

DR. BÉLA RÉGER

به وبسایت ما مراجعه کنید

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USING WINQSB MODELING SOFTWARE FOR ALGIERS LOGISTICS COURSE 2ND PART PRACTICE

A WINQSB MODELLEZÉSI SZOFTVER ALKALMAZÁSAI LEHETŐSÉGE AZ ALGIR LOGISZTIKAI KURZUSON II. RÉSZ. A GYAKORLAT

Given the advances made in information technology, both hardware and software, it has become possible to create software for operations improvement for use in the academic and small business environment that is technically on-par with the most sophisticated product available. In this paper I describe one such software, QSB Quantitative Systems for Business and comment on its managerial orientation. I give examples of its use for case analysis. Keyword: Logistics, modeling transportation- and traveling salesman problem, logistics course

A folyamatos fejl és figyelhető meg az információs technológia, mind a hardver és a szoftver területén, ma már lehet vé vált, olyan könnyen elérhető megfizethető szoftverek alkalmazása a logisztikai folyamatok javításához amely használható az egyetemi oktatási és akkár kis üzleti vállalkozási környezetben. Ebben a tanulmányban bemutatok egy ilyen szoftvert, a QSB-t (Kvantitatív Rendszerek az Üzleti életben a menedzsment szempontjából). Példákon keresztül mutatom be a használatát és az elemzési lehet ségeit. Kulcsszavak: Logisztika, modellezés, szállítási- és az Utazó Ügynök Problém, logisztikai kurzus.

3. Examples Application of WinQSB for Transportation Problem: An Example

Problem: National Support Element needs to transport fuel from four warehouses to five supply center. Information on production plants and their available capacities for the next 3 months is given on the left hand side of the following table. The distribution centers and their forecasted demand is listed on the right hand side of the following table.

NSE	Production Capacity	Distribution Center	Demand Forecast
Source 1	500	Destination I	300
Source 2	200	Destination II.	400
Source 3	400	Destination III.	500
Source 4	800	Destination IV	300
Total	1900	Destination V.	400
		Total	1900

(Source: edit by author)

The transportation cost per unit from each plant to each distribution center is given the table below:

Origin	Destination				
	Destination I	Destination II.	Destination III.	Destination IV.	Destination V.
Source 1	30	25	40	10	20
Source 2	10	30	20	25	40
Source 3	20	15	25	10	25
Source 4	25	20	15	40	35

(Source: edit by author)

Management would like to determine how much of its production should be shipped from each warehouse to each supply center with a minimum total cost. Enter the problem: Select “Network module” from WinQSB. Click on “File” and “New Problem” button. Select “Transportation Problem” and input information that are asked for as below.



(Source: edit by author)

You do not need to consider balancing the transportation problem (dummy supply or dummy demand). The software will do that. However, if you have information for penalty costs you need to define a dummy supply point. You can “Edit” the names for source and demand points (node names). Enter unit cost and capacity information as below:

The screenshot shows the 'Network Modeling' software interface. The title bar reads '1_ALGR: Minimization (Transportation Problem)'. Below the title bar, there is a table for inputting data. The table has columns for 'From \ To', 'Destination 1', 'Destination 2', 'Destination 3', 'Destination 4', 'Destination 5', and 'Supply'. The rows represent 'Source 1' through 'Source 4' and a 'Demand' row.

From \ To	Destination 1	Destination 2	Destination 3	Destination 4	Destination 5	Supply
Source 1	30	25	40	10	20	500
Source 2	10	30	20	25	40	200
Source 3	20	15	25	10	25	400
Source 4	25	20	15	40	35	800
Demand	300	400	500	300	400	

(Source: edit by author)

Solve the problem: Click on “Solve and Analyze” then select “solve the problem”. Below is the solution.

The screenshot shows the 'Solution for 1_ALGR: Minimization (Transportation Problem)' in the software. The table displays the optimal solution with columns for 'From', 'To', 'Shipment', 'Unit Cost', 'Total Cost', and 'Reduced Cost'. The total cost is 30000.

	From	To	Shipment	Unit Cost	Total Cost	Reduced Cost
1	Source 1	Destination 4	100	10	1000	0
2	Source 1	Destination 5	400	20	8000	0
3	Source 2	Destination 1	200	10	2000	0
4	Source 3	Destination 2	200	15	3000	0
5	Source 3	Destination 4	200	10	2000	0
6	Source 4	Destination 1	100	25	2500	0
7	Source 4	Destination 2	200	20	4000	0
8	Source 4	Destination 3	500	15	7500	0
	Total	Objective	Function	Value =	30000	

(Source: edit by author)

Obtain more information: Click on “results?”. You have many options including “Range of Optimality”, “Range of Feasibility”, “Graphic Solution”, and “Perform Parametric Analysis”.

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مهندسی صنایع و مدیریت

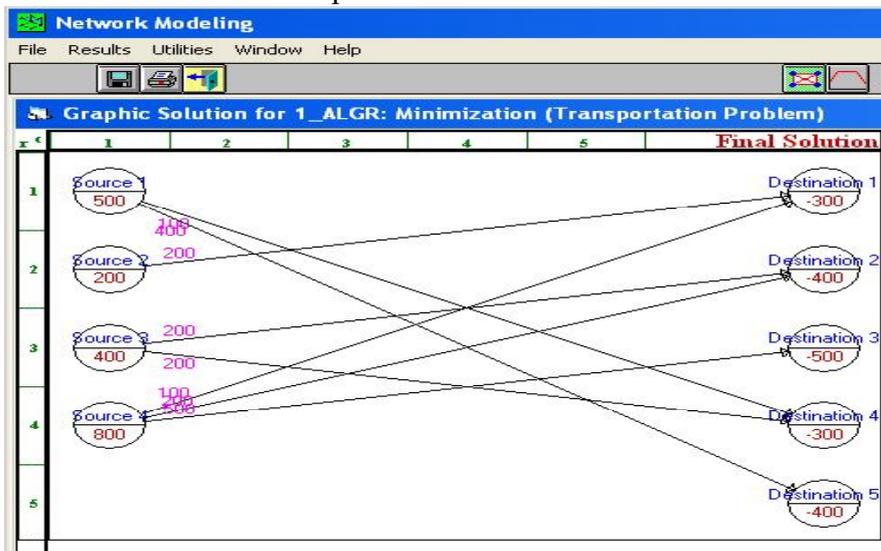
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06-13-2010	From	To	Shipment	Unit Cost	Total Cost	Reduced Cost
1	Source 1	Destination 4	100	10	1000	0
2	Source 1	Destination 5	400	20	8000	0
3	Source 2	Destination 1	200	10	2000	0
4	Source 2	Destination 2	200	15	3000	0
5	Source 3	Destination 4	200	10	2000	0
6	Source 4	Destination 1	100	25	2500	0
7	Source 4	Destination 2	200	20	4000	0
8	Source 4	Destination 3	500	15	7500	0
	Total	Objective Function	Value =		30000	

(Source: edit by author)

Below is the result for “Graphic Solution”:



(Source: edit by author)

Here is the result for “Range of Optimality”: That is coefficients in objective function (unit cost of shipment). It provides the range (Allowable Min and Allowable max) that the coefficient (Unit Cost) can change and still have the same solution (X_{ij}) but with different minimum cost (refer to your slides on sensitivity analysis for LP).

Notice that similar to Linear Programming you have “basic” and “at bound” (nonbasic) variables. For at bound variables you have “Reduced Cost” information similar to Linear Programming.

(Transportation Problem)

06-13-2010 21:49:12	From	To	Unit Cost	Reduced Cost	Basis Status	Allowable Min. Cost	Allowable Max. Cost
1	Source 1	Destination 1	30	10	at bound	20	M
2	Source 1	Destination 2	25	10	at bound	15	M
3	Source 1	Destination 3	40	30	at bound	10	M
4	Source 1	Destination 4	10	0	basic	5	15
5	Source 1	Destination 5	20	0	basic	-5	25
6	Source 2	Destination 1	10	0	basic	-M	25
7	Source 2	Destination 2	30	25	at bound	5	M
8	Source 2	Destination 3	20	20	at bound	0	M
9	Source 2	Destination 4	25	25	at bound	0	M
10	Source 2	Destination 5	40	30	at bound	10	M
11	Source 3	Destination 1	20	0	at bound	20	M
12	Source 3	Destination 2	15	0	basic	5	15
13	Source 3	Destination 3	25	15	at bound	10	M
14	Source 3	Destination 4	10	0	basic	5	15
15	Source 3	Destination 5	25	5	at bound	20	M
16	Source 4	Destination 1	25	0	basic	10	25
17	Source 4	Destination 2	20	0	basic	20	30
18	Source 4	Destination 3	15	0	basic	0	30
19	Source 4	Destination 4	40	25	at bound	15	M
20	Source 4	Destination 5	35	10	at bound	25	M

(Source: edit by author)

Here is the result for “Range of Feasibility”: That is capacities of supply and demand points. It provides the range (Allowable Min and Allowable max) that the capacity can change and still have the same basis (ship from one node to the other) but with different amount of shipment and minimum cost (refer to your slides on sensitivity analysis for LP). Notice that similar to Linear Programming you have “Shadow Price” information.

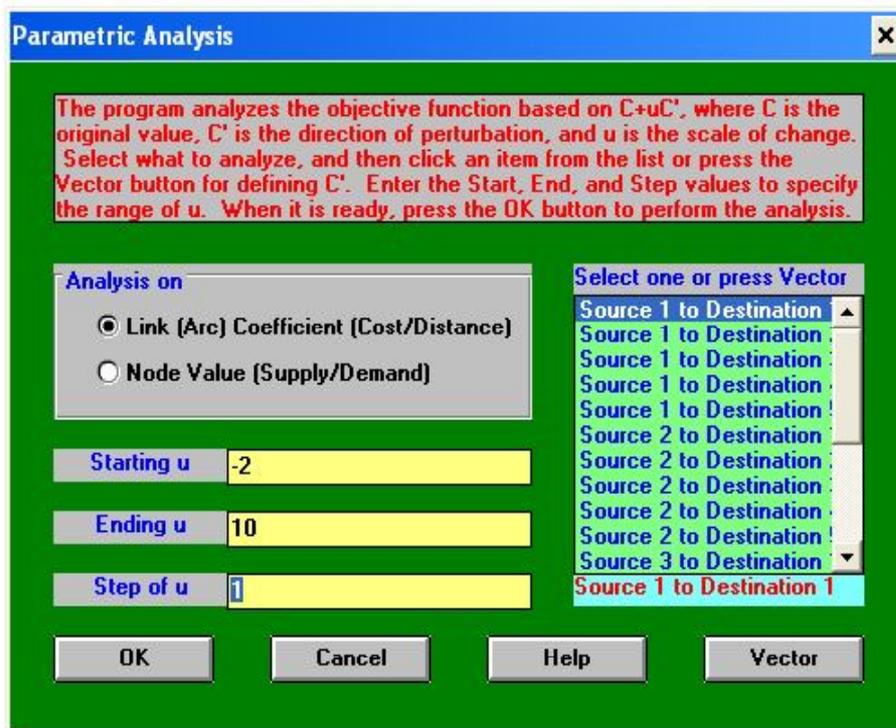
Range of Feasibility for 1_ALGR: Minimization (Transportation Problem)

06-13-2010 21:57:08	Node	Supply	Demand	Shadow Price	Allowable Min. Value	Allowable Max. Value
1	Source 1	500	0	-5	500	700
2	Source 2	200	0	-15	200	300
3	Source 3	400	0	-5	400	600
4	Source 4	800	0	0	800	M
5	Destination 1	0	300	25	200	300
6	Destination 2	0	400	20	200	400
7	Destination 3	0	500	15	0	500
8	Destination 4	0	300	15	100	300
9	Destination 5	0	400	25	200	400

(Source: edit by author)

Application of “Perform Parametric Analysis”: You can select to perform sensitivity analysis on a “Link” or a “Node”. “Link” means cost of unit shipment, coefficient in objective function. “Node” means capacity of demand or supply point.

In the following example, I selected the cost of unit shipment from Cleveland to Boston. Select a range for your sensitivity analysis (starting u and ending u). Your “starting u” will be a negative value that indicates as much as you want to see below the current value. Here starting u is -2, which means start from $3-2=1$. Your “ending u” will be a positive value that indicates as much as you want to see above the current value. Here ending u is +10, which means go up to $3+10=13$. “Steps of u” is selected to be 1 in this example.



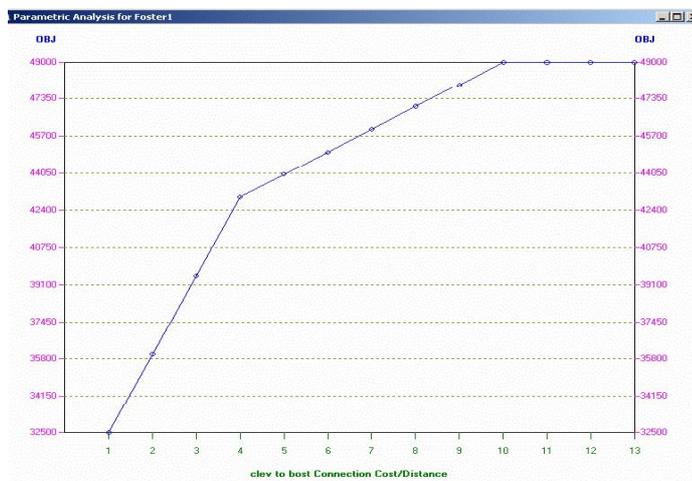
(Source: edit by author)

Below is the result of sensitivity analysis for changing coefficient of objective function as a table:

11-03-2005	clev to bost Connection Cost/Distance	OBJ Value
1	1	32500
2	2	36000
3	3	39500
4	4	43000
5	5	44000
6	6	45000
7	7	46000
8	8	47000
9	9	48000
10	10	49000
11	11	49000
12	12	49000
13	13	49000

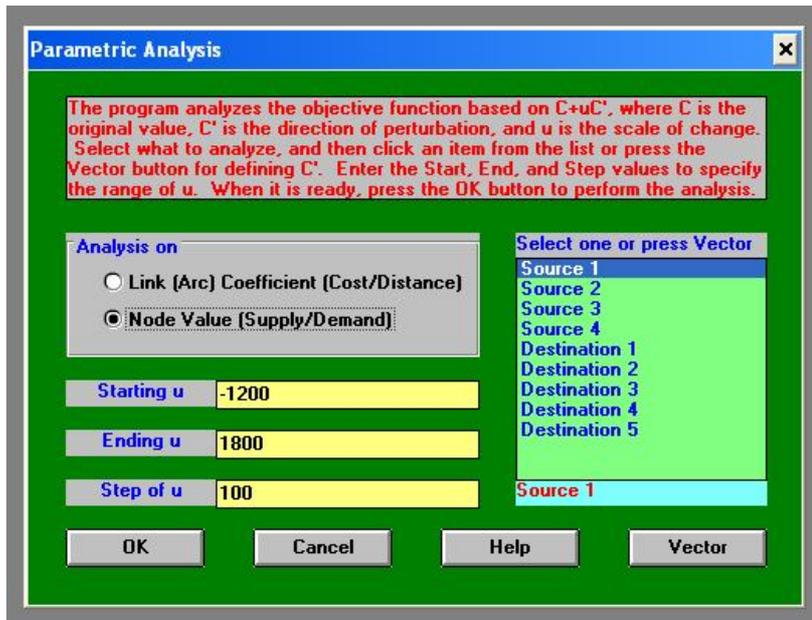
(Source: edit by author)

The same result is presented as a graph below:



(Source: edit by author)

In the following example you can see the result for “Perform Parametric Analysis” on capacity (here Cleveland). You should select the range (starting u and ending u) for capacities of supply or demand points. Your “starting u” will be a negative value that indicates as much as you want to see below the current value. Here starting u is -1200, which means start from $5000-1200=3800$. Your “ending u” will be a positive value that indicates as much as you want to see above the current value. Here ending u is +1800, which means go up to $5000+1800=6800$. “Steps of u” is selected to be 100 in this example.



(Source: edit by author)

The result of sensitivity analysis for changing capacity as a table:

06-13-2010	Source 1 Supply/Demand	OBJ Value
1	-700	20000
2	-600	20000
3	-500	20000
4	-400	20000
5	-300	20000
6	-200	20000
7	-100	20000
8	0	20000
9	100	22000
10	200	24000
11	300	26000
12	400	28000
13	500	30000
14	600	29500
15	700	29000
16	800	29000
17	900	29000
18	1000	29000
19	1100	29000
20	1200	29000
21	1300	29000
22	1400	29000
23	1500	29000
24	1600	29000
25	1700	29000
26	1800	29000
27	1900	29000
28	2000	29000
29	2100	29000
30	2200	29000
31	2300	29000

(Source: edit by author)

The result of sensitivity analysis for changing capacity as a graph:



(Source: edit by author)

Select heuristic method for initial basic feasible solution (optional): You can select a heuristic method for obtaining the Initial Solution. If you do not make a selection the software will use its default method. The heuristic method will not affect the final solution; just the number of iterations to solve the problem may be different.

11_ALGR: Minimization (Transportation Problem)

Solve and Analyze Results Utilities Window WinQSB Help

Solve the Problem
Solve and Display Steps - Network
Solve and Display Steps - Tableau
Select Initial Solution Method
Perform What If Analysis
Perform Parametric Analysis

From \ To	Destination 1	Destination 2	Destination 3	Destination 4	Destination 5	Supply
Source 1	30	25	40	10	20	500
Source 2	10	30	20	25	40	200
Source 3	20	15	25	10	25	400
Source 4	25	20	15	40	35	800
Demand	300	400	500	300	400	

(Source: edit by author)

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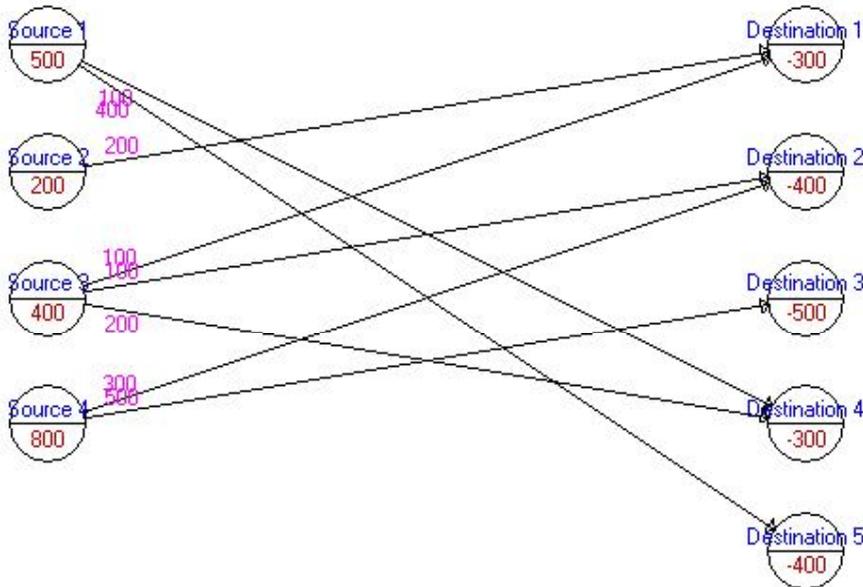
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I selected Obtain Alternative Solution below:

06-13-2010	From	To	Shipment	Unit Cost	Total Cost	Reduced Cost
1	Source 1	Destination 4	100	10	1000	0
2	Source 1	Destination 5	400	20	8000	0
3	Source 2	Destination 1	200	10	2000	0
4	Source 3	Destination 1	100	20	2000	0
5	Source 3	Destination 2	100	15	1500	0
6	Source 3	Destination 4	200	10	2000	0
7	Source 4	Destination 2	300	20	6000	0
8	Source 4	Destination 3	500	15	7500	0
	Total	Objective	Function	Value =	30000	

(Source: edit by author)

Below is the new graphic solution.



(Source: edit by author)

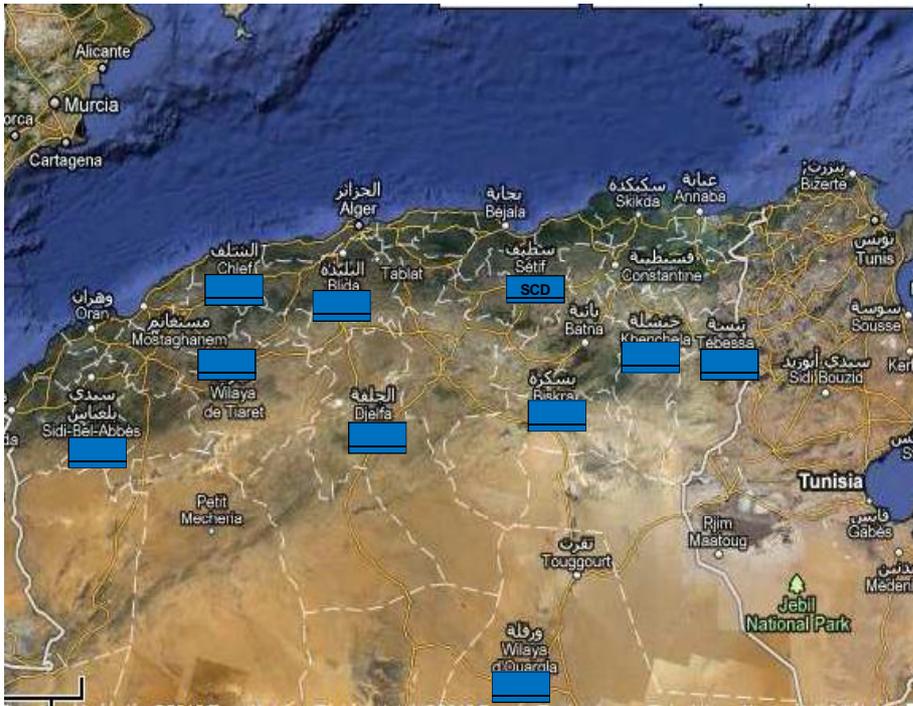
After solving the problem you can select “Show run time and iterations” from “Results” in top menu.

Other example: The Traveling Salesman Problem (TSP) example by CPT SAID LABII, MAJ MECIBAH AHMED, MAJ MEBROUK BOUGOFFA AND MAJ AHMED HAMEL participants of Logistics Course. Imagine a salesman that must visit n customers or cities. He starts at one city and must visit each of the other $n-1$ cities exactly once and then return to the original city. The cost of traveling from city i to city j is given as c_{ij} for all pairs of cities. The problem is to design a route or tour of minimum cost that visits each of the n cities exactly once.

If the cost to travel from city i to city j equals the cost to travel from city j to city i , ($c_{ij}=c_{ji}$) for all cities, then the problem is symmetric. If $c_{ij} \neq c_{ji}$ for some pair of cities, then the problem is asymmetric.

The Algir Logistics Management Agency (LMA)

- A visit must be made to nine local offices of LMA, going out from and returning to the same main office in SÉTIF, North Algeria.



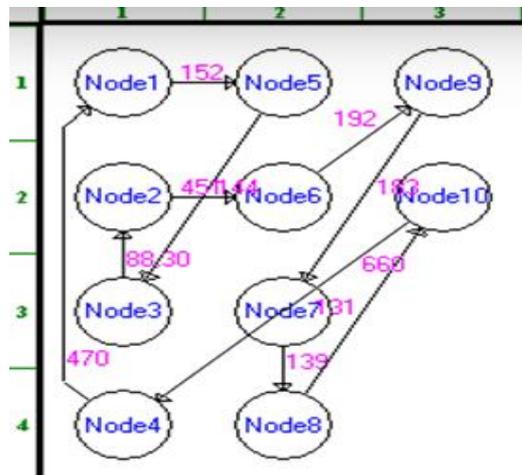
— Data:

HMED 3: Minimization (Traveling Salesman Problem)										
7: Node8										
From \ To	Node1	Node2	Node3	Node4	Node5	Node6	Node7	Node8	Node9	Node10
Node1		259	177	470	152	259	233	367	380	557
Node2	259		88.3	461	226	451	491	618	616	794
Node3	177	88.3		421	144	365	405	531	528	706
Node4	470	461	421		323	358	553	596	531	660
Node5	152	226	144	323		228	319	425	405	581
Node6	259	451	365	358	228		205	241	192	359
Node7	233	491	405	553	319	205			183	139
Node8	367	618	531	596	425	241	139		312	131
Node9	380	616	528	531	405	192	183	312		214
Node10	557	794	706	660	581	359	139	131	214	

— Solution:

ization (Traveling Salesman Problem)							
06-06-2010	From Node	Connect To	Distance/Cost		From Node	Connect To	Distance/Cost
1	Node1	Node5	152	6	Node9	Node7	183
2	Node5	Node3	144	7	Node7	Node8	139
3	Node3	Node2	88,3	8	Node8	Node10	131
4	Node2	Node6	451	9	Node10	Node4	660
5	Node6	Node9	192	10	Node4	Node1	470
	Total	Minimal	Traveling	Distance	or Cost	=	2 610,30
	(Result	from	Nearest	Neighbor	Heuristic)		

— Graphical solution:



— Map graphical solution:



4. Teaching Experience with QSB

Using QSB in the classroom requires that the instructor devote some time to familiarize students with the menu structure and data entry conventions. Some examples of how we go about doing this in our courses are given below. Our Operations Management course places emphasis on process analysis. The process analysis module of QSB is thus invaluable when used to discuss set up time and lot size trade-offs, the effect of product mix on capacity and profitability, staffing issues, as well as, flow time management. On the other hand, due to the versatility of the QSB module, the time required to describe this module can be substantial. Nearly, a class (45 minutes) is required to show how the data is entered, any unique definitions explained and how the options are selected. For example, in process analysis, each task can be “one at a time”, “batch” or “continuous flow.” The differences between these types of operations must be explained if they have not already been covered in class. On the whole, once the initial effort has been made, students rapidly appreciate the power of computers for analyzing proc-

esses. All the other modules are introduced with a “20 minute how to” lecture in the class before their use is required. This gives the student a basic feel for how the data should be entered, the scope for analysis and interpretation of results.

For large problems, such as a process with ten products and/or complex recipes or a project with 30 activities, QSB data files are provided for the student. These data files contain the initial set up of the problem. The student is then required to improve upon the current situation and is set definite targets to achieve. As another example, in an advanced class, the MRP module and a spreadsheet based capacity calculator are provided to the student. The objective is to develop a capacity constrained production plan that minimizes the work-in-progress and finished goods inventory carrying cost while simultaneously avoiding significant backlogs of products demanded.

We have used QSB in our core Logistics Management classes since 2009. The most powerful motivator for using QSB in the classroom is its ability to solve realistic problems of moderate size with relative ease. In addition, we are able to demonstrate counter-intuitive results that are not available through performing backof- the-envelope calculations; such as, situations in which: there is simultaneous excess capacity of labor and long waiting lines due to interference of work, deliberate under-staffing in the cheaper first shift due to minimum workforce size requirements in the costlier second shift, high probability of stockout co-existing with high fill rate service level, etc. Lastly, more complex analysis, such as the computation of optimal lotsize in stochastic networks, simultaneous optimization of the order quantity and safety stock level, and the evaluation of reduction in processing uncertainty, are also facilitated using QSB. Thus, we are not only able to bring state-of-the art approaches for problem solving into the classroom or the small business environment but also to sensitize students and managers to hidden and/or more complex trade-offs.

Based on user feedback, we have learnt that the software is powerful enough that it can be used to solve class problems or to find a first cut solution to problems that might be encountered on the job. Also the time and effort spent in learning how to model problems and interpret results in QSB can be carried forward into future use of this or other commercial process improvement software packages. The feedback from stu-

dents and instructors that have used this software has generally been positive. The more intuitive modules, such as Project Management and Forecasting, have drawn greater praise. Process Analysis is the most complex module and draws criticism due to the amount of learning required. Students and instructors have commented that the output formats and graphics can be improved and that users should be able to cut and paste graphs from the output screen to other software.

Finally, to win the user over teaching note solutions to all cases must be made available.

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