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MIDDLE EAST TECHNICAL UNIVERSITY

IE 252 – Network Flows and Integer Programming

Efes

GROUP 7

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Table of Contents

Introduction

Efes is a Turkish company that deals with beer and its aspects of production. Efes has been excelling in the Turkish beer market and gaining its place as the name of beer. As such, this means that this company is aiming to reduce costs and expand even further. One of the problems this company is facing is transportation costs. As of right now, transportation costs account for 25% of all costs, meaning for every four dollars this company spends, one dollar goes to transportation. This is a very high ratio and a reduction in shipping costs is in consideration.

Efes has three malt sources: two malt plants in Afyon and Konya, and exported malt through Izmir port. Malt is sent from the malt plants towards breweries, of which there are two: Istanbul and Ankara. After processing the malt and using it to produce beer, Efes ships the product to one of six distribution centers, which are in: Istanbul, Izmir, Antalya, Bursa, Kayseri, and exported back again through Izmir port. The transportation costs from a malt source to a brewery are in table 4, and the shipping costs of beer from a brewery to a distribution center are in table 5 (including costs from and to other brewery sites that will be discussed later):

The yield of malt is how much beer can be produced from malt. The yield of domestic malt is 8.333 million liters of beer for every 1000 tons of malt. The yield of imported malt is closer to 9.091. Each brewery and malt plant has a set capacity (table 1).

Table 1

Capacity of Each Malt Plant and Brewery (in each's respective units)

Breweries	Million liters/year
Istanbul	220
Ankara	200

Malt Plant	1000 tons/year
Afyon	30
Konya	68
Import (Izmir)	20

Efes has a plan as of now, but the executives believe they can improve it. Efes does not want to break the professional relationships formed between some of the Brewery-distributor pairs, mainly Istanbul-Antalya and Ankara-Bursa, but may do so if a new plan decreases costs enough.

Beyond that, Efes is planning to build breweries to further sustain demand, and has allotted a 3-year period for building and expanding a new brewery in a new site. These potential sites include Izmir, Sakarya, and Adana. Efes has an idea about how demand will change in the next three-year (in table 2), but wants to study whether building a new brewery within the next 3-years can offset the otherwise-high transportation costs over a 20-year horizon.

Table 2

Demand of Beer in Each Distribution Center for the Next Three Years (in Million Liters)

	Year 1	**Year 2**	**Year 3**
Istanbul	103	110	125
Izmir	74	80	90
Antalya	50	53	60
Bursa	60	75	85
Kayseri	102	110	125
Export(Izmir)	13	13	15

The executives want to pay for the one-time costs of opening these new brewery sites and expanding them by borrowing money for a 10% annual opportunity rate. The costs are in table 3:

Table 3

Cost of Opening and Expanding the Potential Breweries in Each Site (in million $)

	Open	Expand
Izmir	75	30
Sakarya	70	27
Adana	68	25

Any new brewery, when first open, will have a total capacity of 70 million liters of beer. Once expanded, that number rises to 50 million liters. The total is 120 million liters, which is substantially lower than Istanbul or Ankara's brewery, but Efes believes it is enough.

Finally, the transportation costs of malt and beer, from and to the potential breweries and the pre-existing ones, are presented in tables 4 and 5, respectively:

Table 4

Costs of shipping malt (in million $/1000 tons) from a malt source to a brewery

	Istanbul	Ankara	Izmir	Sakarya	Adana
Afyon	0.026	0.017	0.020	0.019	0.032
Konya	0.037	0.017	0.031	0.030	0.022
Import (Izmir)	0.032	0.033	0.004	0.028	0.048

Table 5

Costs of shipping beer (in million $/million liters) from a brewery to a distribution center

	Istanbul	Izmir	Antalya	Bursa	Kayseri	Export (Izmir)
Istanbul	0.000	0.040	0.052	0.017	0.055	0.042
Ankara	0.032	0.041	0.039	0.027	0.023	0.043
Izmir	0.040	0.000	0.032	0.023	0.062	0.002
Sakarya	0.011	0.034	0.041	0.011	0.045	0.036
Adana	0.067	0.064	0.040	0.060	0.024	0.066

This report will encompass the usage of linear and mixed-integer programming models and GAMS to solve each issue separately. The first transshipment model will be tackled in Part I, and the second model will be tackled in Part II.

PART I

As said before, Efes wants to see how much can be saved in transportation costs when all parameters are chosen optimally and without regard to any professionally-established relations. A transshipment-like model will be formulated, with some assumptions:

- All transportation costs are not subject to change in the year of study, even if inflation is present. If inflation is present, it will be assumed that all costs change in the same proportion so that the optimal solution would not change, only the nominal value of the objective function.
- Excess inventory, as Efes executives have explained, shall not transfer over to the next year. For this one-year study, this means that inventories in breweries and distribution centers will be empty at the end.
- There will be no loss in the yield of malt; any amount of malt going into a brewery will transform fully and completely to beer. In other words, breweries are 100% efficient and any inefficiency is neglected.
- Any malt going into a brewery will be immediately transformed into beer; malt inventory does not count towards the maximum capacity of a brewery.
- Certainty, proportionality, and divisibility assumptions are valid.

Under these assumptions, the model is as follows:

Mathematical Model

Sets:

$i \in I = \{Afyon, Konya, Import\}$: plant i

$j \in J = \{Istanbul, Ankara\}$: brewery j

$k \in K = \{Istanbul, Izmir, \dots Export\}$: distribution center k

Parameters:

t_{ij}^{m}: Cost of shipping malt (in million $ per 1000 tons) from malt plant i to brewery j

C_i^m: Capacity of malt plant i (in 1000 tons)

$Y_{domestic}, Y_{import}$: The yield of malt (in million liters) from 1000 tons of malt, depending on the source of the malt

t_{jk}^{b}: Cost of shipping beer (in million $ per million liters) from brewery j to distribution center k

C_j^k: Capacity of brewery j (in million liters)

D_k: Demand of distribution center k (in million liters)

Decision Variables:

m_{ij}: The amount of malt (in thousand tons) transported from malt plant i to brewery j

b_{jk}: The amount of beer (in million liters) shipped from brewery j to distribution center k

Objective Function:

$$\textbf{Min } z = \sum_{i \in I, j \in J} t_{ij}^m m_{ij} + \sum_{j \in J, k \in K} t_{jk}^b b_{jk}$$

$$\textbf{Min } z = [\text{cost of shipping malt}] + [\text{cost of shipping beer}]$$

Constraints:

$\sum_{j \in J} m_{ij} \leq C_i^m \; \forall \; i \in I$ (Supply constraint)

The amount of malt shipping from malt plant i cannot exceed the respective capacity.

$\sum_{k \in K} b_{jk} \leq C_j^b \; \forall \; j \in J$ (Brewery Capacity Constraint)

The amount of beer than can be sustained by a brewery j shall not surpass its capacity.

$Y_{domestic} \sum_{i \in \{Afyon, Konya\}} m_{ij} + Y_{import} m_{(Import)j} = \sum_{k \in K} b_{jk} \; \forall \; j \in J$

(Yield of malt constraint)

Malt going into the brewery will be made into beer according to the yield of the malt, which differs according to its origin.

$\sum_{j \in J} b_{jk} \geq D_k \; \forall \; k \in K$ (Demand Constraint)

Demand must be met.

Sign Restrictions:

$m_{ij} \geq 0 \; \forall \; i \in I, j \in J$

$b_{jk} \geq 0 \; \forall \; j \in J, k \in K$

Results

After formulating the model in GAMS and using Linear Programming Simplex Method to solve it, the objective function value at optimum is $z = 9.9$ Million USD, around 10% less than the current transportation plan. The optimal basis and values of basic variables are presented in tables 9 and 10:

Table 9

Optimal Malt Transportation Plan (in 1000 tons)

m_{ij}	Istanbul	Ankara	Total	Capacity of Malt Plants	Situation
Afyon	24.24	5.759	30	30	Binding
Konya		18.24	18.24	68	Non-binding
Import			0	20	Non-binding
Total malt	24.24	24			
Total beer	202	200			

Table 10

Optimal Beer Transportation Plan (in Million Liters)

b_{jk}	Istanbul	Izmir	Antalya	Bursa	Kayseri	Export (Izmir)	Total	Capacity of Breweries
Istanbul	103	26		60		13	202	220
Ankara		48	50		102		200	200
Total	103	74	50	60	102	13		
Demands	103	74	50	60	102	13		

As a result of this optimal model, Istanbul brewery no longer sends beer to Antalya distribution center, and Ankara no longer sends beer to Bursa either.

In addition, imported malt is no longer being utilized in production, despite its higher yield of beer. This may drive down expenses, though, as inflation may cause importing to prove costly. In the first assumption, it was assumed that inflation would not be a problem, but in case of imported malt, this will not always hold true.

Since the model is solved, the main question comes in mind: Does the reduction in costs justify the brewery-center relationship pairs that have been already established? It is necessary to account for reliability of current distributors. If new distributors are to be sought out, then the possible delays of deliveries may damage sales, effectively decreasing it. In that case, the payment of 10% more for transportation is justified, since it would also pay for just-in-time delivery. Essentially, unreliability may offset the cheaper transportation costs by much more.

Looking at it in a more mathematical sense, distribution costs account for 25% of all costs, lowering that number by 10% means a general decrease in expenditures by roughly 2.5%. If the new distributors are unreliable in their delivery times or sales, demand satisfaction may get hindered by much more than that figure. So, if current distributors are reliable in their delivery times, the extra cost would be justified.

In addition, one should account for future costs. Since inflation seems inevitable, and since there is a well-established relationship between the brewery-distributor pairs, the former may aid the latter by not raising the inflated costs of beer as other breweries might do. A thorough analysis or negotiation between both ends can determine whether changing the relations may be of benefit to Efes or not.

So, what is needed to be done so that Efes can maintain the optimum solution and keep the brewery-distribution center pairs, both? A thorough analysis on the cost of shipping beer between each beer can be made, with the help of GAMS output (output box 11).

Output Box 11

Reduced Cost (Marginal) of the transportation costs Between Established Partners

	LOWER	LEVEL	UPPER	MARGINAL
⋮		⋮	⋮	
Istanbul.Antalya	.	.	+INF	0.0139
⋮		⋮	⋮	
Ankara .Bursa	.	.	+INF	0.0089
⋮		⋮	⋮	

The reduced cost and the amount to decrease the cost of shipping 1 million liter of beer from Istanbul to Antalya is 0.0139 (million dollars) from Istanbul to Antalya, so that Efes can send beer between those partners. Hence: $t^{b}_{Istanbul,Antalya} = 0.052 - 0.0139 \approx \$0.038$ million. Concluding that the shipping cost has to be less than or equal to 0.038 million dollars for Efes to start shipping from Istanbul to Antalya, we would like to note that at a cost of $38,000, Efes doesn't explicitly profit from this action, the optimal objective function value is maintained as that level.

For shipping from Ankara to Bursa, Efes would want to decrease the cost with 0.0088 (million dollars) per kiloton so that Efes can start shipping from Ankara to Bursa. We note here as well that at $t^{b}_{Ankara,Bursa} = 0.027 - 0.0089 \approx \$0.0181$ million, Efes evens out the costs and redistributes them, whilst keeping the established relationships, of course.

Even though importing malt is a decision that Efes may dislike, there may still be an incentive to discuss importing malt through Izmir Port. Such incentives include international relations with international malt distributors, and others. How much should the shipment decrease to achieve that?

As discussed, importing malt in the first year for Efes is not a cost-effective decision. Although decreasing the transportation cost from the import point Izmir to Istanbul's brewery by 0.0029 (i.e., its reduced cost) where it becomes $0.0291 million would make importing malt a cost-effective solution. An alternative or simultaneous solution is to decrease the transport cost Izmir to Ankara's brewery by 0.0143 where it becomes $0.0187 million, or $18,700 per 1000 tons

would make importing malt in the first year a viable solution. Of course, of the two options, it would be easier to decrease the costs from Izmir to Istanbul.

PART II

After discussing the ways to improve the transportation plans in a certain year, Efes is thinking over a 20-year horizon. They have potential brewery sites in mind, and want to open them if and only if the cost of opening the new brewery shall offset some of the transportation costs. Potential brewery sites are Izmir, Sakarya, and Adana. The model will include Yes-No variables, and one-time costs associated with these variables.

To open the breweries, Efes will take a loan at the start of the current year (Year 1) should they decide to open or expand any brewery site. This means any costs of opening or expanding any brewery site are subject to a pre-determined discount rate of 10%, annually. Considering this, the cost of opening a brewery at a year y, where C_{j1}^{N} is the cost of opening that same brewery in year 1, follows the equation: $C_{jy}^{N} = \frac{C_{j1}^{N}}{(1+0.1)^{y-1}}$.

Before starting with the model, some assumptions need to be made:

- All assumptions from the previous model are valid, except for divisibility (due to the inclusion of Yes-No/Binary variables).
- Opening a potential brewery happens instantaneously at the start of the year if decided as so. The payment of the opening costs is also done at the start of the year, coinciding with the opening.
- Expanding the brewery will not halt the production – at least any slowdowns by expansion is negligible.
- Since the demand is elastic in the first three years, it may be a good idea to formulate the model with elastic demand as well. However, there is no guarantee that demand will increase after year 3. What might happen is the demand reaching a plateau. What might also happen is demand decreasing. So, after year 3, the middle ground of demand will be taken; from year 4 to 20, the demand will be exactly the same as year 3.
- The discount rate is assumed to not change over the first three years.
- A brewery is allowed to open and expand in the same year, where both happen instantaneously and simultaneously, as well as at the start of said year.

Based off these assumptions, the model is as follows:

Mathematical Model

Sets:

$i \in I = \{Afyon, Konya, Import\}$: plant i

$j \in J = \{Istanbul, Ankara\}$: brewery j

$k \in K = \{Istanbul, Izmir, \dots Export\}$: distribution center k

$y \in Y = \{1,2, \dots 20\}$: year y

Parameters:

t_{ij}^{m}: Cost of shipping malt (in million $ per 1000 tons) from malt plant i to brewery j

C_i^m: Capacity of malt plant i (in 1000 tons per year)

Y_i: The yield of malt (in million liters) from 1000 tons of malt, depending on the source of the malt

t_{jk}^{b}: Cost of shipping beer (in million $ per million liters) from brewery j to distribution center k

C_j^k: Capacity of already-existing brewery j (in million liters per year)

N_j^b Capacity of new brewery j after being opened (in million liters per year)

E_j^b: Capacity of new brewery j after being expanded (in million liters per year)

D_{ky}: Demand of distribution center k (in million liters per year) in year y

C_j^N: Cost of opening a new brewery j (in million $) bearing the 10% opportunity cost

C_j^E: Cost of expanding a new brewery j (in million $) bearing the 10% opportunity cost

Decision Variables:

m_{ijy}: The amount of malt (in thousand tons) transported from malt plant i to brewery j in year y

b_{jky}: The amount of beer (in million liters) transported from brewery j to distribution center k in year y

$$o_{jy} = \begin{cases} 1, \text{if new brewery in site j opens in year y} \\ 0, \text{otherwise} \end{cases}$$

$$e_{jy} = \begin{cases} 1, \text{if new brewery in site j opens in year y} \\ 0, \text{otherwise} \end{cases}$$

Objective Function:

$$\textbf{Min } z = \sum_{i\in I, j\in J, y\in Y} t_{ij}^{m} m_{ijy} + \sum_{j\in J, k\in K, y\in Y} t_{jk}^{b} b_{jky} + \sum_{j\in J, y\in Y} \left(C_{jy}^{N} o_{jy} + C_{jy}^{E} e_{jy}\right)$$

$$\textbf{Min } z = [\text{cost of shipping malt}] + [\text{cost of shipping beer}] + [\text{cost of opening new brewery sites}] + [\text{cost of expanding any of the newly opened brewery sites}]$$

Constraints:

$\sum_{j\in J} m_{ijy} \leq C_j^m \; \forall \; i \in I, y \in Y$ (Supply Constraint)

Malt exiting the plant i cannot exceed its capacity.

$\sum_{k\in K} b_{jky} \leq C_j^b + \sum_{t=1}^{y} N_j^b o_{jt} + \sum_{t=1}^{y} E_j^b e_{jt} \; \forall \; j \in J, y \in Y$

(Brewery Capacity Constraint)

The brewery cannot sustain more than its capacity. For the potential brewery sites, C_j^b is 0, and the other parameters, N_j^b and E_j^b are 0 for the already existing breweries since they cannot open nor expand.

$\sum_{i\in I} Y_i m_{ijy} = \sum_{k\in K} b_{jky} \; \forall \; j \in J, y \in Y$ (Malt Yield Constraint)

Malt going into the brewery will be made into beer according to the yield of the malt, which differs according to its origin.

$\sum_{y \in Y} o_{jy} \leq 1 \ \forall j \in J$ (Only Open Once)

A potential brewery site j can open only once.

$\sum_{y \in Y} e_{jy} \leq 1 \ \forall j \in J$ (Only Expand Once)

A potential brewery site j can expand only once.

$e_{jy} \leq \sum_{t=1}^{y} o_{jt} \ \forall j \in J, y \in Y$ (Only Expand Opened Site)

A potential brewery site j can expand only when it has been opened before or in the same year.

$o_{jy} = 0; \ e_{jy} = 0 \ \forall j \in \{Istanbul \ Ankara\}, y \in Y$

(Existing Breweries Won't Open or Expand)

Istanbul and Ankara breweries are not allowed to open or expand, since they are pre-built

$o_{jy} = 0; e_{jy} = 0 \ \forall j \in J, y \in \{4, 5, \dots 20\}$ (No Expansion or Opening After 3 Years)

The opening and expansion window of new breweries is only allowed within the first three years.

$\sum_{j \in J} b_{jky} \geq D_{ky} \ \forall k \in K, y \in Y$ (Demand Constraint)

Demand must be met.

Sign Restrictions:

$m_{ijy} \geq 0 \ \forall i \in I, j \in J, y \in Y$

$b_{jky} \geq 0 \ \forall j \in J, k \in K, y \in Y$

$o_{jy}, e_{jy} \geq 0 \geq 0, \text{binary} \ \forall j \in J, y \in Y$

Result

After solving the problem, the optimal objective value is $z = \$248.2$ Million. Since the output is very large, a more detailed representation of the optimal solution is available in appendices A1 and A2.

Planning the capacity expansion is very important to keep up with the demand, hence staying on the market. Solving the capacity expansion model yields a brewery implementation in Izmir – it consumes just under a third of Istanbul's brewery's production, so it makes sense to open a brewery there – that should be ready by the beginning of the second year and expanding it to start the production again in the beginning of the third year. The costs considered in the objective function are cost of shipping malt from the malt plants or import points; costs of shipping beer from opened breweries and breweries to be opened as well, to distribution centers; cost of opening new breweries and the cost of expanding opened ones. These costs are accounted over a period of 20 years.

What are the benefits opening early? There's basically a trade-off: knowing that taking the loan in the 1st year and open the brewery in the 2nd year reduce the cost of the loan by 1% and expansion by 1%, but Efes needs to tolerate the transportation costs of beer from breweries to Izmir, or to take a loan in the 1st year and directly open a brewery in Izmir that year which might be more expensive to achieve and expand it later on either 2nd or 3rd year. Off the results provided by the model, it is better to open the brewery in Izmir in the 2nd year and expand in the 3rd. If the opening cost decreases the GAMS-provided reduced cost, by over a whopping $54 million (over half the current cost!), it becomes feasible to open the brewery in the 1st year.

The parts of the model that are prone to uncertainty are the fact that the expectations of rise in demand of beer can be inaccurate, the behavior of a mass population cannot be predicted, due so many variables. Moreover, the malt supply can also be unstable because of climate conditions (Yawson et al., 2020), which can affect the beer production catastrophically, and it can't really be predicted, especially with climate change nowadays, the behavior of climate in order to take prevention measures.

The cities with no breweries have a much more sensitive demand than cities that have breweries. For example, notice that shadow price for beer demand in Izmir for the first 2 years is high i.e., $0.0435M and $0.0434M then after the brewery opened the shadow price became 0.0092 (when it started supplying to Izmir). We can also see that when Izmir started exporting beer, the shadow price of exporting beer declined more than 3 quarters: from 0.0450 to 0.0107 (all shadow prices are in million dollars). This can be simply explained by the fact that the cities with breweries have also low transportation costs.

The efforts should be spent on forecasting the demand for beer. After all, it is the most important piece of information: it avoids stress and any losses due to implementing new breweries, borrowing money, expanding breweries, buying more malt and resources, etc.

One thing to notice is that the shadow price of the demand of local demand of Izmir shifts by only 0.001 million dollars (or $1000) from year 1 to year 2 at around $430,000. This is most likely to the brewery opening in Izmir prioritizing its output to export, and any additional would then go to local demand of Izmir. This is evident in Izmir dishing out all of its output to both local and export demand of Izmir. Before the opening, Istanbul was fulfilling the international demand. So, the algorithm found it more feasible to prioritize Izmir's output to export in year 2, and direct Ankara's output to Izmir in year 2, which is why the shadow price decreases by only a thousand dollars. After the expansion of the Izmir brewery in year 3, it is now able to sustain both local and international demand, which can be seen from the shadow price decreasing by almost 4 folds to $92,000. In other words, Izmir brewery is prioritizing the international demand over local demand.

Another thing to notice is that if Efes chose to open breweries past the three-year horizon, in the fourth year perhaps, then Sakarya would have been a very good option to open, since its reduced cost is -$10million, meaning adding it would have decreased the objective function by that much. However, due to the decision taken by Efes executives, this is not possible. Uncertainty is high after three-years.

In addition, Afyon malt plant could direct its shipment towards Izmir after it opens, given that the transportation cost is decreased by $16,200. And, if the transportation between Istanbul brewery and Kayseri decreased by $335,000, it would direct its shipment there. The cost would then be $\approx \$0.019$ Million per million liters of beer.

Also, if Ankara increased its breweries capacity by 1 million liters, it year 1, it would be able to decrease the optimal objective value by a miniscule amount, in the magnitude of 10^{-5}. In the following years, however, the capacity isn't full and slack is present, so increasing the capacity would have no effect.

Conclusion

To summarize the findings of the mathematical models and analyses of the results, Efes should only consider changing the relationships established between the Ankara-Bursa and

Istanbul-Antalya breweries-distribution centers if they find truly reliable and consistent distribution centers with consistent delivery times and sales. So, maybe Efes does have to cut ties with these distributors, if they can guarantee optimal delivery times, and transportation cost would be reduced by 10%, causing roughly 22.5% now to go to deliveries.

On the other hand, alternatives also have been considered, for example reducing the cost of shipping beer by choosing another truck company for example or changing the type of transportation, would allow Efes to keep the pre-established relationships (Istanbul-Antalya and Ankara-Bursa) while keeping the objective cost stable. Alternatives can also be explored to actually make the objective function value better while keeping the relationships afloat – it really is something to think about – by exploring other means of transportation.

The malt used by Efes in the 1st year will be all domestic malt and Efes may find it better to keep it domestic for the following years so it can be a 100% Turkish beer, which would be a marketing strategy as well. Then, Efes should open a brewery in Izmir in its 2nd year and expand it in the 3rd year in order to keep up with the increasing demand of the beer market and preserve its perennity. Even with the uncertainty of the demand forecasts, Efes can figure out ways to profit from this new plant since it alone consumes a big amount of beer, and it can export from there as well.

References

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Appendix A

Group of Tables A1

Optimal Malt Transportation Plan for Years 1, 2, and 3 and Beyond

$y = 1$	m_{ijy}	Istanbul	Ankara	Total	Capacity of Malt Plant
	Afyon	24.24	5.759	30	30
	Konya		18.2419	18.24	68
	Import			0	20
	Total Malt	24.24	24		
	Total Beer	201.99	200		
	Capacity of Brewery	220	200		

$y = 2$	m_{ijy}	Istanbul	Ankara	Izmir	Total	Capacity of Malt Plant
	Afyon	22.20009	7.7991		30	30
	Konya		14.5218		14.52	68
	Import			7.6999	7.7	20
	Total Malt	22.2	22.32	7.7		
	Total Beer	184.99	186	70		
	Capacity of Brewery	220	200	70		

$y = 3, 4, \ldots 20$	m_{ijy}	Istanbul	Ankara	Izmir	Total	Capacity of Malt Plant
	Afyon	25.201	4.799		30	30
	Konya		15.6018		15.6	68
	Import			13.1999	13.2	20
	Total Malt	25.2	20.4	13.2		
	Total Beer	210	170	120		
	Capacity of Brewery	220	200	120		

Group of Tables A2

Optimal Beer Transportation Plan for Years 1,2, and 3 and Beyond

	b_{jky}	Istanbul	Izmir	Antalya	Bursa	Kayseri	Export	Total	Capacity of Brewery
$y = 1$	Istanbul	103	26		60		13	202	220
	Ankara		48	50		102		200	200
	Total Beer	103	74	50	60	102	13		
	Demand of Distribution Center	103	74	50	60	102	13		

	b_{jky}	Istanbul	Izmir	Antalya	Bursa	Kayseri	Export	Total	Capacity of Brewery
$y = 2$	Istanbul	110			75			185	220
	Ankara		23	53		110		186	200
	Izmir		57				13	70	70
	Total Beer	110	80	53	75	110	13		
	Demand of Distribution Center	110	80	53	75	110	13		

$y = 3, 4, \ldots 20$	b_{jky}	Istanbul	Izmir	Antalya	Bursa	Kayseri	Export	Total	Capacity of Brewery
	Istanbul	125			85			210	220
	Ankara			45		125		170	200
	Izmir		90	15			15	120	120
	Total Beer	125	90	60	85	125	15		
	Demand of Distribution Center	125	90	60	85	125	15		