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## **DAMAGE ASSESSMENT ANALYSIS FOR A LOGISTICS COMPANY BY USING DATA MINING TOOLS: AN APPLICATION IN TURKEY**

### **Abstract:**

This study is conducted using the data of a Logistics Company which operates in Turkey. The company aims to analyze the problems faced by the damage or loss in the physical distribution process and also wants to determine the source of the problems. According to the analysis' results it is aimed to improve the quality of services in the Logistics Company.

Data set consists of 56 variables and 3245 records. Data acquired either from automation system, delivery of documents, bills and customers' damaged or lost invoices.

The automation system provides information about goods, customers, region, shipping information, vehicles, time, transfer centers, delivery status, damage assessment date.

The damage or losses may cause decrease of the quality of service. This also affects the reputation of the company. Therefore, examining the errors that cause these problems and taking preventive measures are very important. In this study data mining tools were used to identify the problems.

### **Keywords:**

Damage Assessment, Logistics, Data mining.

**JEL Classification:** M11

## Introduction

The smooth operation of a logistics system in an international environment requires careful planning. All aspects have to be planned for and every possible contingency examined. Once the shipment leaves the shipper's dock it is out of his control until it arrives at the consignee's location. International logistics systems work best when all the possible interfaces are planned for. One of the most important areas is packaging. It is the package that will determine whether the product arrives at a customer's location in proper condition. It is the package that will give the transportation company the information it needs to move the product to the proper customer location. (Lancioni R. A. Chandran R. 1990, pp.41-43) The damage or losses may cause degradation of the quality of service. This also affects the reputation of the company. In this study data mining tools are applied to the data set consisted of 56 variables and 2038 records. The errors that cause these problems are examined in order to take preventive actions.

## Logistic and Damage

Logistics may be described as the science of the efficient flow of the materials. It is a generic term for all the activities which together ensure that materials and products are at the right place at the right time, that is, create place time and utility (Johnson P.2008, p:3). Logistics is a little known term in the construction industry. In the Concise Oxford Dictionary it is defined as: art of moving, lodging and supplying troops and equipment. As stated, logistics would appear to be limited to the military. It was only with the onset of the industrial revolution that the concept of logistics extended beyond its military context. Transport and distribution are cornerstones of logistics and its most visible manifestations (Agapiou et al. ,1998, p: 131-137)

Major categories of commodities that are transported around the country via motor carriers, and are a subject of major damage due to improper packaging. Carriers of all modes of transport (truck, rail, ship and air) are faced daily with the challenge of optimizing the available space in the logistical vehicle with the largest number of shipping units that can be shipped without causing damage and compromising. The complexity increases as carriers develop intermodal transport solutions for their customers by using a combination of truck, rail, sea, and air modes to efficiently deliver packaged products economically in the global environment, while staying competitive. Proper loading methods, securement of load, blocking and bracing along with the packaging play a very important role in not only preventing damage to the products, but also facilitate in the safe handling and stowing of the products for carriers. Shippers, carriers, and manufacturers of package systems should provide additional safe means based on new research and information available to them to improve safety and stability of loads during transportation to prevent damage and injury. (Singh et. al, 2014).

Packaging is one of the most important activities in the distribution systems and supply chains. Nevertheless, it attracts little attention of people, especially in the manufacturing sector because packaging has been intensively used as a protective agent only. One of the prime factors that inhibit manufacturing efficiency and productivity is treating packaging activities as an individual task. In other words, traditional packaging is usually considered as a cost driven center rather than a value added component throughout the manufacturing and distribution processes. If we reconsider the packaging design in a systematic approach, it is easy to develop more cost effective solutions for

manufacturing processing that can support handling and distribution as well as providing protection of the product. By the same token, it will bring additional values to a company because of the improvement in manufacturing and distribution efficiency. (Chan et al. 2006,p:1088–1101)

The unique thing about the LTL or mixed load environment is that a carrier has no control over the type of freight leaving a terminal and going to a particular destination. They are dependent on what their customers provide them and must transport the freight quickly and safely through their distribution centers to the final destination. Thus, they are faced with the challenge of loading various types of freight, which are all packaged differently, together on one trailer, and then unloading it and reloading it with other freight, depending on the route the freight must take. Time is a critical component and any time a dock worker has to handle the freight manually, time is lost ( Paul et al. 2014). Packaging is typically viewed as being either consumer focused, primarily on marketing, or industrial, focused on logistics. The primary concern of logistic operations is industrial package design. Individual products or parts are typically grouped into cartons, bags, bins, or barrels for handling efficiency.( Bowersox D. J. Closs D., Cooper 2002, p:408).

## **Loading tips for damage prevention**

### **1) Packaging and Pallet Building**

Pack products in durable packages.

Seal packages properly.

Use strong, damage-free pallets.

Stabilize pallet loads with shrink wrap.

### **2) Handling Practices**

Create a balance for forklift operators between productivity and safety.

Use the proper type of forklift for each load.

Provide forklift training that is unique to the facility's forklifts and the work environment.

### **3) Loading Practices**

Install dock leveling and trailer stabilizing devices.

Add cushions to forklift forks.

### **4) Load Configurations**

Double-stack pallets only when it is safe to do so.

Stack light loads on top of heavy loads.

Stack dry good loads on top of liquid good loads.

•Minimize empty space between pallets and loads by pinwheeling or dunnage. (Atkinson,2006)

There are some general practices that have been developed by leading LTL freight carriers, based on their years of hauling cargo.

1. Large and heavy freight should be placed on the bottom. 2. If the trailer is partially loaded, a stair-case method may be used to step down the freight to the rear of the

trailer. 3. Trailers should be loaded tight. 4. Void spaces should be avoided in both lateral and longitudinal directions inside closed van trailers or intermodal containers and box-cars. Use of additional devices such as wooden blocks, load bars, other freight, dunnage, airbags or friction rubber mats may be used based on industry standards that provide safe loading methods.( Paul et al. 2014)

This study contains Figures from shipments that depict the type of damage in packaging an loading practices that is commonly seen in LTL and mixed load environments, and discusses methods to reduce damage and enhance safety In trying to understand how packaging and different loading methods can affect damage claims. This study is conducted from the Data set consists of 56 variables and 2038 records. By studying the figures provided in this section, it is apparent that the strength and protective capabilities of individual packages is critical, not only for the protection of the product, but facilitates loading with other freight.

- **Vehicle's physical condition**

The metal part of the vehicle damaged the cartoon box.

**Figure 1: Example 1 on the vehicle's bad physical condition**

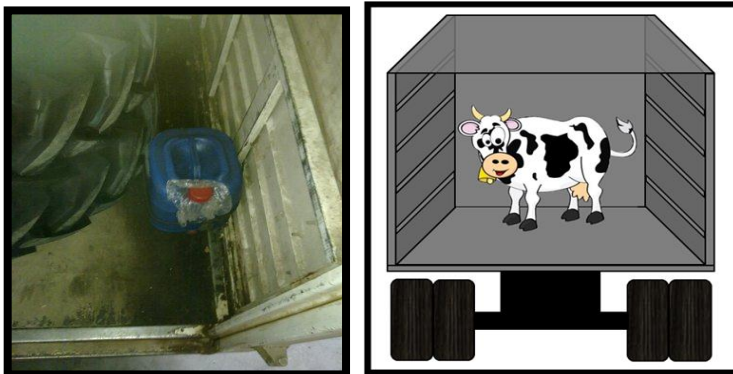


Due to the bad weather conditions there should be a cover for the products not to be damaged. It could be seen in Figure 2 material on the ground floor of the vehicle is not tight.

**Figure 2: Example 2 on the vehicle's bad physical condition**

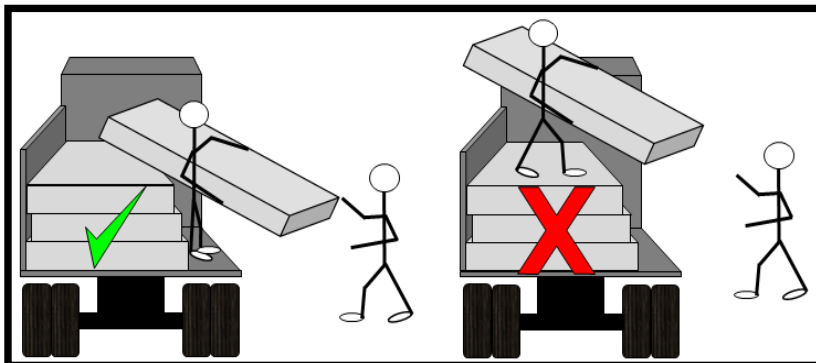


There shouldn't be any liquids which may harm the products. The vehicle should be dry and without any odour.

**Figure 3: Example 3 on the Vehicle's bad physical condition**

- **Stacking Rules**

The big percentage of the loading damages are due to the violation of the stacking rules. The number of stacks, stepping on the product etc.. might be the reasons of the load damage.

**Figure 4: Wrong and right stacking examples**

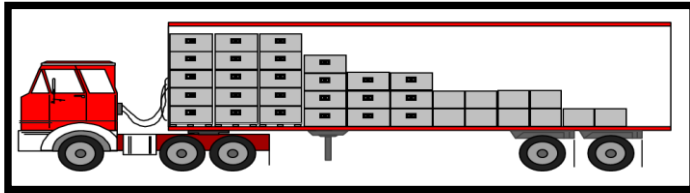
It is also important to distribute the load weight evenly on the floor of the truck or railcar. Lighter cargo should be loaded on top of heavier cargo, and dry goods should be loaded over liquid goods. If the heavy items are not placed on the bottom and the light ones should be on top than the package would be ruined and the one on the top would have the risk of falling down.

**Figure 5-6: Wrong stacking example**

If it is not full truck load than step method should be used. In these conditions the load is more spread across the floor of the trailer to distribute it over the axles and wheels. The trailer shown in Figure 7 have a large amount of boxed freight that is not unitized

and must be stacked from floor to ceiling in order to prevent the products from falling down.

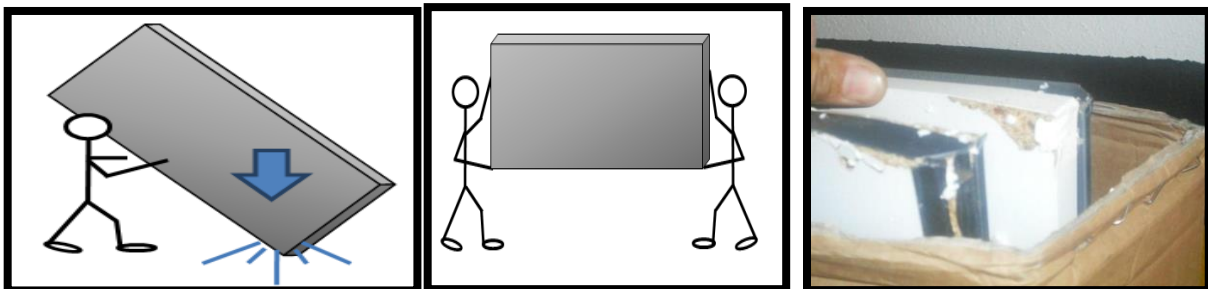
**Figure 7: Step method in stacking**



- **Handling**

During handling and usage of equipments the material and physical conditions of the product should be in mind. If the big items are carried by one person the corners would be damaged. Big and heavy items should be carried by two people.

**Figure 8-9-10: Wrong handling- Right Handling- Damage caused by wrong handling**



- **Attention on the material of the product**

Even if a shipment is loaded properly, it can still sustain damage if the products were not packaged properly in the first place. "Cartons may be too weak to hold the products securely or even if not glass items should be handled more carefully.

**Figure 11: Damage in a box**



- **Physical condition of the warehouse and arrangement of the warehouse**



The distribution warehouses should be organized in order to minimize the walking distances in the warehouses. Otherwise all the handling and loading and stacking efforts should be useless and the warehouse would be in a state which would lead to loss of the products, damage of the products or late products, the risk of accidents etc... In Figure 11 thin boxes are placed under the bigger boxes so it is most likely that the thinner one will get hurt.

**Figure 12-13: Wrong stowage in a warehouse**

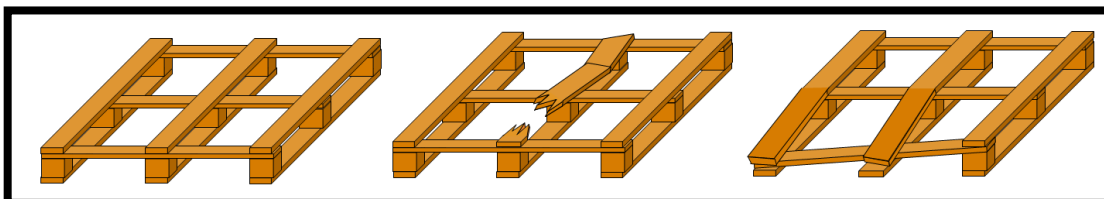


The physical condition of the warehouse is also important, due to extreme weather conditions, the roof should be strong enough and the preventive controls should be done. Cold chain warehouses should be in different conditions. The food products and chemicals should not be kept in the same warehouse.

- **Usage of Broken Pallets**

The most common reason for claims is damage during transit caused by inadequate pallet building. The broken parts of the pallet might damage the products.

**Figure 14: Broken pallet samples**



## APPLICATION

### Data Set

In our application we determined the variables that have an effect on logistic damage. Data set obtained from one of the logistics firms which operates in Turkey. Data set consists of 56 variables and 3245 records. Data mining tools and SPSS Clementine programme is used for the analysis.

**Table 1: Data Set**

	A	B	C	D	E	F	G	H	I
1	CUSTOMER	YEAR	REASON OF THE INVOICE	MONTH	FINAL DESTINATION	PRODUCT TYPE	DAMAGE DAY	PACKAGE TYPE	INVOICE
2	15	2012	LOST-INCOMPETE	12	AVRUPA	PHARMACEUTICAL PRODUCTS	TUESDAY	CARDBOARD	41244
3	15	2012	LOST-INCOMPETE	12	İZMİR	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41272
4	15	2012	LOST-INCOMPETE	12	DIYARBAKIR	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41265
5	15	2012	DAMAGED	11	İZMİR	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41243
6	15	2012	DAMAGED	11	BURSA	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41242
7	15	2012	DAMAGED	11	İZMİR	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41242
8	15	2012	DAMAGED	11	BURSA	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41242
9	15	2012	LOST-INCOMPETE	11	ANTALYA	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41236
10	15	2012	LOST-INCOMPETE	12	KONYA	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41274
11	15	2012	DAMAGED	12	ESKİŞEHİR	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41267
12	15	2012	DAMAGED	12	AVRUPA	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41267
13	15	2012	PENALIZED	12	AVRUPA	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41274
14	15	2012	DAMAGED	12	ANKARA	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41256
15	15	2012	DAMAGED	12	İZMİR	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41256
16	15	2012	LOST-INCOMPETE	11	ANTALYA	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41241
17	15	2012	DAMAGED	12	AVRUPA	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41274
18	15	2012	LOST-INCOMPETE	11	ANTALYA	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41241
19	15	2012	LOST-INCOMPETE	11	ANTALYA	PHARMACEUTICAL PRODUCTS	TUESDAY	CARDBOARD	41241
20	15	2012	DAMAGED	12	AVRUPA	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41247
21	15	2012	LOST-INCOMPETE	11	ANTALYA	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41243
22	15	2012	DAMAGED	11	ANTALYA	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41243
23	15	2012	LOST-INCOMPETE	11	ERZURUM	PHARMACEUTICAL PRODUCTS	FRIDAY	CARDBOARD	41241

15 variables of the data set will be explained in detail:

**1. CUSTOMER GROUP:** These are customers of the Logistics company. Logistics company groups the customers based on sectors. The highest claim rates are for Customer 15, 63 and 23 respectively. It can be seen in Figure 15.

**Figure 15: Distribution of the customers**

Value	Proportion	%	Count
15.000		38,9	1262
63.000		23,58	765
23.000		11,65	378
30.000		7,18	233
40.000		6,57	213
27.000		5,83	189
8.000		3,79	123
43.000		1,36	44
4.000		1,14	37

Customer 15: Pharmaceutical products  
 Customer 63: Home appliances  
 Customer 23: Furniture,  
 Customer 30: Small appliances  
 Customer 40: Glassware  
 Customer 27: Electronic  
 Customer 8: Bath furniture  
 Customer 43: Automotive  
 Customer 4: Textile

The highest claim rates are from Pharmaceutical products, home appliances, furniture, small appliances, glassware, electronic, bath furniture, automotive and textile. Logistics company should focus on preventing steps to lower these rates.

**2. THE YEAR OF THE INVOICE:** Invoices that are dated on 2012 and 2013 are considered on this analysis.

**3. REASON OF THE INVOICE:** This variable shows why Customer invoices to Logistics company.



According to analysis' results damaged goods are the first reason with 76,1%. Lost- incomplete is second reason with 17,46%. Then penalized and lost come with 5,21% and 0,082% respectively. The results can be seen in Figure 16.

**Figure 16: Distribution of reason of the invoice**

Value	Proportion	%	Count
DAMAGED		76,1	2219
LOST-INCOMPLETE		17,46	509
PENALIZED		5,21	152
LOST		0,82	24
OBJECTION		0,17	5
REVISION		0,1	3
PRICE DIFFEREN...		0,07	2

**4. MONTH:** Month of the invoice is considered to analyze claims.

Figure 17 shows that although sales are higher in summer, claims rates are higher in autumn and winter.

**Figure 17: Distribution of the month**

Value	Proportion	%	Count
1.000		20,12	410
2.000		15,21	310
3.000		12,41	253
4.000		3,53	72
5.000		0,88	18
6.000		1,57	32
7.000		1,82	37
8.000		2,21	45
9.000		3,73	76
10.000		6,28	128
11.000		14,38	293
12.000		17,86	364

**5. FINAL DESTINATION:** This is the city of the Customer where good should be handled.

**Figure 18: Distribution of the final destination**

Value	Proportion	%	Count
AVRUPA		10,16	207
ANKARA		9,76	199
ANADOLU		9,52	194
IZMIR		9,18	187
ANTALYA		8,0	163
ADANA		5,99	122
BURSA		3,83	78
KOCAELI		3,48	71
KAYSERI		3,34	68
GAZIANTEP		3,24	66
TRAKYA		3,24	66
MERSIN		3,09	63
SAMSUN		3,09	63
MANISA		2,6	53
BALIKESIR		2,26	46

Claim rate is higher for the cities where delivery rate is higher.

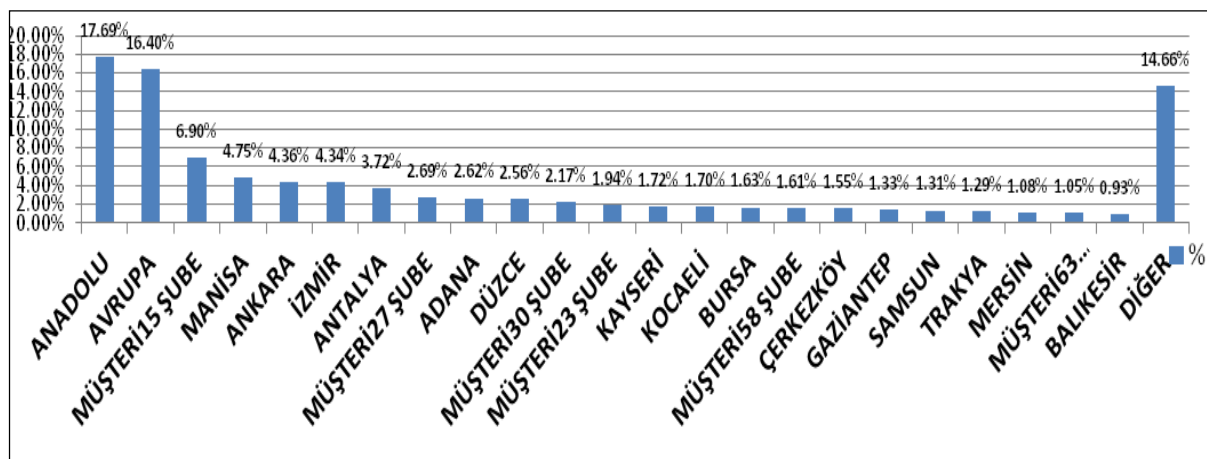
**6. PRODUCT TYPE:** Analysis' results show that which product type get damaged during delivery. Pharmaceutical goods are the one with higher rate. The reason is the damage rate of serums.

**Figure 19: Distribution of Product Type**

Value	Proportion	%	Count
PHARMACEUTICAL PRODUCTS		22,5	730
APPLIANCES		15,32	497
FURNITURE		14,36	466
GLASSWARE		8,6	279
ELECTRONIC		8,26	268
BATH FURNITURE		8,23	267
SMALL APPLIANCES		5,39	175
AUTOMOTIVE		4,25	138
INSTALLATION MATERIAL		4,25	138
MACHINERY UNITS		3,08	100
TEXTILE		2,28	74
SPORTS EQUIPMENT		1,63	53
PLASTIC		1,57	51
CONSTRUCTION EQUIPMENTS]		0,25	8

**7. MODEL OF THE PRODUCTS:** Explain concepts of product type for instance home appliances include dishwasher, oven, microwave and so forth. Electronic includes LCD TV, notebook, etc.

**8. DISTRIBUTION CENTER:** The products might stop in different distribution and transshipment centers due to the logistic or distribution plan. The important issue in this part of the analysis is the place of the damage whether they are damaged on the vehicle or during the distribution.

**Figure 20: Distribution centers**

Due to Figure 20 above Anatolian and European, Customer 15, Manisa, Ankara, İzmir distribution centers have the highest rate of damage and loss cases.

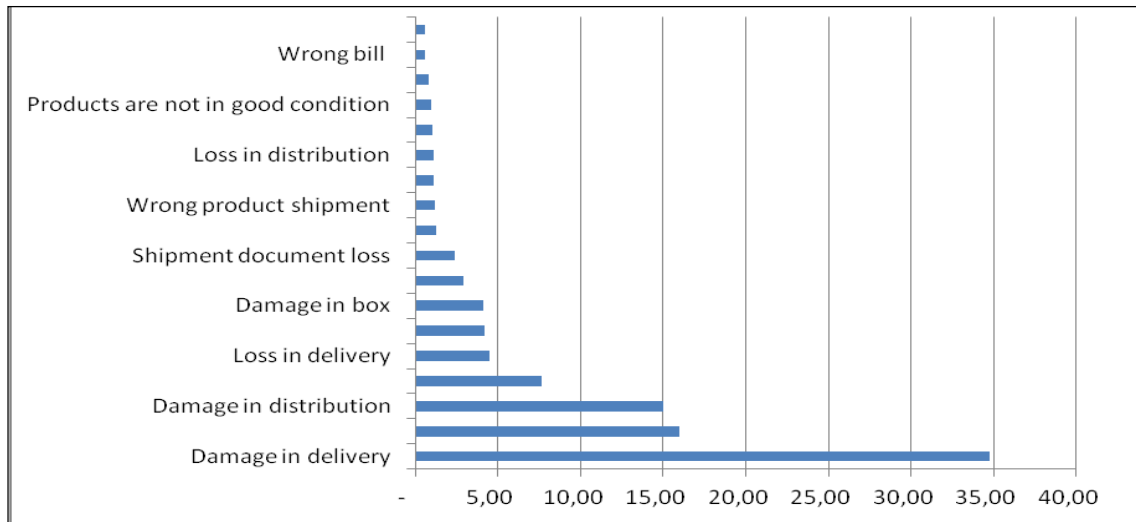
**9. DAMAGE/ LOSS DAY:** Friday has the highest rate of the damage.

**Figure 21: Distribution of the Damage Day**

Value	Proportion	%	Count
FRIDAY		45,47	1475
WEDNESDAY		33,11	1074
THURSDAY		13,75	446
TUESDAY		2,9	94
MONDAY		2,71	88
SATURDAY		1,45	47
SUNDAY		0,52	17
\$null\$		0,09	3

**10. DAMAGE/ LOSS FREQUENCIES:** Due to the Figure 22 damage in delivery and damage in distribution have the highest frequencies.

**Figure 22: Damage/ Loss frequencies**



**11. PACKAGE TYPE:** Packaging is important in logistics. In the Figure 23 the highest damage occurred in cartoon packaging.

**Figure 23: Distribution of Package Type**

Value	Proportion	% ▼	Count
CARDBOARD		92,79	1582
PLASTIC BAG		6,04	103
WOOD BOX		0,65	11
PALLET		0,53	9

## 12.VOLUME:

Deci= Length\* Width \* Height / 3000= 50 cm X50 cm X100 cm / 3000 = 83. 33 (1)

**Table 2: Volume range**

VOLUME (DECI)	
0-5000	1
5001-10000	2
10001-15000	3
15001-20000	4
20001+	5

According to the Figure 24, 30.7% of the boxes are in the 0-5000 deci range. 28.19% are in 5001-10.000 deci range.

**Figure 24: Distribution of volume**

Value ▲	Proportion	%	Count
1.000		30,7	1642
2.000		28,19	1508
3.000		16,58	887
4.000		9,18	491
5.000		15,35	821

**13. SHIPMENT DURATION:** 59.86% of the shipment loaded on the vehicles in 0-1 hour.

%11.7 of the shipment are done in 1:01-2:00 hour.

%6.642 of the shipment are done in more than 10 hours. The loading process can not take 10 hours. We expect idle times in loading the vehicle.

**Table 3: Shipment Duration**

Duration (hour)	
0-1	1
1,01-2	2
2,01-3	3
3,01-4	4
4,01-5	5
5,01-6	6
6,01-7	7
7,01-8	8
8,01-9	9
9,01-10	10
10,01 +	11

**Figure 25: Distribution of the shipment duration**

Value ▲	Proportion	%	Count
1.000		59,86	3202
2.000		11,7	626
3.000		4,23	226
4.000		3,68	197
5.000		3,38	181
6.000		2,41	129
7.000		2,97	159
8.000		2,22	119
9.000		1,61	86
10.000		1,29	69
11.000		6,64	355

**14. Correspondancy of the volume and duration:** The correspondance of the volume loaded on the vehicle and the time of the loading process is important. On time shipment is so important in logistics, for this reason this process should be managed carefully. A problem in an organization might cause the products to arrive to the transshipment centers late which cause to the vehicles to be late to the distribution center. There is a competition in time and there is a continuous circulation of products in transshipment centers. Loading time of the handling personel due to this concerns the duration is so important.

**Table 4: Correspondancy of the volume and duration**

	1	2	3	4	5
1.0	1414	1056	442	121	169
10.0	0	5	16	10	38
11.0	17	15	28	98	197
2.0	157	253	119	65	32
3.0	19	66	75	33	33
4.0	12	33	59	34	59
5.0	13	30	45	20	73
6.0	4	17	31	29	48
7.0	4	18	37	30	70
8.0	1	9	20	39	50
9.0	1	6	15	12	52

**15. License Plate:** With 1262 different license plates 5349 shipments are done. License plate 487 is the one who did the biggest number of shipments. License plate 1259 is the second one. According to our data it is known that shipments are done mostly with these vehicles. This is why the damage records are coming from those vehicles. More analysis should be done on those vehicles.

**Table 5: Correspondancy of the volume and duration**

License Plate	Count	%
License Plate 487	158	1,68
License Plate 1259	120	1,28
License Plate 489	118	1,26
License Plate 650	102	1,09

## Conclusion

In this study the data of the Logistics Company which operates in Turkey is used. Data mining tools and SPSS Clementine programme is applied to the data. Invoices that are dated on 2012 and 2013 are considered on this analysis.

According to the analysis' results, we identified that the highest claim rates are from pharmaceutical products, home appliances and furniture. Logistics company should focus on preventing steps to lower these rates.

The company mostly face with damage and lost-incomplete products problems. Claims rates are higher in autumn and winter. Damage in delivery and damage in distribution have the highest frequencies. The highest damage occurred in cartoon packaging.

When the license plates are examined it's identified that License plate 487 is the one who did the biggest number of shipments. License plate 1259 is the second one. According to our data

it is known that shipments are done mostly with these vehicles. This is why the damage records are coming from those vehicles. More analysis should be done on those vehicles.

The correspondance of the volume loaded on the vehicle and the time of the loading process is important. On time shipment is so important in logistics, for this reason this process should be managed carefully. A problem in an organization might cause the products to arrive to the transshipment centers late which cause to the vehicles to be late to the distribution center. There is a competition in time and there is a continuous circulation of products in transshipment centers. Loading time of the handling personel due to this concerns the duration is so important.

The planning, management and control in logistics is so complicated due to the many factors like man, machine and material. Decision making in logistic regarding those factors are curtial. Improvement of the service quality is dependent on finding the root causes of the damages, they should be studied and improvements should be done on the problems.

Because most of the damages occured more on the vehicles, distribution and transshipment center, the effect of human factor should be considered. Doing the right stacking, handling or the organization of the distribution center are all dependent on human. So the training efforts on the company should be increased.

From the analysis it can be seen that the damage and the losses in distribution decrease the service quality and a big cost of the company due the penalties and it severely effect the reputation of the firm.

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