IE4210 Operations Research II
AY2017/2018 Semester 2
Group Assignment

This group assignment is an adaptation of Case 7, pages 1362-1363 of the textbook, *Operations Research: Applications and Algorithms* by Wayne L. Winston:

BestChip: Expansion Strategy

BestChip (BC) is a large nationwide corporation that produces low-fat snack products for an expanding market. Basically, BC takes materials (corn, wheat, and potatoes) and turns them into two types of snacks: chips (regular and green onion) and party mix (one variety). BC is expanding into the western United States and is considering sites for locating production facilities.

BC currently has eight candidate sites. Table 1 shows the sites' purchase prices and the purchase and shipping cost per ton of each material to each site. The purchase cost represents the yearly amortized cost of opening and operating the site (exclusive of shipping costs). Each site may produce as many as 20,000 tons of products per year.

BC has six major customers. The customers, their location, and their yearly demand in tons for each product are listed in Table 2. All demand must be met.

The makeup of the products does not depend on the production plant. Table 3 gives the product-ingredient mix data. The company requires that its business be consolidated and so plants cannot be located in more than two states.

For this analysis, ignore the differences in property and income tax rates between the states. In addition, many critical factors actually determine locations (for example the method of financing the site purchase will also be a major factor in the decision), but they will be ignored also.

Table 1: Site Information and Material Shipping Cost

Site	State	Purchase Cost ($/Year)	Material Shipping Cost ($/Ton)		
			Corn	Wheat	Potato
Yuma	Arizona	125,000	10	5	16
Fresno	California	130,000	12	8	11
Tucson	Arizona	140,000	9	10	15
Pomona	California	160,000	11	7	14
Santa Fe	New Mexico	150,000	8	14	10
Flagstaff	Arizona	170,000	10	12	11
Las Vegas	Nevada	155,000	13	12	9
St. George	Utah	115,000	14	15	8

Table 2: Demand Information

Customer	Location	Demand		
		Regular	Green Onion	Party Mix
Jones	Salt Lake City	1,300	900	1,700
YZCO	Albuquerque	1,400	1,100	1,700
Square Q	Phoenix	1,200	800	1,800
AJ Stores	San Diego	1,900	1,200	2,200
Sun Quest	Los Angeles	1,900	1,400	2,300
Harm's Path	Tucson	1,500	1,000	1,400

Table 3: Product-Ingredient Mix

Product	Ingredient		
	Corn	Wheat	Potato
Regular chips	70	20	10
Green onion chips	30	15	55
Party mix	20	50	30

(a) Suppose all demand is shipped by truck from the plant to the customer warehouse. The shipping cost depends on the tonnage and distance, and comes to $0.15 per ton-mile ($0.09 per ton-km). Your job is to determine how the company should be expanded into western United States and develop alternatives. Questions that you should answer include:

- What sites should be selected? How should the customers be served?
- If gasoline gets more expensive and trucking costs change, then how is the recommendation affected?
- If rail freight costs for material shipping increase, then how is the recommendation affected?

(b) Suppose BC is considering shipping from the selected production plants to the customers via four possible distribution centers. Each distribution center has a fixed annual operating cost if it is being used, and a variable cost for each product that is handled. These information, as well as the minimum and maximum allowable total amounts of products in tons that can be handled each year at each distribution center, are listed in Table 4. Each customer can only be served by one distribution center for each product type. In addition, the maximum fraction of a plant's supply that may be sent to any one distribution center is given by 50%, and the maximum fraction of a customer's demand that may be satisfied by any distribution center is given by 60%.

Table 4: Site Information and Material Shipping Cost

Distribution Center	Operating Cost ($/Year)	Variable Cost ($/Ton)	Allowable amount of products handled	
			Minimum	Maximum
Kingman	6,000	50	1,000	15,000
Las Cruces	5,000	30	1,000	12,000
Provo	8,000	60	2,000	18,000
Victorville	9,000	70	2,000	20,000

Similar to (a), the shipping cost from the plant to the distribution center depends on the tonnage and distance, and comes to $0.15 per ton-mile ($0.09 per ton-km). However, the shipping cost from the distribution center to the customers comes to $0.08 per ton-mile ($0.05 per ton-km). Furthermore, if there is to be any shipment of a product type from a plant to a distribution center, or from a distribution center to a customer, the minimum amount for that shipment of the product is 1 ton.

You would need to address the questions in (a) with the focus on which distribution centers should be used, and also how the customers would now be served.

Your report should include a description of your models and any additional assumptions made in model formulation. You may have to make such assumptions because this problem has incomplete information or details that may be difficult to model. Different modeling approaches or different objectives to address the problem could be used. You may use Excel, AIMMS or any other relevant software, or you may propose heuristics to obtain solutions to this problem, depending on your modeling approaches. Please consider other sensitivity analysis issues that you feel might be important for the decision-making process.