulk: …….
□ Liquid bulk: …….
□ Cargo: …….
□ Container: …….
□ Hazardous goods: …….
□ Other: .....

15. Does your company own any warehouses/ refrigerated warehouses / bonded warehouses? Please indicate their quantities, areas (m2), capacity usage rates, and locations.

	Quantity	Area(m2)	Capacity Usage Rate	Location
□ Warehouse				
□ Refrigerated Warehouse				
□ Bonded Warehouse				

16. Which of the following services does your company outsource?
□ Warehouse
□ Refrigerated Warehouse
□ Bonded Warehouse
□ Other

17. How much does your company outsource services of warehouses/ refrigerated warehouses / bonded warehouses?

Warehouses	Refrigerated Warehouses	Bonded Warehouses

a.	100 m2 and less	□	□	□
b.	101 – 300 m2	□	□	□
c.	301 – 500 m2	□	□	□
d.	500 - 1000 m2	□	□	□
e.	1001 m2 and more	□	□	□

18. By how much do you foresee your warehousing needs will increase in the next 5 years?

		Warehouses	Refrigerated Warehouses	Bonded Warehouses
a.	% 0-10	□	□	□
b.	%11-20	□	□	□
c.	% 21-30	□	□	□
d.	%30 and more	□	□	□

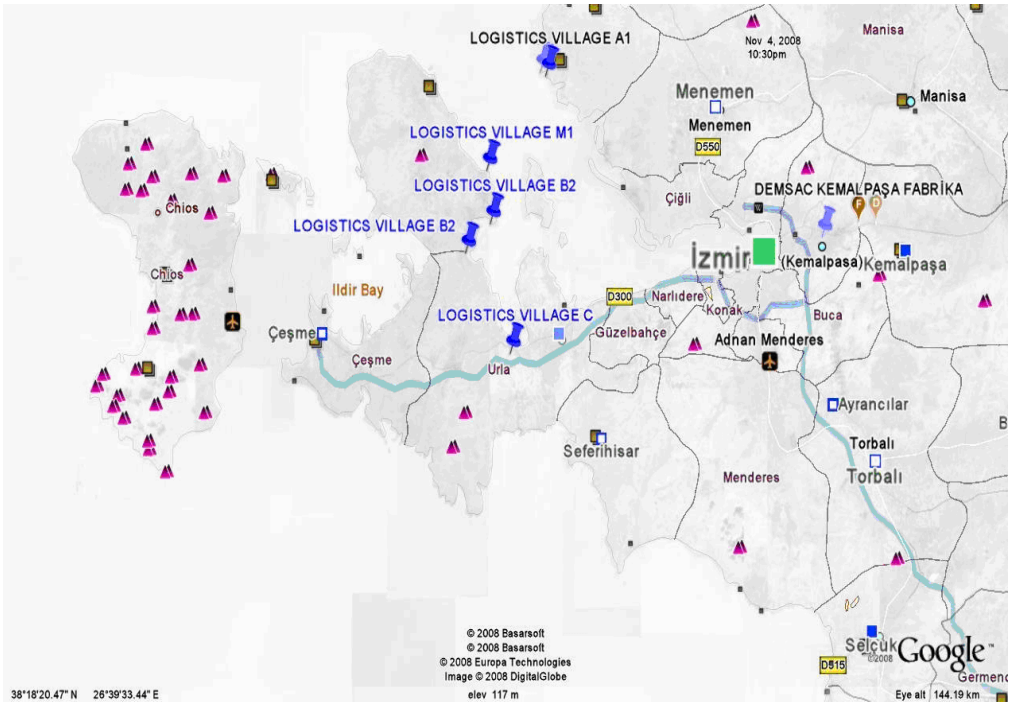
19. Do you own your own fleet? Please indicate quantities and volumes.

□ Truck:
□ Refrigerated vehicle:
□ Ship:
□ Plane:
□ Wagon:

20. Please indicate the quantities and volumes of the vehicles you lease from other firms?

□ Truck:
□ Refrigerated vehicle:
□ Ship:
□ Plane:
□ Wagon:

Appendix-3 Alternative Locations Map



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ÇAMLI YEM BESİCİLİK FEED PRODUCTION OPERATIONAL PLANNING

Hande Mavisu, Erman Güleyüz, Cihad Kocabıyık, Mehmet Sevici, Evren Keskin

Asst. Prof. Dr. Muhittin H. Demir

EXECUTIVE SUMMARY

In the beginning, we have been expecting a basic VRP solution for our problem, but when have got the data about the routes, truck capacities and so on, we have seen that there could have been additional solutions like traveling salesmen, heuristics and linear programming. We have had meetings with our academic advisor and we have learned that there could be different solutions to the problem.

In summary, we have focused on heuristic solution to reach full truck load for feed production distribution. We have applied heuristics to whole problem, looking at the main types of constraints (distances between points, full truck loads, time (weekly). We have also provided time schedule for Çamlı Yem Company. We have aimed at finding an easier and a more practical solution for the problem in order not to make the problem more complicated. We have assumed that the company owners could best solve their own problem on their own; we just needed to tell them the right method of the reaching the solution.

1. INTRODUCTION

1.1. General Overview of the Context

The problem was similar to Capacitated Vehicle Routing Problem. A set of identical vehicles were located at a central depot which were optimally routed to supply customers. Customers had demand which was known by the suppliers and which was subject to vehicle capacity constraints.

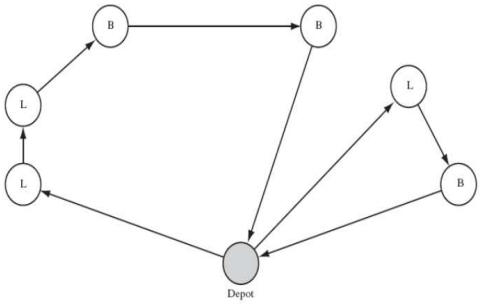
What is heuristics?

Heuristics is an adjective qualifying the methods that help in problem solving, in turn leading to learning and discovery. These methods in most cases employ experimentation and trial-and- error techniques. Heuristic method is particularly used to rapidly come to a solution that is reasonably close to the best possible answer, or the 'optimal solution'.

Intuitive Heuristics

In intuitive heuristics,

1. Load points are closest together on the same truck.
2. Build routes are starting with points farther from depot first.
3. Fill the largest vehicle to capacity first.
4. Routes should not cross.
5. Form teardrop pattern routes.



1.2 Motivation

- We have chosen this subject because we have thought that it would have been useful for our individual future works.
- We could have gained future experience.
- The company’s working area was interesting.
- We have had an interest to mathematical problems.
- We have cared that the solution could have been practical.
- The technical part of this project has been valuable; it would have helped us in our future careers.

1.3 Goals

Our main goal has been

- Trying to carry out some studies about planning and increase the company's profitability.
- Provide better information about business process, cost items and cost items' potential reduction.
- See what the related costs were
- Give a planning tool to the company.

We have had to determine some routes that could have helped us minimize the company's total distribution cost. Best route could have been providing the company with minimum cost, minimum distance, or minimum travel time. While these studies have been carried out, we have been trying to reach the company's profitability. We have required solving the supply chain system problem. The objective has been to make the delivery of products much more efficient and faster than usual. Thus, the company would have been one step ahead of the competition.

1.4 Company Background

Camli Yem, established in 1983, has united with Pinar Deniz Urunleri in 2003. It has been bounded to Yasar Holding since then. They have made first fish establishment in Turkey. It was the first application of fish feed production and feed production for farms.

2. PROBLEM DEFINITION

In this project, the problem was a vehicle routing problem in the supply chain. As expected, distribution performance has had a serious effect on all the processes in the supply chain. Moreover, it also has had a direct effect on the quality of service and had been increasing the transportation cost. The supply chain has been focusing on 50 changeable predetermined demand points with five different types of products. Demand at each point was assumed to be deterministic. Demand points may or may not involve storage silos for periodic replenishment. Deliveries to demand points were to be made using vehicles of varying capacities. The transportation mode was road transportation. Demand and number of vehicles were pre-determined.

Before the establishment of the solutions of the problem, we first have had to collect a lot of data concerning the demand points (locations), demand quantities, production capacity, vehicle capacity and capacity at customer locations.

We have focused on feed delivery from the central plant in Pinarbasi to various locations.

Çamlı has a manufacturing plant, producing five different types of products for 50 demand points. The company has been determining routes for every demand point using its seven trucks of different capacities, for a weekly known demand. The production capacity was infinite and the storage capacity has not been considered.

2.1 Challenges

The problem has never been worked on before in the literature. Collecting data has been a hard process for the team members. Number of demand points was quite high. The problem

has included storage capacities which made the problem analytically difficult. Production capacity was not considered - it was assumed to be infinite.
There could have been investments made for trucks because demands on the production needed more than five trucks of capacitated 22 tons. The company could have needed more than 22 tons of capacitated trucks.

3. LITERATURE REVIEW

We have aimed at finding the most suitable network for this problem by searching the academic literature, as well as several cases. Having obtained the data, we have decided that we could have solved the problem through vehicle routing, heuristics and modeling and optimization.

This problem could have been solved neither by VRP solution nor CVRP (capacitated vehicle routing problem). There must have been combined models.
VRP solution, especially, could have not been accepted for this problem, because the problem has had different types of capacities and CVRP could have not been used, because they have had weekly known demands. This problem was difficult like a VRP, CVRP. But the solution was expected to be interesting in the end.

Usage of the Heuristics:
There have been some cases that we have searched for and analyzed which have included heuristic solutions and heuristic implementation to the computer sciences, as well as the real life situations.
A Heuristic Approach towards Finding Ramsey Numbers:
In this case, there was an implementation for the increasing demand and the company required to decrease the disorder points and satisfy all the demand. They have assigned some symbols to demand points, showed all demand points on the graph and combined them with the arcs. They, then, have searched for the best routes for their existing distribution system.
This was the practical way for the companies to see the whole picture in order to be able to understand easily their total distances. The relation between the nodes gives them the weight of the arc and they could understand the most efficient way to combine the nodes. Landman, Bruce M., and Aaron Robertson.
Technical Communication
In the other case, there was an implementation for the computer science works. It was mentioned that the main characters of the case were legibility, arrangement, readability, pictures and illustrations, icons, and animations. The case combined them as the nodes and the weight of the relation, gave the arc importance and the weight of the arc is bigger they must assign that arc as a must. Williams, T. (2000).
Evaluating the Usability of an Online Learning System within a Public Sector Organization:
This case included the e-commerce (e-trade) contents which led them to reach more customers on the web. The web, as globally known, combines all materials on one base. If a piece of advertisement is sent to a customer, it is expected to reach more than an individual

because the message will be sent to the friends of the customer, as well. The implementation of the heuristic walkthrough proved to be rather problematic. As stated in the literature, a heuristic evaluation could have been proven to be difficult to be used.

4. APPROACH/METHODOLOGY

4.1 Approach

In the beginning of this project, a simplified version has been obtained (truck silos and production capacity have not been taken into account). Only the basic steps in the problem and its solution have been considered.

For this problem, two solution approaches have been set: exact and heuristics solutions.

Exact Solution

Mathematical algorithms have been looked at and worked on for this approach. Because of the complexity of the approach, it was decided to look at the exact solution in case of having enough time.

Heuristics Solution

Definition: An algorithm that usually, but not always, works or that gives nearly the optimum answer.

There are some advantages for this solution, namely:

- Fast and easy method
- More practical
- Helps gain detailed information
- Can be applied to similar problems (same character products)

First, the problem has been solved for only one product. Then, a weekly time schedule for trucks has been made. The problem has been solved step by step because it has been expected to help the team reach the solution more efficiently. Then this has been applied for all types of products. Different heuristic ideas has been found and implemented to the problem, and then compared with the solution. It has been concluded that the first implementation was more efficient than the others.

4.2 Methodology

After the process of searching and analyzing, it has been decided to bear heuristics solution which was applicable to the problem. We have moved along by getting into more complexity step by step. First, a single product type solution with its time window has been dealt with. Then, other types of solutions have been looked at. This method has helped the team continue the work easily.

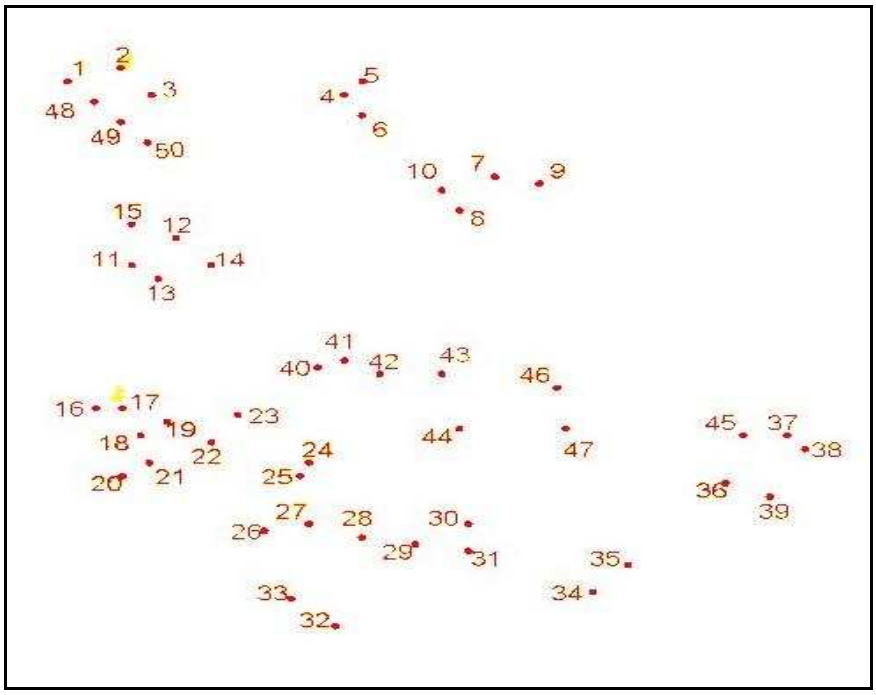
In the beginning, the solution area has been limited by the team. First, the simplest mode has been attached (plant, demand points, demands, routes etc.), and then, the constraints has been added to the problem (truck capacity, storage capacity etc.). Some of group members have looked at the exact solution and the others have dealt with heuristics solution. In the end, different effective heuristics solutions have been developed.

5. DATA COLLECTION AND ANALYSIS

Gathering Data: Unfortunately, an appointment with the Çamlı Yem Besicilik Company could have not been arranged, so the team has had to get the whole data from the academic advisor of the team.

To recall the data;

- The company has seven trucks, five of them of 22-ton capacity, and two of them of 17-ton capacity.
- The demand was known according to product types. (demand changes between 0 and 10)
- There were 50 demand points. (The longest demand point is Alaşehir, being 155 km away from Çamlı and the nearest demand point is Kemalpaşa, being 24 km away from Çamlı)
- Assumptions
- Speed of trucks was assumed to be 60 km/hr.
- Delivery time has also included 0.5 hr for truck loading.
- Fixed Cost= 50000 TL per truck
- Fuel cost per km=0.6 TL

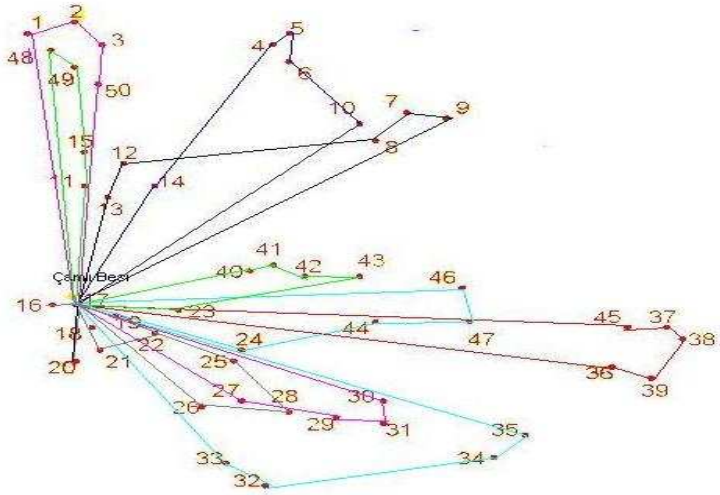


Demand Point	Demand (Tons/Week)					Storage Capacity (Tons)
	Product 1	Product 2	Product 3	Product 4	Product 5	
1	10	5	4	4	3	50
2	6	10	4	6	4	40
3	4	6	5	5	4	35
4	4	5	3	4	3	40
5	5	5	0	4	3	35
6	6	3	5	8	5	40
7	7	4	2	3	3	40
8	7	7	5	5	4	50
9	10	4	4	4	2	50
10	10	5	4	5	5	60
11	4	6	5	4	7	50
12	4	7	7	6	4	50
13	5	8	7	7	4	60
14	5	3	3	7	6	50
15	6	4	4	3	4	50
16	6	5	5	5	6	50
17	5	3	6	7	6	50
18	6	2	7	4	5	45
19	6	4	4	2	5	45
20	7	3	5	4	7	50
21	7	5	2	0	3	40
22	7	6	8	6	3	60
23	2	5	8	4	8	50
24	2	5	4	6	4	50
25	4	8	4	7	5	60
26	5	4	4	4	3	40
27	4	5	4	5	5	50
28	5	7	3	6	8	60
29	5	4	7	7	7	60
30	6	6	9	4	3	60
31	8	7	3	5	7	60
32	9	2	5	5	4	50
33	7	7	2	6	5	40
34	7	3	2	8	6	60
35	3	6	7	9	7	50
36	3	6	3	8	8	50
37	3	5	4	4	3	40

38	8	7	2	4	2	45
39	8	4	5	5	4	50
40	4	5	7	2	3	50
41	4	5	7	3	5	50
42	5	6	4	6	4	50
43	2	2	3	8	2	40
44	3	5	4	2	7	40
45	7	4	7	5	3	60
46	6	8	4	4	6	50
47	5	3	5	3	5	40
48	8	4	2	4	7	50
49	7	6	6	7	4	60
50	3	8	5	2	9	60

6. IMPLEMENTATION

The problem has been defined and the possible solutions of the problem have been planned. In the beginning, the plan has been set as to solve the problem in different ways. It has been decided that the solution method should have been similar to CVRP and the problem definition has been searched for and analyzed. Then, some different solutions have been focused on and application of heuristics solution was decided on. Data has been collected and analyzed. First, heuristics has been applied to one type of product. Then, a time schedule for Product type 5 has been made.



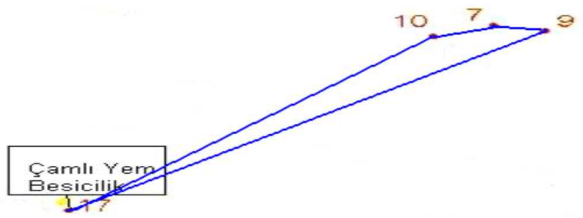
The figure above has been prepared by the team in the previous semester for the fifth product type and all truck types have been used for distribution. It was our idea regarding a heuristic of 13 clusters and 8 of them has made full truck loads. Our trucks were not overloaded and

we have satisfied demands efficiently. A time window-schedule for the trucks considering capacities has been determined.

Product Type 5				
REGIONS(ROUTE)	**TRUCK No.**	**TRUCK CAPACITY**	**TOTAL DIST.**	**DEMANDS IN ORDER**
14-4-5-6-10	*1*	*22*	*260*	*6+3+3+5+5=22*
48-49-15-11	*2*	*22*	*206*	*7+4+4+7=22*
1-2-3-50	*3*	*22*	*251*	*3+4+4+9=20*
12-13-7-8-9	*4*	*17*	*231*	*4+4+3+4+2=17*
45-37-38-36-39	*5*	*22*	*318*	*3+3+2+8+4=20*
24-44-47-46	*6*	*22*	*230*	*4+7+5+6=22*
23-40-41-42-43	*2**	*22*	*193*	*8+3+5+4+2=22*
33-32-34-35	*6**	*22*	*264*	*5+4+6+7=22*
27-29-30-31	*3**	*22*	*250*	*5+7+3+7=22*
25-26-28	*7*	*17*	*160*	*5+3+8=16*
17-19-22-21	*7**	*17*	*80*	*6+5+3+3=17*
18-20	*4**	*17*	*50*	*5+7=12*
16-	*7**	*17*	*10*	*6*

Time Window of Trucks							
Truck Numbers	*1(22 t)*	*2(22t)*	*3(22t)*	*4(17t)*	*5(22t)*	*6(22t)*	*7(17t)*
leave (MONDAY)	00:00	00:00	00:00	00:00	00:00	00:00	00:00
arrive	05:20	04:25	04:50	04:50	06:20	04:50	03:50
leave		04:55	05:20	05:20		05:20	04:20
arrive		08:35	10:10	06:40		10:10	06:00
leave							06:30
arrive							07:10

Implement for all demand points for all product types.



For Truck Number #

	Demand point	Product Types
Çamlı	***17***	start point
	10	***3***
	7	***1,2,3,5***
	9	***5***

Demand Point has taken its orders in this cluster 1,2,3,5, but there has been a missing demand order (4).
So Point 7 has taken its order in another cluster-(6-1,2,3,5)+(7-4)=22, having looked at the routes table.
For now, this heuristics solution has been applied to all demand points. To recall the problem, there were 50 demand points and five product types. These have been shown on the images. Full truck loads have been looked for. Usually, trucks of 22-ton capacity have been used for all demand points. That has shown that trucks of 17-ton capacity were not necessary for usage. Therefore, it has been concluded that the company could have changed the 17-ton capacity trucks with 22-ton capacity trucks. It will be mentioned in the following part of the Project (Results and Analysis).

7. RESULTS AND ANALYSIS

This figure shows the demand points, product types and truck tonnages which we used full-truck load

(1-1,2,3,5) =22 tones (2-1,2,4) =22 t.
(1-4)+(2-3,5) =22t. (3-1,2,5)+(48-1) = 22t.
(48-2,3,4,5)+(50-3)=22 (50-1,2,4,5)=22t.
(49-3,4,5)+(11-3)=22t. (49-1,2)+(15-1,4)=22t.
(5-1,2,4,5)+(4-2)=22t. (4-1,3,4,5)+(6-4)=22t.
(6-1,2,3,5)+(7-4)=22t. (9-1,2,3,4)=22t.
(7-1,2,3,5)+(9-5)+(10-3)=22t.(in the example)
(10-1,2)+(8-1)=22t. (8-2,3)+(10-4,5)=22t.
(8-4,5)+(14-4,5)=22t. (38-4,5)+(39-2,4,5)+ (36-3)=22t.
(37-1,3,4,5)+(39-1)=22t. (36-1,2)+(39-1,3)=22t.

(36-4,5)+(47-2,4)=22t. (45-1,3,4,5)=22
(47-1,3,5)+(45-2)+(44-1)=22
(35-1,2,3)+(34-5)=22 (35-4,5)+(30-2)=22
(34-1,2,3,4)+(24-1)=22 (31-1,2,5)=22
(31-3,4)+(29-4,5)=22 (30-1,3,4,5)=22
(29-1,2,3)+(28-4)=22 (26-4,5)+(28-1,2,3)=22
(46-2,3,4)=22 (46-1)+(44-2,3,5)=22
(42-1)+(43-1,2,3,4,5)=22 (42-2,3,4,5)+(40-4)=22
(40-3)+(41-3,4,5)=22 (40-2,5)+(41-1,2)=22
(40-1)+(23-1,3,5)=22 (15-2,3,5)+(12-4,5)=22
(12-1,2,3)+(11-4)=22 (32-4,5)+(33-3,4,5)=22
(33-1,2)+(26-2,3)=22 (25-4)+(27-2,4,5)=22
(25-3,5)+(26-1)+(27-1,3)=22
(24-4)+(28-5)+(25-2)=22
(25-1)+(24-2,3,5)+(21-2)=22 (22-1,2,4,5)=22
(19-1,3)+(22-3)+(23-4)=22
(11-1,2,5)+(13-1)=22 (13-2,3,5)+(14-3)=22
(13-4)+(14-1,2)+(17-4)=22
(16-1,2,3,5)=22 (20-1,2)+(21+1,3,5)=22
(18-2,4)+(20-3,4,5)=22
(17-2)+(18-3,5)+(19-4,5)=22
(16-4)+(17-1,3,5)=22 (19-2)=4

Have totally: 58 routes to satisfy the whole demand.

Main ideas:

1. Make use of demand clusters
2. Try to construct full truck loads
3. Can use multiple demand points to fill one truck

TIME WINDOW FOR ÇAMLI YEM BESİ FEED PRODUCTION(FOR FIVE PRODUCTION TYPE-FIVE TRUCK)

(22 TONS OF CAP.)		T1	T2	T3	T4	T5
Monday	00:00	03:15	03:30	04:30	04:00	03:45
		03:45-05:35	04:00-7:00	05:00-09:15	04:30-8:45	04:15-07:15
		06:15-11:15	07:30-10:30	09:45-13:15	09:15-12:45	07:45-10:45
		11:45-17:15	11:00-14:15	13:45-18:45	13:15-18:15	11:15-16:30
		17:45-23:30	14:45-19:45	19:15-23:30	18:45-23:00	17:00-21:30
			20:15-22:15		23:30-02:30	22:00-02:00
			22:45-01:00			
Tuesday	00:00	00:00-03:00	01:30-04:15	00:00-03:00	03:00-05:15	02:30-06:00
		03:30-05:45	04:45-07:30	03:30-05:45	05:45-08:00	06:30-09:30
		06:15-08:30	08:00-11:00	06:15-08:30	08:30-11:30	10:00-14:15
		09:00-12:00	11:30-12:45	09:00-12:45	12:00-14:30	14:45-17:15
		12:30-14:30	13:15-15:15	13:15-15:15	15:00-16:40	17:45
		15:00-15:55	15:45-17:05	15:45-18:05	17:10-17:55	
		16:25-18:00	17:35	18:45	18:25	
		18:30				

TIME WINDOW FOR ALL PRODUCT TYPES AND TWO (2) TRUCKS (22 TONS OF CAP.)

		Truck1	Truck2
Monday	00:00	03:15	03:30
		03:45-07:30	04:00-07:30
		08:00-11:15	08:00-09:30
		11:45-14:45	10:00-13:00
		15:15-20:15	13:30-17:45
		20:45-00:45	18:15-21:15
			21:45-01:15
Tuesday		01:15-04:45	01:45-05:00
		05:15-10:30	05:30-11:00
		11:00-16:00	11:30-16:30
		16:30-21:30	17:00-21:30
		22:00-03:15	22:00-02:15
Wednesday		03:45-08:00	02:45-07:00
		08:30-12:30	07:30-09:30
		13:00-16:00	10:00-13:15
		16:30-19:30	13:45-16:45
		20:00-22:15	17:15-20:45
		22:45-01:00	21:15-23:30
Thursday		01:30-03:45	00:00-02:45
		04:15-06:30	03:15-05:30
		07:00-10:00	06:00-09:00
		10:30-12:30	09:30-12:30
		13:00-17:15	13:00-15:45
		17:45-19:00	16:15-18:45
		19:30-21:30	19:15-21:15
		22:00-00:30	21:45-23:45
Friday		01:00-02:40	00:15-01:10
		03:00-04:45	01:40-03:20
		05:15-06:30	03:30-04:50
		05:15-06:30	05:20

The heuristics solution has been worked on with assumed demand points, truck capacities and combined product types.
Full truck loads have been made.
A large scale of time schedule has been created.
Total Distance: 9740 km
Total loading-unloading time: 87 hours
Variable Cost: 5844 TL per week expense fuel consumption
If the demand does not change: 303,888TL variable cost in total, per year.
Total routes: 58
Two trucks spend 121 hour and 45 minutes for delivery.
Total fixed cost for 7 trucks is 350.000 per year (50.000 TL/per truck).
Two trucks of 22-ton capacity have been used. It was assumed that a decrease in the total cost with necessary trucks could be provided. Because of this, trucks of 17-tons capacity have not been used.
Two trucks have been enough to supply the demand; therefore, the company could have stopped renting these insufficient trucks. This helps the company decrease the rent cost, as well as the total cost.

8. PROJECT EVALUATION

In the first term, our group has worked on expectations of our academic advisor Muhittin Demir. We have made a research from our text book and also searched for the solution ways

for that problem if there was one solution on the web or on some of case studies. In the beginning, we have had a more specific and a more complicated data. We have had to decrease the amount of data to be able to reach the solution easily. We have found some mathematical models but they had not fit our problem (like traveling sales man, VRP, etc). For that problem there must have been a combined model to understand the whole data. There were capacities of trucks, of production, and also of the demand points. So, the project has turned out to be more complicated at that point.

So we have ended up with a better and more practical solution; 'heuristic idea'. We have only done the fifth product type for all demand points and our academic advisor has helped us reach some of the specific data like map, demand orders, truck fixed costs and also variable costs, distances between the demand points (only distances between Çamlı Yem Besi demand point 17 to other demand points). This has led us to find the other distances to reach the solution.

8.1Contribution to Our Group:

This project has led us understand the meaning of `heuristics`, as well as to understand that heuristic idea was being used in different ways of technological parts of the web, pc's, and also real life relations between two situations. We have also learned how to prepare professional reports and presentations and how to present them. We have understood how to reach the information and how to work in a group.

8.2 Performance of Team:

The performance of the team was neither so high nor so low. The most important reason of this as we could have put it, was the difficulty of gathering people together. We were five members in our group. Mehmet Sevici was looking at our web site and searching for data for the Çamlı Yem Besi Company. Hande Mavisu was working on the team book and was trying to get us together as she could. Evren Keskin was working on writing the data on the documents. Erman Güleryüz and Cihad Keskin were working on the mathematical models and as well as working on the heuristic ideas to find the best one. In the end, we have come up with the easier solution with Heuristic idea.

8.3 Performance of Academic Advisor:

The advisor of our team was Muhittin Demir. He has shared all his knowledge with us for the success of this project. Our academic advisor has given us ideas about the solution ways and led us to understand the whole picture of the problem.

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WAREHOUSE DESIGN
EGE DURU LOGISTICS

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Asst. Prof. Dr. Burcu Adıvar

Our project is about the design of warehouse for Ege Duru Logistics. Ege Duru Logistics is the logistics company of Ege Duru Marketing A.S, which is a member of the Duru Group. After the Kemalpasa warehouse fire, they have continued to work in another warehouse facility in Pinarbasi. Their concerns were satisfying the customers and continuing to make profit. At that situation making profit was too difficult because they have had large operational costs because of this sudden change and the biggest cost they have faced right now was the rent of the Pinarbasi warehouse.

1. INTRODUCTION

Our project is about the design of warehouse for Ege Duru Logistics. Ege Duru Logistics is the logistics company of Ege Duru Marketing A.S, which is a member of the Duru Group[3] and it operates its activities with more than 180 employees and 100 vehicles in the cities of Izmir, Manisa, Aydin, Denizli and Mugla and the districts of these cities. The company's main scope is to realize marketing and the sales of basic food items, personal care products, cleaning products and other consumption products which totally make around 2,200 types of products. Ege Duru Marketing serves approximately 5,500 points. The company is located in Kemalpasa, Izmir, and has a facility with a total area of 16,300 m2 (3500m2 closed area) and modern automation systems are used to carry on its operations.

In 2007, the warehouse which was used to store food and cosmetics products, in the Kemalpasa district of Izmir, was faced with a fire disaster. Despite the intervention of a large number of firefighters in the burning warehouse, approximately 5 million TL of financial damage was reported. Now, they are serving in a rented warehouse in Pinarbasi, while they try to rebuild the burned down warehouse in Kemalpasa, in a way that has better standards and that has an ability to give better service to customers.

2. PROBLEM STATEMENT

After the Kemalpasa warehouse fire, they have continued to work in another warehouse facility in Pinarbasi. Their concerns were satisfying the customers and continuing to make profit. At that situation making profit was too difficult because they have had large operational costs because of this sudden change and the biggest cost they have faced right now was the rent of the Pinarbasi warehouse.

The newly rented warehouse was a tobacco manufacturing facility. There was a huge tobacco handling machine in the middle of the facility and the aisles were too narrow. They were not using forklifts in the warehouse. Also the warehouse has had no information technology infrastructure such as RFID or barcode. Every operation has been carried out manually. First of all, we have analyzed the whole processes and transactions of Ege Duru Logistics in order to understand how the loading/unloading operations have been carried out. After understanding how their system was working, we have defined where and why the problems were occurring and we have done some research for academic papers and cases which could have been related to our problem, in order to help us in finding solutions for these problems. We have believed that these cases would have been very useful during our project because these problems were common problems that have been faced in different companies and some of these cases were actually applied in real life to solve these kinds of problems. We have tried to apply the formulations and mathematical problems in the academic papers to solve the problem of Ege Duru Logistics.

[3] Detailed information about Duru Group can be reached at: http://www.egeduru.com.tr/

3. OBJECTIVES

Like in every project, we have needed to define things we have required to achieve (goals), and the actual status as well as the constraints in which the warehouse design must fit, in order for our project to be in line with reality. If we haven't had the goals and constraints articulated and understood, we wouldn't have been able to achieve a successful design, and decide whether the design was successful or not.

As the warehouse design has progressed, goals have become more detailed and were applied to smaller "building blocks" of the overall design. Constraints were better understood, and they have given rise to goals. These goals then have become the specifications for equipment that was necessary in the warehouse and processes, all of which has had a role in making the design successful. We have taken the information and placed them in the formula and tried to find out the answers to these questions: "How many doors should have been there?", "Which type of warehouse would have been better for Ege Duru Logistics?", "How many shelves should the new warehouse have had?", "How many zones would have been there in the warehouse, and how would these zones have been located in the warehouse?", "The height, length and width of the warehouse".

A complication in the project was that Ege Duru Logistics has already started the project themselves but they were doing things by traditional ways. But the traditional way was not necessarily the best way. With the support of academia, we have analyzed the results of Ege Duru Logistics' efforts and showed them the best solution supported by scientific results. The results of the project could have been separated into two perspectives. In the first perspective, we have been able to gain experience in the real business area. As a result of having experience in such a process like re-engineering in a global company, we would have differed from our colleagues when we have started working. In the second perspective, the company has developed its current system and now has a more effective system that has allowed them to carry on their shipments in a more efficient way. Also this project would have proven to be helpful for the company in the financial basis for the long-term.

4. METHODS

We have divided our methods into the following steps:

1. Following the processes in the current logistics operations.
2. Gathering necessary data (trucks' size, material types, sizes of pallets, truck capacities, the weight and volume of the warehouses, weekly/monthly loading averages for specific destinations, time interval between ordering and loading processes, types of products, names of the customers, SKUs).
3. Going to the operation area and viewing the current warehouse.
4. Talking with the managers and trying to learn their needs and demands.
5. Gathering the necessary data for the warehouse design.
6. Adapting the data to fit our formulas and compare, contrast with the current system.

7. If our system has been more advantageous for the company trying to develop it. If not, getting feedback.

5. QUALIFICATIONS

Our team has met most of the qualifications required to successfully manage this project. We have all had experience in project management, analyzing and transforming data in the appropriate format, work experience in the logistics sector, computer and communication skills.

Ege Duru Logistics is the logistics company of Ege Duru Marketing A.S, which is a member of the Duru Group and it operates its activities with more than 180 employees and 100 vehicles in the cities of Izmir, Manisa, Aydin, Denizli and Mugla and the districts of these cities. The company's main scope is to realize marketing and the sales of basic food items, personal care products, cleaning products and other consumption products which totally make around 2,200 types of products. Ege Duru Marketing serves approximately 5,500 points.

Their customers are:
- Reckitt Benckiser (Calgon, Kosla, Marc)
- Tukas Food A.S. (Tukas)
- Evpas Evyap (Duru, Arko,)
- Dogus Cay
- Diageo (JBJW)
- Karpak Packaging A.S. (Karcay)
- Kurukahveci Mehmet Efendi
- Pasabahce
- Fora Olives

Besides serving these customers, Ege Duru is the distributor of Eczacibasi marketing at Izmir, Aydın and Denizli for the products of Ipek Kagit (Sile, Selpak, Solo). The company is located in Kemalpasa, Izmir, and has a facility with a total area of 16,300 m2 (3500 m2 closed area) and modern automation systems are used to carry on its operations. Ege Duru Marketing is working close to its customers, increasing the number of sales every day either by making the delivery just after taking the orders or being with retailers at the moment of hot sales aiming the policy of working as close to the customer as possible.

Designing and Operating a Warehouse
Overview
Warehouses, as defined here, are facilities that provide a proper environment for the purpose of storing goods and materials that require protection from the elements. Warehouses must be designed to accommodate the loads of the materials to be stored, the associated handling equipment, the receiving and shipping operations and associated trucking, and the needs of the operating personnel. The design of the warehouse space should be planned to best

accommodate business service requirements and the products to be stored/handled. The economics of modern commercial warehouses dictate that goods are processed in minimal turnaround time.

Ownership

With respect to ownership, there are three main types of warehouses.

Company-owned warehouses require a capital investment in the storage space and in the material handling equipment. They usually represent the least-expensive solution in the long run in the case of a substantial and constant demand. Moreover, they are preferable when a higher degree of control is required to ensure a high level of service, or when specialized personnel and equipment are needed. Finally, they can be employed as a depot for the company's vehicles or as a base for a sales office.

Public warehouses are operated by firms providing services to other companies on a short-term basis. As a rule, public warehouses have standardized equipment capable of handling and storing specific types of merchandise (e.g. bulk materials, temperature- controlled goods, etc.). Here, all warehousing costs are variable, in direct proportion to the storage space and the services required. As a result, it is easy and inexpensive to change warehouse locations as demand varies. For these reasons, public warehouses can suitably accommodate seasonal inventories.

Finally, *leased warehouse space* is an intermediate choice between short-term space rental and the long-term commitment of a company-owned warehouse.

Costs

The total annual cost associated with the operation of a warehouse is the result of four main activities: receiving the products, holding inventories in storage locations, retrieving items from the storage locations, assembling customer orders and shipping. These costs depend mainly on the storage medium, the storage/retrieval transport technology and its policies. As a rule, receiving the incoming goods and, even more so, forming the outgoing lots, are operations that are difficult to automate and often turn out to be labor-intensive tasks. Holding inventories depends mostly on the storage medium, as explained in the following. Finally, picking costs depend on the storage/retrieval transport system which can range from a fully manual system.

Structure and operations

The structure of a warehouse and its operations are related to a number of issues:

- The physical characteristics of the products (on which depends whether the products have to be stored at room temperature, in a refrigerated or ventilated place, in a tank, etc.)
- The number of products (which can vary between few units to tens of thousands);
- The volumes handled in and out of the warehouse (which can range between a few items per month to hundreds of pallets per day).

Typically there are;

- One or more *receiving zones* (each having one or more rail or truck docks), where incoming goods are unloaded and checked;
- A *storage zone*, where SKUs are stored;
- One or more *shipping zones* (each having one or more rail or truck docks), where customer orders are assembled and outgoing vehicles are loaded.

The storage zone is sometimes divided into a large *reserve zone* where products are stored in the most economical way (e.g. as a stack of pallets), and into a small *forward zone*, where goods are stored in smaller amounts for easy retrieval by order pickers. The transfer of SKUs from the reserve zone to the forward zone is referred to as replenishment. If the reserve/forward storage is well-designed, the reduction in picking time is greater than replenishment time.

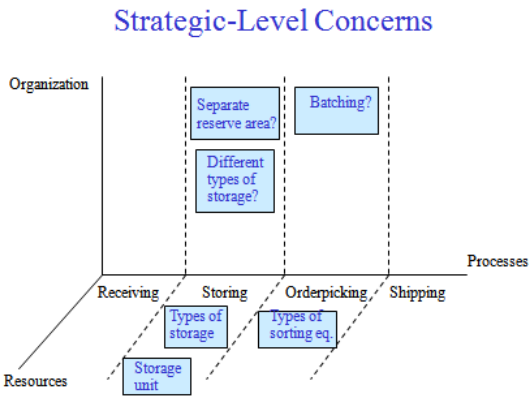
Storage media

The choice of a storage medium is strongly affected by the physical characteristics of the goods in stock and by the average number of items of each product in a customer order. Briefly, when storing solid goods three main alternatives are available: stacks, racks and drawers. In the first case, goods are stored as cartons or as pallets, and aisles are typically 3.5–4 m wide. Stacks do not require any capital investment and are suitable for storing low-demand goods, especially in reserve zones.

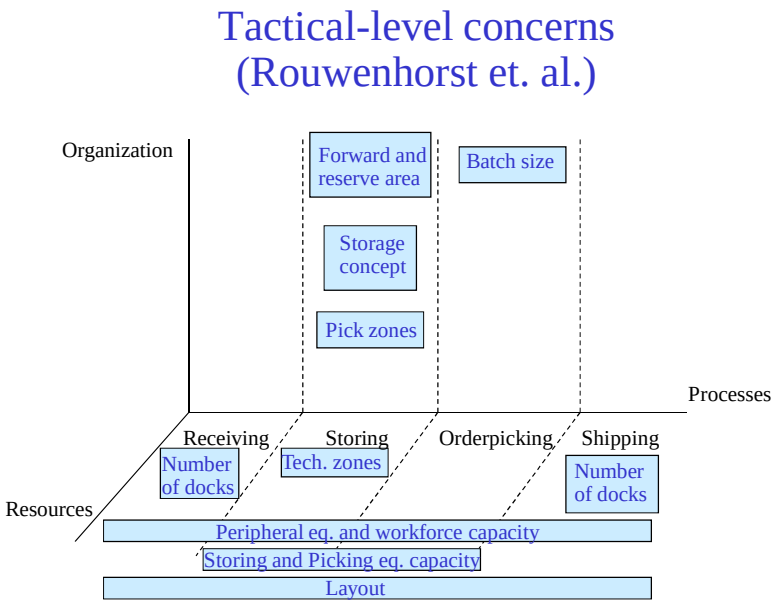
In the second case, goods are stored as boxes or pallets on metallic shelves separated by aisles. Racks are usually 5–6 m tall and aisles are around 3.5 m wide. Racks are typically 10–12 m tall and aisles are usually 1.5 m wide. Finally, in the third case, items are generally of small size (e.g. metallic small parts), and are kept in fixed or rotating drawers.

During the establishment of a new warehouse or upgrading of an old one, the company will face some problems. There are lots of questions that have to be answered. If the problem complexity is defined; there'll be three important points as listed below:

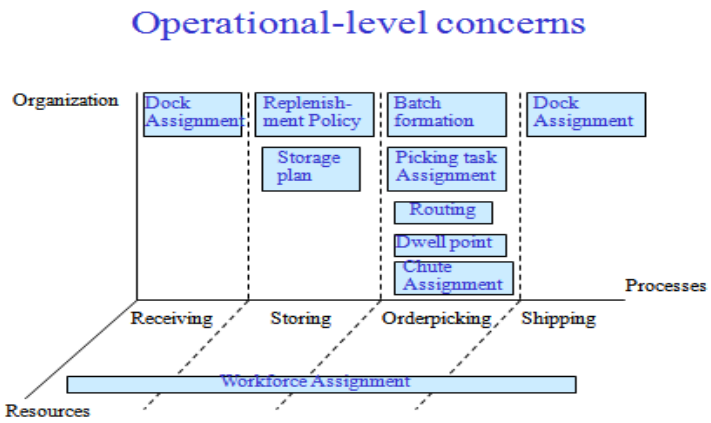
1. Strategic –Level Decisions: They have the longer-lasting impact on the operation of the warehouse, and involve major establishment. Process flow design and equipment selection are some of the criteria.



2. Tactical-Level Decisions: Medium-term decisions which might still involve significant investments. Sizing of the facility areas and its equipment, storage layout, resolution of organizational issues like the storage and replenishment schemes, and batching size are some of the criteria.



3. Operational-Level Decisions: Decisions and policies related to the real-time operation of the facility. Assign and control problems of people and equipment is one of the criteria that has to be decided.



Warehouse Design

Warehouses should:

- Be designed based on current and future needs.
- Facilitate changes in business/agency growth, and size/population of office and warehouse spaces within the building. Warehouse space should be easily adapted to new functions such as office (on ground or upper levels), computer centers, or light industrial/fabrication.
- Accommodate need for future loading docks, truck space, and car parking spaces if space configuration changes through effective site design.
- Address material handling technologies and business practice, such as "just-in-time" storage, which have fundamentally changed operation of warehouses and distribution centers, and will continue to do so.
- Include roof design with built-in extra structural capacity to handle addition of future rooftop equipment.
- Be designed with fire protection capacity to accommodate storage of materials with a greater fire hazard, especially needed with high plastic product content or packaging, and plastic shrink-wrapped pallets.
- Maximize utilization of space while providing adequate circulation paths for personnel and material handling equipment such as forklift trucks.
- Use higher bays to take advantage of height allowances in the space.
- Optimize layout and configuration for the warehouse operation, including efficient circulation and material handling and storage processes.
- Relate interior and exterior receiving and shipping operations to the process flow of goods through the warehouse.
- Receiving and shipping are best separated to avoid congestion at the loading dock areas in the building, and in the truck maneuvering areas.
- Alternative material handling methods will determine other building aspects, such as aisle widths, lighting design, need for mezzanine space, fire protection, and egress design. Businesses will often use different methods of storage handling simultaneously for different products.

Designing a warehouse means to deciding which type of shelves will be used, how the layout and the equipment will be. The main design decisions are; deciding on the length, width and height of shelves, locating and sizing the receiving, shipping and storage zones, deciding on the storage capacity and also how the storage/retrieval transport mechanisms will work. Design of the warehouse has to fit the firm’s needs and also has to decrease expected annual costs and should be subject to an upper bound on capital investment. There are lots of design alternatives but in the real life all of them don’t fit the firms and some design decisions are intertwined.

Selecting the storage capacity and storage/retrieval transport mechanism

Decision of the storage and retrieval systems is influenced by the physical characteristics of the goods which refer to their packaging at the arrival and the composition of outgoing lots. In the storage zone palletized goods are stocked on the racks because there is a high demand to that product if not they are stocked in stacks. If there is automation and if the goods are identified in the system, then it is available for automated-computer based systems. But the setup cost for such a system is quite high.

Sizing the receiving and shipment

To avoid traffic congestion which could occur in the loading step; the receiving zone has to be larger than the shipping area. This is not under the control of the warehouse management. So number of truck docks is important.

There is a Formula to determine the number of docks

nD refers to number of docks,

d refers to daily demand of specific product,

q refers to truck capacity, and

T refers to time for loading/unloading activities in one day period.

$$n_{\mathrm{D}} = \left\lceil \frac{dt}{qT} \right\rceil$$

Ege Duru Logistic Company has handled a wide range of products. There was no constant number for the goods which have been loaded into the boxes. In a box, there were usually 4, 8 or 12 pieces. This number has depended on the specific volumes and types of the products. For example, cosmetics were small goods and there were 12 pieces in one box.

The company has worked between 8.00am-18.00pm. But there were also shifts after 18.00pm. We could have mentioned that they were sometimes working more than 14 hours a day. They have had special and privileged customers and they might have served them after the day-shift. So, they were almost working 10 hours a day on average, which has equaled to 600 minutes.

During our meeting at Ege Duru Logistics, we were able to explore their stock systems and amount of stock movement and their stock capacity. There have been huge numbers of stock flow but for us, the priority was to apply the theoretical knowledge into practice and we have reduced the stock flow information in a busy day. The exact dates were 13-14 April 2009. On those days, 97,697 units of products were loaded onto trucks. If we were to calculate the total number of boxes, considering the fact that a box usually has carried 12 units of products, 8,141 boxes were loaded onto trucks.

We have spoken to a worker and he has told us that a truck's capacity was 33 pallets and that loading one pallet has taken 1.5 minutes, therefore the whole loading activity has taken 45 minutes for one truck.

Ege Duru Logistics' daily demand was d=97,697 units which has referred to 8,141 boxes. Loading a truck has taken 45 minutes. They were working ten hours=600 minutes in one day.

So; for example for Tukas if daily demand was d=30000 unit which has referred to 900 boxes. And loading this 900 boxes has taken t =300 minutes and if it has taken 20 working hours

nD = $\frac{97697 \times 600}{8141 \times 45}$ =12 doors has to be presented at the facility.

Determining the capacity of a storage area

The size of a storage area depends on the storage capacity. It means each product is assigned to a pre-established-position. This study was easy to implement but would have caused an underutilization of the storing capacity, in fact the space required was equal to the sum of the maximum inventory of each product in time. This study is called as the dedicated storage policy.

n refers to number of product,

Ij(t) refers to the inventory level of item j at time t (j=1,…..n), and

md refers to the number of required storage location.

$$m_{\mathrm{r}} = \max_{t} \sum_{j=1}^{n} I_j(t) \leqslant m_{\mathrm{d}}$$

In a random storage policy product allocation is decided in a very active way which depends on the warehouse occupation, future arrival and request forecast. In this case the number of storage location is mr.

$$m_{\mathrm{d}} = \sum_{j=1}^{n} \max_{t} I_j(t)$$

Random storage policy allows a higher utilization of the storage space, but requires that each item will be automatically identified with barcode, RFID, and a database, indicating its current position. In this situation, stock information has to be updated at each inventory and every retrieval activity.

EGE DURU LOGISTICS				
LOCAL SHIPMENT ROUTE PLAN				
No	Route 1	Route 2	Route 3	Route 4

1	Alsancak	Pınarbaşı	Bayraklı	Gültepe
2	Kahramanlar	Işıkkent	Yamanlar	Toros
3	Karataş	Doğanlar	Örnekköy	Levent
4	Mithatpaşa	Altındağ	Gümüşpala	İşçi Evleri
5	Hatay	Yeşilova	Karşıyaka	Şirinyer
6	Bahçelievler	Çamdibi	Çiğli	Karabağlar
7	Poligon	Mersinli	Alaybey	Beyaz Evler
8	Göztepe	Koşukavak	Bostanlı	Gaziemir
9	Yeşilyurt	Bornova	Cumhuriyet Mah	Buca
10	Eski İzmir	Manavkuyu	Egekent	Menderes
11	Narlıdere	Atatürk Mahallesi	Evka 2	Sarnıç
12	Balçova	Evka 3	Evka 5	Kaynaklar
13	Limontepe	Evka 4	Balatçık	Akıncılar
14	Esentepe	Osmangazi	Şemikler	Zeytinlik

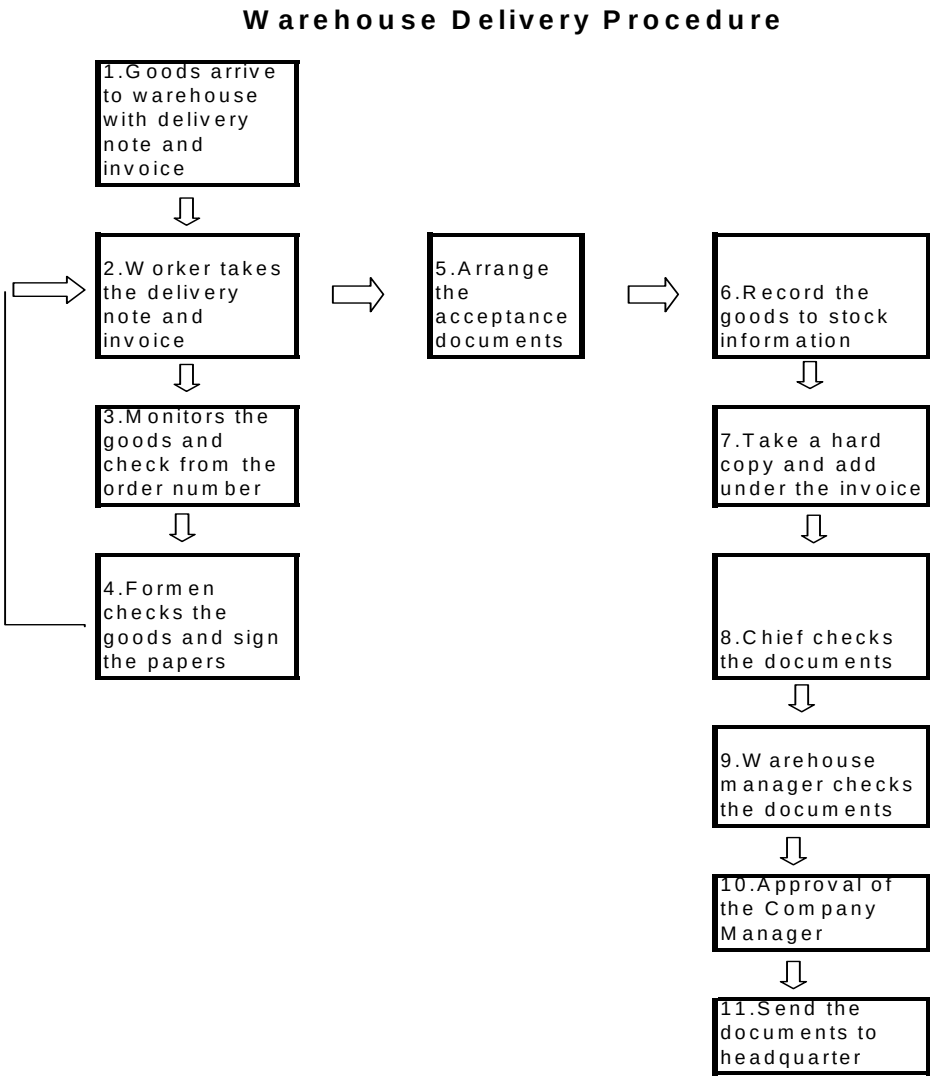
15	Güzelbahçe		Mavişehir	Kozağaç
16	Çimentepe			Gediz
17	Bozyaka			
18	Kadifekale			
19	Eşrefpaşa			
20	Ballıkuyu			

EGE DURU LOGISTICS

CITY SHIPMENT ROUTE PLAN

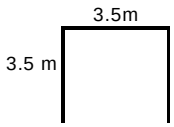
No	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	Turgutlu	Torbalı	Menemen	G.Bahçe	Tire	Urla
2	Ahmetli	Bayındır	Aliağa	Urla	Torbalı	Seferihisar
3	Alaşehir	Ödemiş	Eski Foça	Mordoğan	Selçuk	Gümüldür
4	Sarıgöl	Beydağ	Yeni Foça	Karaburun	Kuşadası	Ürkmez
5	Kula	Kiraz	Dikili	Çeşme	Söke	Özdere
6	Ortaklar	Köprübaşı	Çandarlı	Ortaklar	Didim	Manisa
7	Germencik	Demirci	Bergama	Germencik	Milas	Saruhanlı
8	İncirliova	Gördes	Manisa	Aydın	Bodrum	Gölmarmara
9	Aydın		Saruhanlı	Umurlu		Akhisar

10	Umurlu		Gölmarmara	Köşk		Kırkağaç
11	Köşk		Akhisar	Sultanşehir		Soma
12	Sultanşehir		Kırkağaç	Nazilli		Kınık
13	Nazilli		Soma	Denizli		
14	Bozdoğan		Kınık			
15	Denizli					



6. CONCLUSION

The data which was given to Ege Duru Logistics has been prepared by traditional ways by a company which is under the Ege Duru Holding structure. They have been told that the warehouse would have been type I. There would have been a total of eight doors for incomings and outgoings. Door's volumes would have been:



The new warehouse would have been located in Kemalpasa for 3,070 m2 with 9m height. The company has decided to use back-to-back shelf system, and the properties of the shelves would have been as follows:

4 levels of shelves,
9 line of shelves
Base level 2 m high
First level 1.6 m
Second level 1.6 m
Third level 1.6 m
Gap for ceiling 2.20

→ a total height of 9 m.

There would have been special forklifts, called reach-trucks which could have reached 7m high in the warehouse. The reach-truck's maximum speed was 18-20km but in the warehouse, the speed limit would have been 8-10km.

One truck's pallet capacity was 33 pallets and one pallet has contained approximately 48 boxes.

One pallet could have been loaded in 1.5 minutes by the reach-truck operators. 33 pallets x 1.5 minutes = ~ 45 minutes. So it has taken approximately 45 minutes to load one truck.

In 13-14 April 2009, 83,814 units of goods were loaded onto trucks, which have been translated into 6,985 boxes. And also there were some stock-out cases. The total shipment in that day has meant 237,890 TL. Ege Duru has faced with 16,529 units of stock-out which would have meant 1,378 boxes and a loss of 175,260 TL due to stock-outs.

Their old warehouse was burned in 07.07.2007, but Ege Duru Logistics has reacted very quickly and moved to the other facility. They have kept pace with this situation and printed their first invoice, after they have moved to the newly rented warehouse, in 12.07.2007. Right now, their facility is in a very bad mood, so some customers do not want to work with them when they have seen the warehouse. One of these customers is Milupa. On the other hand, there are also new customers that have known about and believed in Ege Duru Logistics.

7. REFERENCES

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