SCHOOL OF INDUSTRIAL ENGINEERING AND TELECOMMUNICATION

UNIVERSITY OF CANTABRIA

Final Project

IMPROVEMENTS FOR EFFECTIVE PRODUCT LAYOUT IN NETLOG'S WAREHOUSE

To access the title of

INDUSTRIAL ENGINEERING

Author: Hasan Can Tunç

June-2013

SCHOOL OF INDUSTRIAL ENGINEERING AND TELECOMMUNICATION

UNIVERSITY OF CANTABRIA

Final Project

IMPROVEMENTS FOR EFFECTIVE PRODUCT LAYOUT IN NETLOG'S WAREHOUSE

To access the title of

INDUSTRIAL ENGINEERING

Author: Hasan Can Tunç

June-2013

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

FLP: Facility Layout Problem

GT: Group Technology

ICL: InterCombiTrasport&Logistics

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

In this project, warehouse management system is going to be implemented in order to transfer products faster, more efficient, and more flawless to the desired destination. Netlog has a warehouse that is used for storage. In storage, there are two types of placement systems called automatic and semi-automatic systems. Automatic system provides storage and shipping to vehicles automaticallywhen order is sent by Ülker. Semi-Automatic System contains two levels that are to transport products with forklifts to elevators and to transmit them desired destination.

Placement of products in warehouse is shaped according to experience of engineers. Engineers change places of products from time to time. Main goal is about final placement of products in areas of Semi-Automatic System according to existing problems. Group Technology Techniques is utilized to solve problems. Final placement of the products is rearranged according to some factors and workers' total time is decreased.

Keywords*:* Warehouse, semi-automatic system, products

ÖZET

Bu projenin amacı,Netlog'un ürün siparişinin alınmasından, ürünlerin müşteriye ulaşmasına kadar geçen süreci daha hızlı ve etkili biçimde kontrol etmektir.Netlog'un deposunda iki farklı sistem uygulanmaktadır.Bunlar, otomatik ve yarı otomatik sistem olarak adlandırılmaktadır.Otomatik sistemde ürünlerin yerleştirilmesi ve gönderilmesi, makineler tarafından otomatik olarak yapılmaktadır.Yarı otomatik sistemde, yerleştirme işlemi işçilerin kullandığı forklift yardımı ile olurken; gönderilme işlemi ise işçilerin ürünleri besleme gözüne getirip asansörlere yüklemesiyle gerçekleşmektedir.

Netlog'un deposunda 3 kat bulunmaktadır. Ürünler 1. katta atıştırmalık, 2. Katta içecekler, 3.katta kuru ve donmuş gıdalar olacak şekilde konumlanmıştır. Mevcut sistemde ürünlerin depo içinde sıralanması mühendislerin ve şeflerin tecrübelerine dayanarak oluşturulmaktadır. Çoğu zaman ürünlerin yerleri sabit kalırken, zaman zaman bazı ürünlerin yerleri değiştirilmektedir. Bunun esas nedeni ise değişen sipariş bilgileridir. Sistem bu haliyle verimli olamamaktadır ve işçilerin taşıma süresini artırmaktadır. Bu alandaki problemleri çözmek için Grup Teknoloji Metodu uygulanmıştır.

Proje boyunca her ürün grubu için rastgele alınan 50 ürün incelendiğinde atıştırmalık katında yüzde 13.42, içecekler katında yüzde 18.32, kuru ve donmuş gıda katında yüzde 28.58 ilerleme kaydedilmiştir. Böylece depo daha etkili ve verimli bir hale gelmiştir.

CHAPTER 1: INTRODUCTION

Warehouse management system was implemented in order to transfer products faster, more efficient, and more flawless to the desired destination. Company in which project is implemented is a top leading company in logistics area named Netlog Logistics Group. Introducing the company, objectives of project, improvement of warehouse in company are going to be examined in the report.

CHAPTER 2: DEFINITION OF COMPANY

Netlog is one of the biggest companies in logistics area. They serve Supply Chain Management, Domestic and International Transportation. Main industries of service are Dry Food, Cold Chain, Textile, Automotive, Chemical, Pharmaceuticals, Construction and Technology. Number of Employees is 3500, number oof vehicles is over 2000 and number of warehouses is 51. We will give some general information about Netlog Logistics Group Company.

2.1 Land Transportation

ICL which is sub-company of Netlogmanagesthree hundred fifty eight trucks and four hundred fifty trailers in its international road transport partition. Five hundred fiftyexperienced and talented ICL employees work twenty four / seven to provide its customers international transportation services between Turkey and thirty eight countries within the range of Norway to United Arab Emirates. ICL is one of the top five shippingcompanies in Turkey for theland transportation.

2.2 Air Transportation

In ICL, time section stands at center of the transportation, therefore ICL air freight specialists will work in order to send cargos to its final destination as fast as possible and damage free.

2.3 Sea Freight

Importance of Sea Freight and Container Transport has high level for Netlog. ICL Sea Freight department reaches two hundred fifty countries worldwide, while managing all the services.

2.4 Design and Control of Warehouse Order Picking: A Literature Review

In this survey, some definitions will be handled about design and control in order-picking processes. There are also some examples of terms which are optimal

layout design, storage assignment methods, routing methods, order batching zoning and batching.

In these days, most of the companies have larger warehouse so coming order scale is high whereas time used is short. So, these companies are shifting to a postponement strategy in order to be more flawless and efficient through customers. Warehouses generally cause high cost, but they also exist because; they supply not only easy-coordination and transportation through customers, but also availability in customer services by saving time.Order picking is a process of grouping the customer orders, releasing orders to the floors, picking and sendingthe orders. The most important goal about order-picking is to decrease timeduring receiving orders and giving them to costumers as fast as possible.

In layout design section, it is mostly mentioned about internal layout design.The goal is to identify best warehouse according to some criteria. In the other hand, zoning has low reputation to be used even though it is useful. Order picker is comfortable when he picks orders because of separation of areas into zones. So, there is also less traffic in warehouse. Batching is the other term in the review. It means that a party of orders must be allocated to a number of sub-party. So, saving time would be come true if batching is implemented accurately.

In conclusion, order-picking systems get less attention, although they have easy-implementation for practice. Also, in spite of publications of areas of layout, batching, zoning are limited, it is tried to keep up with them with new improvements. As the last word, there is still deficiency in order-picking to implement methods in spite of new improvements.

2.5 Improving the productivity of order picking of a manual-pick and multi-level rack distribution warehouse through the implementation of class-based storage: A literature Review

Storage designation is the most important factor affect the performance of picking. Many factors such as order picking method, sizeand layout of the storage system, material handling system, productcharacteristics, demand trendsinfluence the

location of productsin the warehouse. It is hard and important to be able to determine appropriate storage assignment policy.

There are three storage assignment systems called random storage, dedicated storage and class-based storage. Randomstorage has all products in a single class and dedicated storage separates all of products to different groups. The main ideaof class-based storage is to divide products into classes. Each class is arranged to a dedicated area of the warehouse. Storagewithin an area is random. The advantage of this policy is that fastmoving products can be stored close to the depot.

Storage assignment in picker-to-parts systemis evaluated according to two factors which are products and customerorders. Class-based storage according to product characteristics increases the accuracy of picking and reduces order retrieval time. It is important to know the relationship between order retrieval time and travel distance for orderpicking. For customer orders, the statisticalrelation between items can help to improve the efficiencyof order picking although there are some difficulties which must be overcome such as the stability of order contents and adhesiveness to particular storage assignment policy. Moreover, automated Storage/Retrieval System (AS/RSA) must be handled when class-based storage is performed. Products are separated into groups according to three prospects: system cycle time, inventory turnover and Bill of Materials. The class-based storage according to system cycle time uses process time for performance measurement and finds the best location analyzing the simulation.For the class-based storage assignment based on inventoryturnover, it is the case to minimizethe maximum value of the expected total time of the command cycles.Bill of Material orientedclass-based storage is presented as a method for AS/RS. This method has the feasibility to integrate an AS/RS into a Computer Integrated Manufacturing system.

Random storage is widely utilized in warehousesbecause it is simple to use. All incoming pallets are arranged to a location in the warehouse that is selected randomly with equal probability. Random storage is applied in bulk storageareas with a computerized infrastructure system, since stocklevels and locations need to be updated in real time.

In conclusion, most researches focused on efficiency of picking are interested in single-level rack warehouses orAS/RS systems. It is vital to arrange the balance between the order retrieval time and travel distance to be able to find out the optimal storage assignment with suitable methods via simulations.

CHAPTER 3: PROJECT DEFINITION

Netlog has a warehouse that is used for storage and shipping. In storage, there are two types placement systems called Automatic and Semi-Automatic System.

Figure 1.Netlog, Kurtköy Istanbul, Turkey

Systems used for storing and shipping in warehouse are crucial for company. There are two systems which are Automatic and Semi-Automatic.

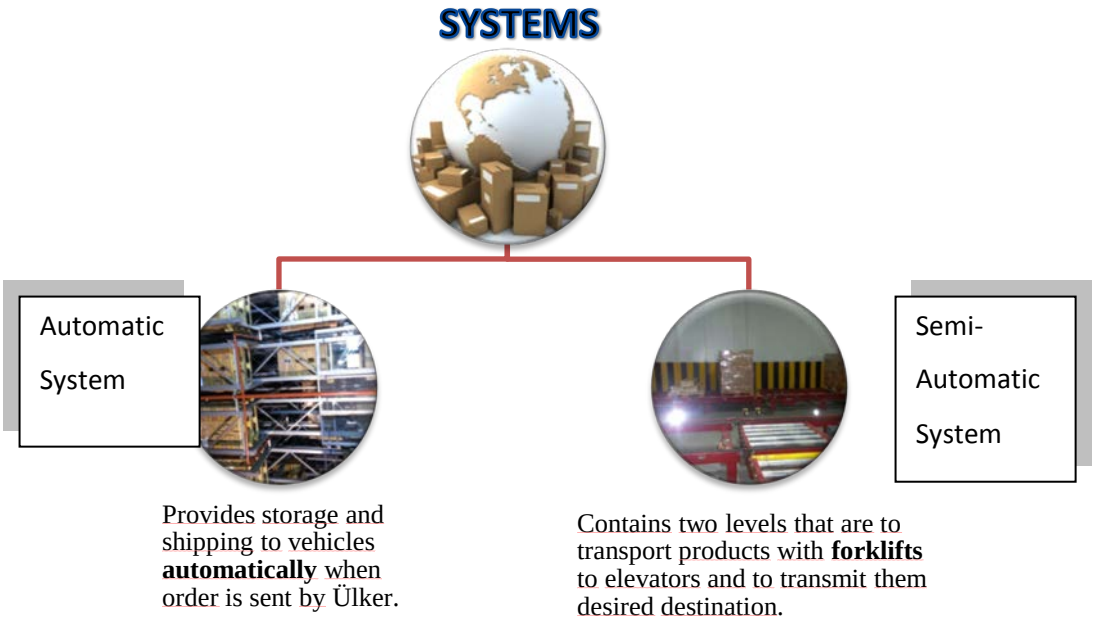


Figure 2. Explanations of Automatic and Semi-Automatic Systems

Systems used are dependent on quantity of orders. If order quantity is at standard level, we choose Automatic-System; if order quantity is less or more, we choose Semi-Automatic System.Area where we will work on is Semi-Automatic System.

CHAPTER 4: SYSTEM DEFINITION

Placement of products in warehouse is shaped according to experience of engineers. Engineers change places of products from time to time. It is dependent on special days, weeks (Ramadan Festival) and mostly orders. It is so important to provide flow of products as efficient as possible in warehouse. For example; snacks and sugars are scattered through the first floor in case of easy transportation on Ramadan month every year.For another example; consuming of snacks are incrementally increasing in the beginning of new year. Companies desire demand more and our firm has to change its methods to meet the demand. Another example is that coke sales are decreasing in cold winter days. So, it was needed to decrease number of products available in packages. This nonstandard conditions led us to use Semi-Automatic System. Appendix B presents process flow of non-automatic stage of semi-automatic system. After this process, products were passed automatically. Semi-automatic system was the part which was interested during the project. Main goal was about final placement of products in areas of Semi-Automatic System according to these problems:

1) Redesigning placement of product layout according to coming orders

2)Minimizing working times of workers on the routes according to redesigning product layout

CHAPTER 5: DATA COLLECTION

Firm categorizes their orders into three types:

1)Snacks (chocolates, biscuits, cracker, cake)

2)Beverages (cola, soda pop, soda, buttermilk, water, milk, chocolate and fruited milk)

3)Dry-Cold Foods (spices, soup, legumes, margarines and oils, ice cream)

Each floor is adjusted according to each type of products. Snacks stand at first; beverages stand at second floor; dry foods and cold foods stand at third floor.

CHAPTER 6: METHODS

6.1 Group Technology Techniques

The classic production systems, that have improved conveniently with the custom of mass production and have been raised as centralized management, meet with crucial problems related to the competitive market. High quality, flexible manufacturing and low cost cannot be acquired by traditional organization, which constitutes important percentage of centralized management. As a result, the most important part for the approach to problems is the conversion of functional organization to group technology techniques. In the producing system, the main process of GT is grouping parts into part families, and machines into machine groups.

6.2 How Are Group Technology Techniques Related To Layout?

Facility Layout Problem (FLP) is identified as the physical adjustment of determined products or machines in a predefined area. "*According to Immer, most of the industries production cost is related to cost of material utilization or the transportation of materials between the products*" (Immer, 1953). This cost can be decreased using two techniques, which are fitting and moving facilities. Fitting is the process of allocation of unequal shaped departments into large objects by optimizing the given goals. Moving the facilities involve changing the facility with respect to time to preserve the fitness of the facility.

CHAPTER 7: ANALYSIS FOR REDESIGNING LAYOUT

In Semi-AutomaticArea, it is important to know the relationship between the placement of the products and the time spent by workers. There will be shown critical information in the last quarter of 2012 which indicates average number of packages and average number of orders for each type of products. We have evaluated thes equence of the final placement of all of the products using the average number of packages for each order.

There are three tables which indicate number of orders and number of packages for last quarter of 2012 and average number of packages for each order for each type of products. Product types are sequenced according to the floors.

Table 1.Top Ten Products in Beverages

	October		November		December				
Products	# of Packages	# of Orders	# of Packages	# of Orders	# of Packages	# of Orders	Total # of Packages	Total # of Orders	Average # of Packages for each order
SAKA SU 5LT2x2 TÜRKÇE	490	17	484	7	496	29	1470	53	29
SAKA SU 5LTx2 TÜRKÇE ZİNCİR	3521	151	3509	147	3536	157	10566	455	23
COLA TURKA 2,5LTx6 KASE HED.	1283	57	1277	47	1298	72	3858	176	23
SAKA SU 10LTx2 TÜRKÇE ZİNCİR	2563	138	2556	127	2579	155	7698	420	19
COLA TURKA 2500 ML	2963	178	2956	167	2979	195	8898	540	17
SAKA SU 0,5LTx24 TÜRKÇE ZİNCİR	1268	85	1258	77	1302	101	3828	263	15
MALTANA ŞEFTALİ 270MLx12 CAM ŞİŞE	2075	171	2067	167	2098	181	6240	519	12
SAKA SU 1,5LTx6 TÜRKÇE	903	78	892	67	923	95	2718	240	12
FLORES SADE 6x200ML	1460	130	1453	127	1467	133	4380	390	11
MALTANA ANANAS 270MLx12 CAM ŞİŞE	1972	177	1966	167	1984	191	5922	535	11

Table 2.Top Twenty Products in Snacks

	October		November		December				
Products	# of Orders	# of Packages	# of Orders	# of Packages	# of Orders	# of Packages	Total # of Orders	Total # of packages	Average # of Packages for each order
ÇOKOPRENS ATIŞTIRMALIK 81GRx18	114	3227	110	3220	118	3234	342	9681	28
HANIMELLER ÇOKODAMLA KURABİYE 110GRX18	110	2827	105	2824	115	2830	330	8481	26
DANKEK 8 KEK MUF.KEK 50GR KARMA KOLİ	87	2145	83	2140	91	2150	261	6435	25
ÇOKOKREM GOLDEN CAM KAVANOZ 400GRx12	143	3286	139	3279	147	3293	429	9858	23
KRİSPİ ÇUBUK KRAKER PEYNİRLİ 50GRx18	324	7152	320	7148	328	7156	972	21456	22
SUPERTON TON EKO (80GRX3)X8	260	5383	253	5374	267	5392	780	16149	21
DANKEK ISLAK KEK KARMA KOLİ	55	1135	50	1130	60	1140	165	3405	21
SUPERFRESHASİK TON (80GRX3)X8	225	4418	221	4410	229	4426	675	13254	20
DANKEK DİLİM KEK MOZAİK 30GRx40 FİYATSIZ	112	2136	108	2130	116	2142	336	6408	19
ÇOKOPRENS SANDVİÇ BİSKÜVİ 28GRx48	247	4561	240	4550	254	4572	741	13683	18
METRO KAPLAMALI BAR 40GRX24X6 YENİ DZ.	136	2497	130	2485	142	2509	408	7491	18
DANKEK PÖTİ MUFFIN KEK MEYVELİ 48GRx24	390	6791	387	6725	393	6857	1170	20373	17
ÇOKOMEL MARSH.SADE 6x13GRx12	199	3348	195	3300	203	3396	597	10044	17
ÜLKER ÇİKOLATALI GOFRET 35GRx36x4	112	1773	108	1689	116	1857	336	5319	16
ALBENİ KAPLAMALI BAR 40GRx24x6 YENİ DZ.	118	1783	110	1745	126	1821	354	5349	15
RONDO CANPARE ÇİKOLATALI 90GRx24	168	2486	165	2435	171	2537	504	7458	15
ALPELLA MİNİ RULO PASTA SÜT KRE.35GRx72	227	3304	224	3289	230	3319	681	9912	15
DANKEK ÇAY SAATİ MEYVELİ KEK 220GRx8	402	5845	400	5802	404	5888	1206	17535	15
YUPO JELLY ÇİLEK 100GRx24	10	145	8	140	12	150	30	435	15
SUPER FRESH GARNİTÜR 330 GRx12	115	1607	113	1600	117	1614	345	4821	14

Table 3.Top Twenty Products in Dry-Cold Foods

	October		November		December				
Products	# of Orders	# of Packages	# of Orders	# of Packages	# of Orders	# of Packages	Total # of Packages	Total # of Orders	Average # of Packages for each order
KALBİM TON BALIĞI 3X80GRX8	17	453	13	449	21	457	51	1359	27
DANKEK DİLİM KEK MEYVELİ 30GRx40 FİYATSZ	109	2420	100	2405	118	2435	327	7260	22
HORECA SELECT KIZARTMA YAĞI 4,55KG	25	546	22	540	28	552	75	1638	22
BİZİM AYÇİÇEK YAĞI 4x1,25LT	23	447	19	444	27	450	69	1341	19
RONDO CANPARE FINDIK KREMALI 90GRx24	126	2037	120	2031	132	2043	378	6111	16
HANIMELLER 48Lİ KARMA KOLİ	77	1208	66	1200	88	1216	231	3624	16
UFO FİŞEK DRAJE ŞEKER 3X30 GR	97	1511	85	1498	109	1524	291	4533	16
HERO BABY BEBE BİSK. BİM KOLİ 190GRx12	19	292	15	288	23	296	57	876	15
BİZİM MUTFAK KETÇAP 9 KG EDT	17	246	20	240	14	252	51	738	14
HERO BABY BEBE BİSK.1200GRx4 (BİM)	48	692	44	676	52	708	144	2076	14
BİZİM AYÇİÇEK YAĞI 18 LT EDT	26	364	23	352	29	376	78	1092	14
YUPO MEYVE BAHÇESİ 100GRx24	72	980	69	951	75	1009	216	2940	14
ÜHB TAHILLI EK BESİN KARMA KOLİ 500GA101	50	668	44	674	56	662	150	2004	13
SERA ÇÖP TORB.NORMAL ORTA 55X60CM 30L	33	387	31	373	35	401	99	1161	12
ONA AYÇİÇEK 4x5 LT TNK.	65	680	60	669	70	691	195	2040	10
SPECIAL K SADE 375GRx10	22	204	25	191	19	217	66	612	9
ONEO SLIMS KARP&AHU.ARO.TATL.27GRx18x6	47	415	44	403	50	427	141	1245	9
SUPERFRESH ROYAL TON EKO (160GRX2)X12	32	278	29	270	35	286	96	834	9
YUPO LOLLİPOP TOP ŞEK.KARMA POŞ.5x18Gx24	13	112	10	98	16	126	39	336	9
ÇOKOMEL MARSHMALLOW SADE 13GRx40x6	28	237	24	244	32	230	84	711	8

Firstly, all products were classified according to types of the products. There were 215 snack products, 192 dry and cold food products and 70 beverage products. After the classification, they were sequenced decreasingly according to their average number of packages per order in excel. Formula which shows how the average number of packages per order was found is demonstrated as:

Average # of Packages for each Order = Total # of Packages / Total # of Orders

Total number of packages equals to sum of number of packages for last three months. Likewise, total number of orders equals to sum of number of orders for last three months. After ordering process of products for each type of product was completed in excel, all products were separated to the groups which had 10 or 20 types of products. Beverage products were separated to groups in which had ten products. The groups separated for the other product types had 20 products. Sorting products to groups provided convenience to place the products according to final product placement. For example, there were192 dry and cold food products in the warehouse. 12 products were placed by putting to the furthest corner from the elevator after 180 products were placed according to each group in which had twenty products.

Seven, ten, nine different groups were created when the beverages, snacks and dry-cold foods were analyzed respectively. There is shown maximum and minimum average numbers of packages for each group in the following table.

Table 4. Classification Of Each Group For Each Type Of Product According To The Average Number Of Packages Per Order

	Beverages		Snacks		Dry-Cold Foods	
Groups	Max. Value	Min. Value	Max. Value	Min. Value	Max. Value	Min. Value
1	27	11	28	15	27	13
2	11	8	15	11	12	6
3	8	7	11	7	6	5
4	7	6	7	6	5	4
5	5	4	6	5	4	3
6	4	3	5	4	3	3
7	3	2	4	4	3	2
8	0	0	4	3	2	2
9	0	0	3	2	2	1
10	0	0	2	1	0	0

Classification of products shown in the table provides us easier placement. First groups for each type of product in the table are placed in the manner that they are the closest groups to the elevator. Second groups for each type of products are juxtaposed in the manner that they are the second closest groups to the elevator. All groups are sequenced in that order.

CHAPTER 8: CALCULATION OF WORKERS' TIME

In the warehouse, the defined problem was related about workers' time. Because of the long time spending during the picking process, the workers' fatigue was high, total process time was too long and the system was not efficient.After the lists have been listed according to their popularities related with their average number of packages for each order, the process was analyzed, the time standards were fixed and both the old and the new system's process time were calculated considering its fixed and variable parts.

10.1 Fixed time

In the placement system, all of the products have their own barcodes. And these barcodes should be scanned before they are picked from the shelves, so the system can identify the placement. It takes 15 seconds for each type of product during the scanning of the barcode and it is considered as fixed time.

10.2 Variable Time

There are also some kind of works taking time which are varying depending on the distance of products to the elevators and the number of packages needed. There are two processes spending variable time; first of them is the time spending on forklifts between the cells during the transportation. It takes 1 second to reach the next cell from the previous cell. The other one is the settling time of the products to the forklifts. The time which is needed to complete that work takes 4 seconds for each package. Because there are hundreds of product types and thousands of packages stored, it was very difficult to measure the process time for the orders. On the other hand, when time standards were set, it became possible to calculate the time according to them. The formulation of total process time is;

Time(in seconds) = 15 + 1(# of cells) + 4(# of packages)

# of cells means that number of cells needed to be passed to reach the elevator and # of packages means that number of packages ordered

In the first part of the project, the products have been listed according to their number of packages for each order. After that, in the second part the products were placed considering their popularities, as the popular ones became closer to the elevator than they used to be.

In this sketch, the old product placement of the Beverage area (2nd floor) is shown:

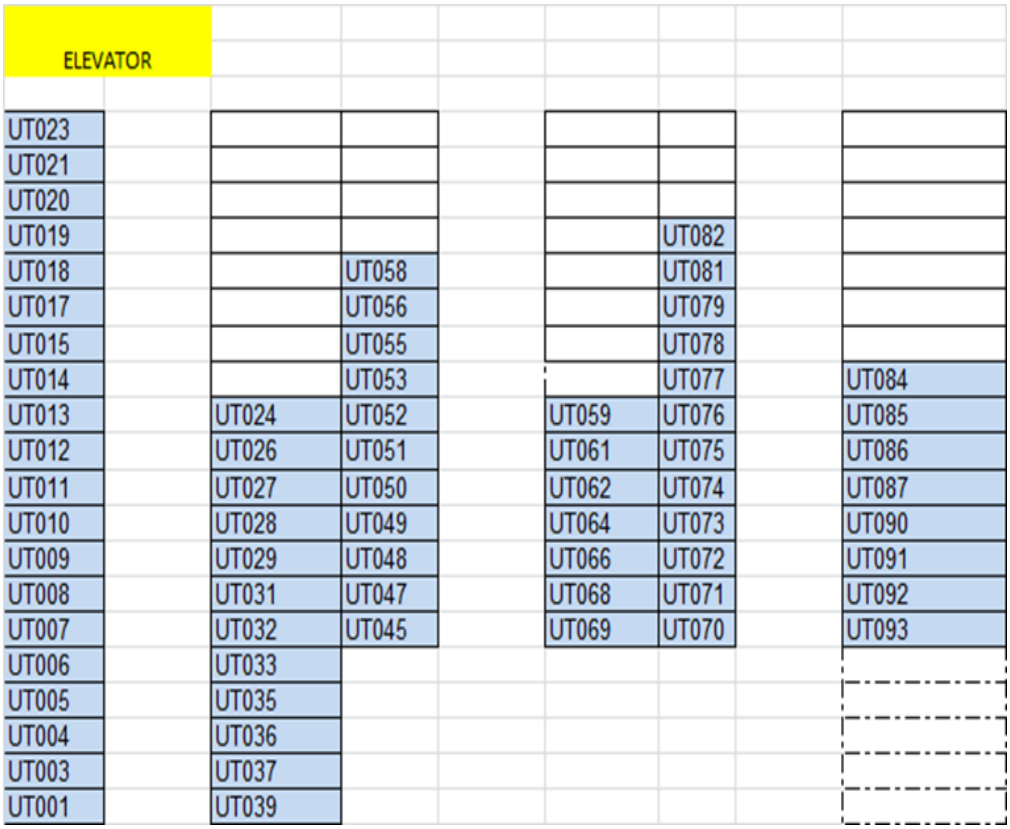


Figure 3: The Old Product Placement of the Beverage Area

It can be seen that products were listed considering the alphabethic arrangement of them.

After the evaluation, the new product placement became like the sketch shown below.

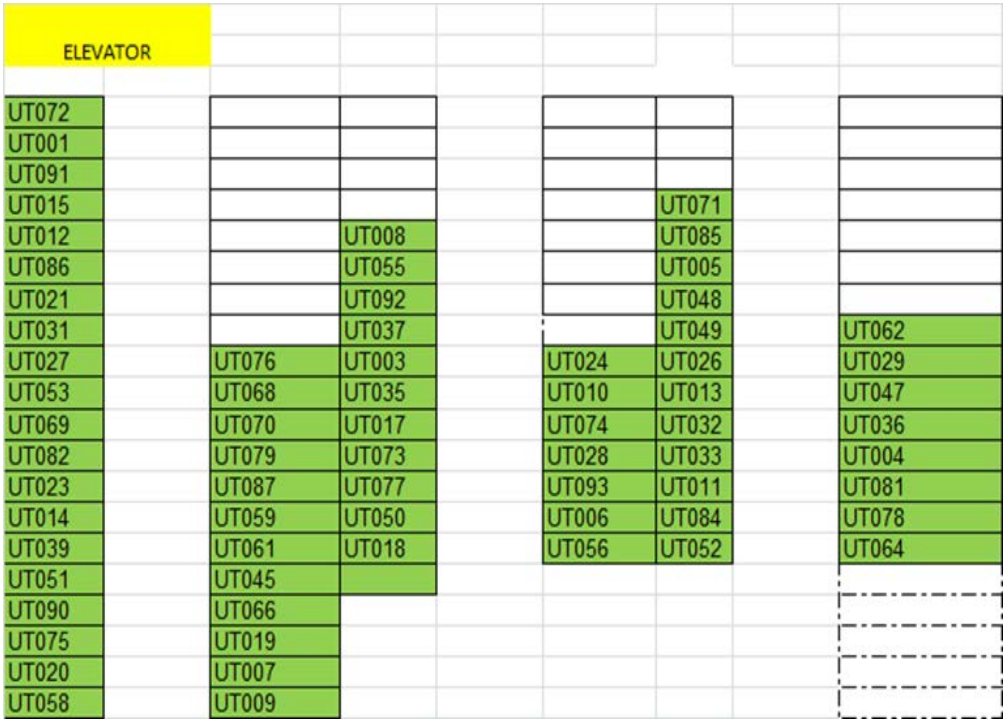


Figure 4: The New Product Placement of the Beverage Area

In the new placement, the popular products are closer to the elevator and the time spending for their transportation is reduced. Real order examples were examined for each floor and prooved that there was a significant improvement.For instance, an order taken is shown in the schedule;

Table 5: The Codes, Product Types And Number Of Packages Ordered For Beverages

Codes of Products	Types of Products	# of packages
UT091	COLA TURKA 2,5LTx6 KASE HED.	3
UT012	COLA TURKA 2500 ML	5
UT086	SAKA SU 0,5LTx24 TÜRKÇE ZİNCİR	6
UT031	SAKA SU 1,5LTx6 TÜRKÇE	1
UT082	CAMLICA PET 1500 ML	3

The client ordered ;

3 packages from “Cola Turka 2,5ltx6 Kase Hed.”,

5 packages from “Cola Turka 2500 Ml” ,

6 packages from “Saka Su 0,5ltx24 Türkçe Zincir”,

1 packages from “Saka Su 1,5ltx6 Türkçe”,

3 packages from “Camlica Pet 1500 Ml” ,

Using the formula (Time(in seconds) = 15 + 1(# of cells) + 4(# of packages)) the process times of both old and new system were calculated. Using the old placement, and the first distances of products to the elevator, the calculation of total time for each type of product and total order time results like the schedule shown below;

Table 6: Order Example for Old System of Beverage

Codes of Products	Types of Products	# of packages	Fixed Time (s)	Variable Time (s)	Total (s)
UT091	COLA TURKA 2,5LTx6 KASE	3	15	1x25 + 4x3	52
UT012	COLA TURKA 2500 ML	5	15	1x20 + 4x5	55
UT086	SAKA SU 0,5LTx24 TÜRKÇE	6	15	1x24 + 4x6	63
UT031	SAKA SU 1,5LTx6 TÜRKÇE	1	15	1x14 + 4x1	33
UT082	CAMLICA PET 1500 ML	3	15	1x13 + 4x3	40
	Total	18	75 seconds	168 seconds	243 seconds

Table 7: Order Example for New System of Beverage

Codes of Products	Types of Products	# of packages	Fixed Time (s)	Variable Time (s)	Total (s)
UT091	COLA TURKA 2,5LTx6 KASE HED.	3	15	1x2 + 4x3	29
UT012	COLA TURKA 2500 ML	5	15	1x1 + 4x5	36
UT086	SAKA SU 0,5LTx24 TÜRKÇE ZİNCİR	6	15	1x2 + 4x6	41
UT031	SAKA SU 1,5LTx6 TÜRKÇE	1	15	1x4 + 4x1	23
UT082	CAMLICA PET 1500 ML	3	15	1x11 + 4x3	38
	Total	18	75 seconds	92 seconds	167 seconds

It can be easily seen that the products’ transportation time and so the total process time wasreduced. If it is wanted to calculate the improvement, the difference between the systems can be divided by the old system’s time.

So the improvement is 31.27 percent. This sketch below shows the old product placement of the Snacks Area (1st floor) .Like Beverages, products were listed considering the alphabethic arrangement of them.

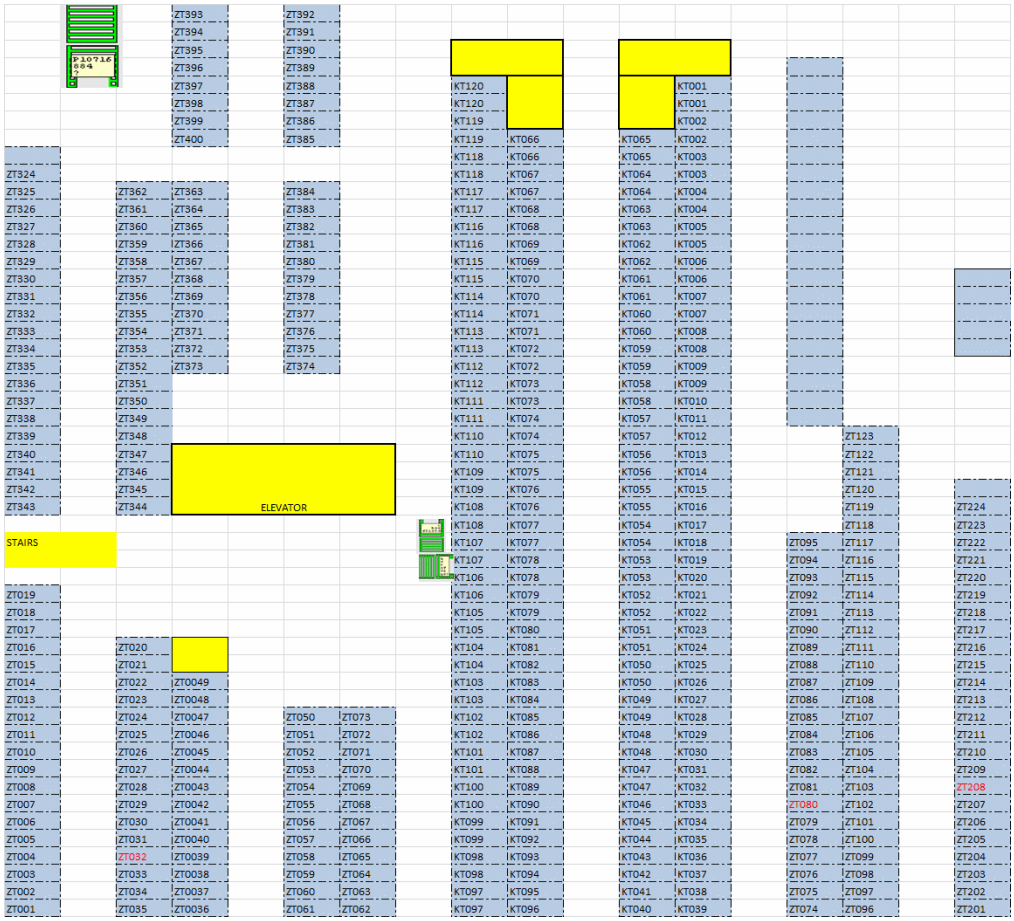


Figure 5: The Old Product Placement of the Snacks Area

After the product replacement, the new product placement became like the next sketch.

Figure 6: The New Product Placement of the Snacks Area

There is another order example here which was ordered from snacks area.

Table 8: The Codes, Product Types And Number Of Packages Ordered For Beverages

Codes of Products	Types of Products	# of packages
ZT208	ÇOKOPRENS ATIŞTIRMALIK 81GRx18	4
ZT080	DANKEK 8 KEK MUF.KEK 50GR KARMA KOLİ	3
ZT032	KRİSPİ ÇUBUK KRAKER PEYNİRLİ 50GRx18	1
ZT010	SUPERTON TON EKO (80GRX3)X8	1
ZT011	DANKEK DİLİM KEK MOZAİK 30GRx40 FİYATSIZ	2
ZT047	ÇOKOPRENS SANDVİÇ BİSKÜVİ 28GRx48	7
ZT332	DANKEK PÖTİ MUFFIN KEK MEYVELİ 48GRx24	5

The client ordered ;

4 packages from “Çokoprens Atiştirmalik 81grx18”,

3 packages from “Dankek 8 Kek Muf.Kek 50gr Karma Koli” ,

1 packages from “Krispi Çubuk Kraker Peynirli 50grx18” ,

1 packages from “Superton Ton Eko (80grx3)X8”

2 packages from “Dankek Dilim Kek Mozaik 30grx40 Fiyatsiz” ,

7 packages from “Çokoprens Sandviç Bisküvi 28grx48”

5 packages from “Dankek Pöti Muffin Kek Meyveli 48grx24”

Using the old placement, and the first distances of products to the elevator, the calculation of total time for each type of product and total order time results like the schedule shown below;

Table 9: Order Example for Old System of Snacks

Codes of Products	Types of Products	# of packages	Fixed Time (s)	Variable Time (s)	Total (s)
ZT208	ÇOKOPRENS ATIŞTIRMALIK 81GRx18	4	15	1×16 + 4×4	47
ZT080	DANKEK 8 KEK MUF.KEK 50GR KARMA KOLİ	3	15	1×23 + 4×3	50
ZT032	KRİSPİ ÇUBUK KRAKER PEYNİRLİ 50GRx18	1	15	1×6 + 4×1	25
ZT010	SUPERTON TON EKO (80GRX3)X8	1	15	1×1 + 4×1	20
ZT011	DANKEK DİLİM KEK MOZAİK 30GRx40 FİYATSIZ	2	15	1×14 + 4×2	37
ZT047	ÇOKOPRENS SANDVİÇ BİSKÜVİ 28GRx48	7	15	1×26 + 4×7	69
ZT332	DANKEK PÖTİ MUFFIN KEK MEYVELİ 48GRx24	5	15	1×14 + 4×5	49
	Total	23	105 seconds	192 seconds	297 seconds

Table 10: Order Example for New System of Snacks

Codes of Products	Types of Products	# of packages	Fixed Time (s)	Variable Time (s)	Total (s)
ZT208	ÇOKOPRENS ATIŞTIRMALIK 81GRx18	4	15	1×2 + 4×4	33
ZT080	DANKEK 8 KEK MUF.KEK 50GR KARMA KOLİ	3	15	1×2 + 4×3	29
ZT032	KRİSPİ ÇUBUK KRAKER PEYNİRLİ 50GRx18	1	15	1×1 + 4×1	20
ZT010	SUPERTON TON EKO (80GRX3)X8	1	15	1×1 + 4×1	20
ZT011	DANKEK DİLİM KEK MOZAİK 30GRx40 FİYATSIZ	2	15	1×3 + 4×2	26
ZT047	ÇOKOPRENS SANDVİÇ BİSKÜVİ 28GRx48	7	15	1×1 + 4×7	44
ZT332	DANKEK PÖTİ MUFFIN KEK MEYVELİ 48GRx24	5	15	1×23 + 4×5	58
	Total	23	105 seconds	125 seconds	230 seconds

It can be easily seen that the products’ transportation time and so the total process time were reduced.If it is wanted to calculate the improvement, the difference between the systems can be divided by the old system’s time.

In this sketch, the old product placement of the Dry-Cold (3rd floor) is shown.

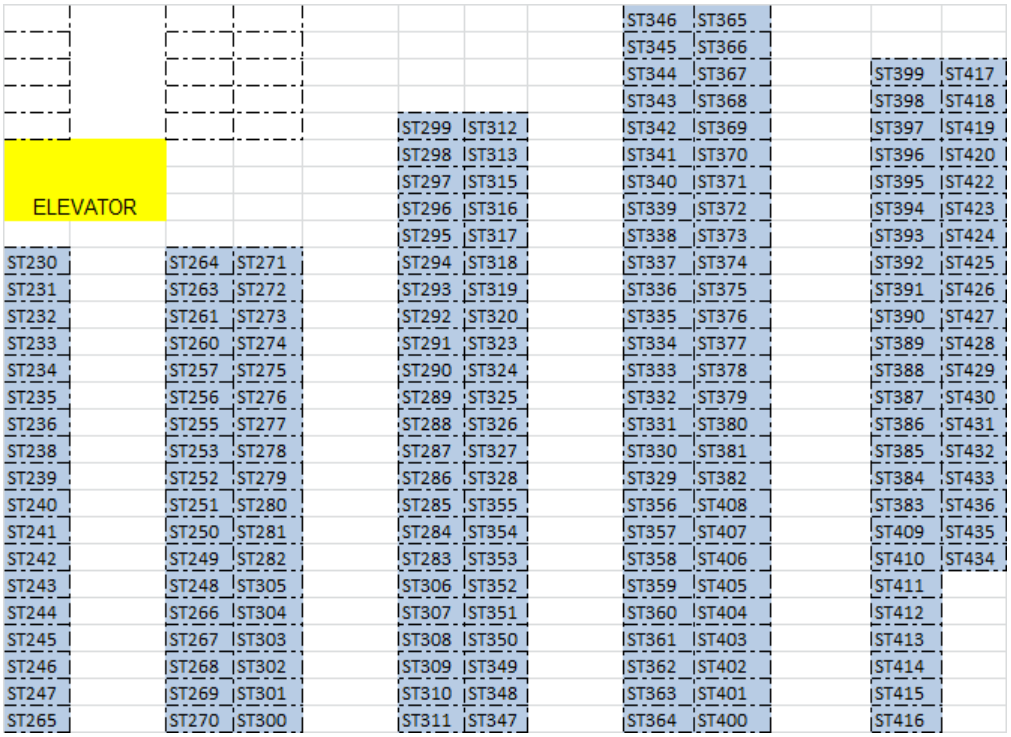


Figure 7: The Old Product Placement of the Dry-Cold Food Area

It can be seen that products were listed considering the alphabethic arrangement of them. After the evaluation, the new product placement became like the sketch shown below.

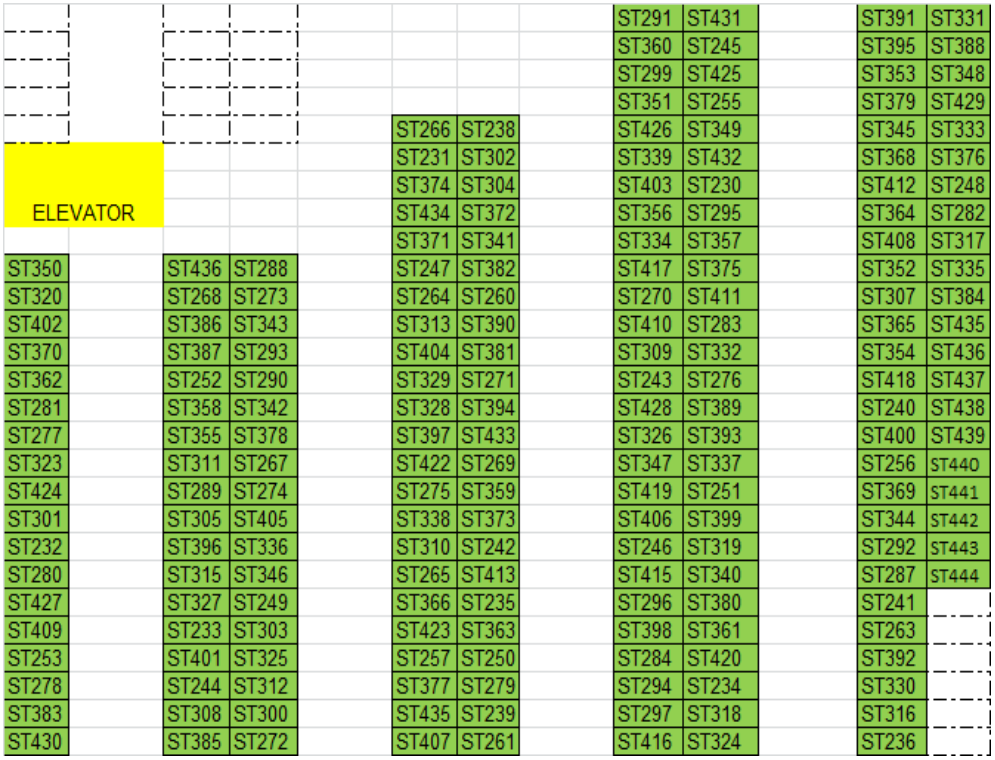


Figure 8: The New Product Placement of the Dry-Col Food Area

For instance, a real order taken is shown in the schedule ;

Table 11: The Codes, Product Types And Number Of Packages Ordered For Dry-Cold Foods

Codes of Products	Types of Products	# of packages
ST320	DANKEK DİLİM KEK MEYVELİ 30GRx40 FİYATSZ	5
ST370	BİZİM AYÇİÇEK YAĞI 4x1,25LT	2
ST362	RONDO CANPARE FINDIK KREMALI 90GRx24	4
ST424	BİZİM MUTFAK KETÇAP 9 KG EDT	5
ST280	YUPO MEYVE BAHÇESİ 100GRx24	6
ST430	SUPERFRESH ROYAL TON EKO (160GRX2)X12	3

The client ordered ;

5 packages from “Dankek Dilim Kek Meyveli 30grx40 Fiyatsz.”,

2 packages from “Bizim Ayçiçek Yağı 4x1,25lt”,

4 packages from “Rondo Canpare Findik Kremali 90grx24” ,

5 packages from “Bizim Mutfak Ketçap 9 Kg Edt”

6 packages from “Yupo Meyve Bahçesi 100grx24”

3 packages from “Superfresh Royal Ton Eko (160grx2)X12”

Table 12: Order Example for Old System of Dry-Cold Foods

Codes of Products	Types of Products	# of packages	Fixed Time (s)	Variable Time (s)	Total (s)
ST320	DANKEK DİLİM KEK MEYVELİ 30GRx40 FİYATSZ	5	15	1×21 + 4×5	56
ST370	BİZİM AYÇİÇEK YAĞI 4x1,25LT	2	15	1×34 + 4×3	61
ST362	RONDO CANPARE FINDIK KREMALI 90GRx24	4	15	1×40 + 4×4	71
ST424	BİZİM MUTFAK KETÇAP 9 KG EDT	5	15	1×37 + 4×5	72
ST280	YUPO MEYVE BAHÇESİ 100GRx24	6	15	1×31 + 4×6	70
ST430	SUPERFRESH ROYAL TON EKO (160GRX2)X12	3	15	1×32 + 4×3	59
	Total	25	90 seconds	299 seconds	389 seconds

Table 13: Order Example for New System of Dry-Cold Foods

Codes of Products	Types of Products	# of packages	Fixed Time (s)	Variable Time (s)	Total (s)
ST320	DANKEK DİLİM KEK MEYVELİ 30GRx40 FİYATSZ	5	15	1×2 + 4×5	37
ST370	BİZİM AYÇİÇEK YAĞI 4x1,25LT	2	15	1×1 + 4×3	28
ST362	RONDO CANPARE FINDIK KREMALI 90GRx24	4	15	1×4 + 4×4	35
ST424	BİZİM MUTFAK KETÇAP 9 KG EDT	5	15	1×3 + 4×5	38
ST280	YUPO MEYVE BAHÇESİ 100GRx24	6	15	1×6 + 4×6	45
ST430	SUPERFRESH ROYAL TON EKO (160GRX2)X12	3	15	1×18 + 4×3	45
	Total	25	90 seconds	138 seconds	228 seconds

It can be easily seen that the products' transportation time and so the total process time were reduced.If it is wanted to calculate the improvement, the difference between the systems can be divided by the old system's time.

Types of Products	Number of Improved Orders	Minimum Improvement Percentage	Maximum Improvement Percentage	Average Improvement Percentage
Beverage	45	9,12%	31,27%	18,32%
Snacks	42	5,44%	22,55%	13,42%
Dry-Cold Foods	46	3,37%	41,38%	28,58%

CHAPTER 9: CONCLUSION

Data andmethods relatedto thisproject have been determined during the first term. After collection of data, it has been filtered for analyzing part considering project needs. In the next step, average number of packages for each type of product per order was found by utilizing group technology tecniques. Furthermore, all products on all floors were replaced according to the calculations. Improvements for beverages, snacks and dry-cold foods became 18.32 %, 13.42 % and 28.58 % respectively.

Finally, time which workers spend on the system and total process duration were reduced. So, the warehouse became much more efficient.

REFERENCES

Felix T.S. Chan, H.K. Chan (2011). Improving the productivity of order picking of a manual-pick and multi-level rack distribution warehouse through the implementation of class-based storage. *Expert Systems with Applications,* 38(3), pp. 2686-2700

Hakan Kurnuç (2012).*Air Freight.*Netlog Logistics Company. Retrieved, from: http://www.netlog.com.tr/EN/services/global-freight-management/air-freight.asp

Hakan Kurnuç (2012).*Land Transportation.*Netlog Logistics Company. Retrieved, from: http://www.netlog.com.tr/EN/services/global-freight-management/land-transportation.asp

Hakan Kurnuç (2012).*Sea Freight.*Netlog Logistics Company. Retrieved, from: http://www.netlog.com.tr/EN/services/global-freight-management/sea-freight.asp

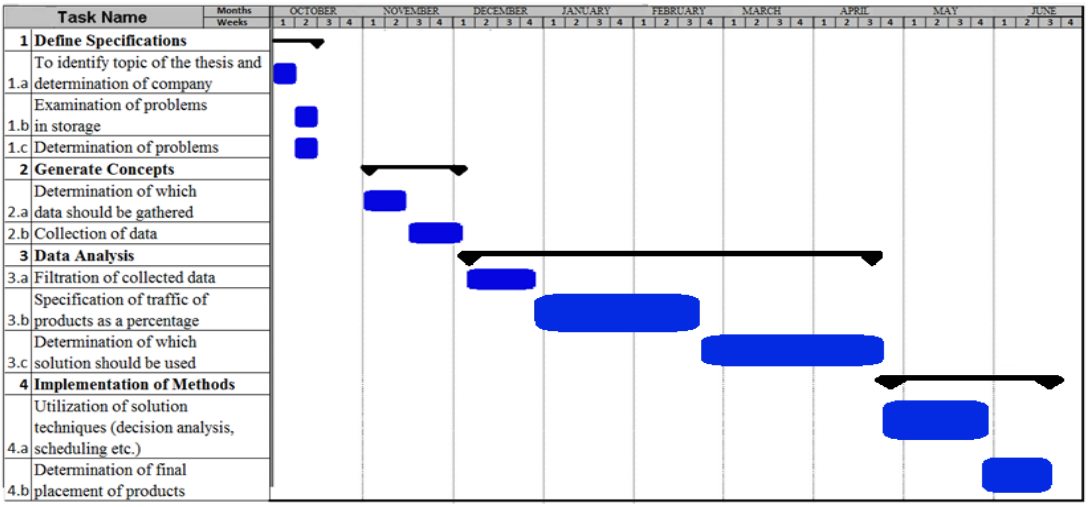
Jai Kannan Janaki Jaganathan (2003). *Solution to Large Facility Layout Problems Using Group Technology.*A thesis in Bachelor of Engineering in Mechanical Engineering, Bharathiar University. India. Retrieved November, 2012, from: http://soar.wichita.edu/xmlui/bitstream/handle/10057/1139/t07022.pdf;jsessionid=2DA3B2290DCA149469978003A7E9C048?sequence=1

JR Immer, (Dec, 1953). *Materials handling.* United States

Kees Jan Roodbergen, René de Koster, Tho Le-Duc. (2007)*Design and control of warehouse order picking: a literature review*. European Journal of Operational Research 182(2), 481-501.Retrieved, from: http://www.roodbergen.com/publications/EJOR2007.pdf

M. Bulent Durmusoglu, Affan Nomak (2005). GT Cells Design and Implementation in a Glass Mould Production System *Computers and Industrial Engineering*, 48(3), pp. 525-536

APPENDIX A: GANTT CHART



APPENDIX B: PROCESS FLOW OF SEMI-AUTOMATIC SYSTEM