COURSE PROJECT

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Current and optimal policy

The report outlines the recommendations for Super Chip, a Virginia-based computer chip manufacturer, regarding their production and distribution operations for the upcoming fiscal year. The company has five manufacturing facilities with varying production capacity levels, and each facility has different equipment and setup costs that impact the cost of manufacturing each of the 30 types of computer chips. Additionally, there are variations in shipping costs for distributing the computer chips to 23 sales regions across the US. The report evaluates an alternative production policy that could potentially reduce costs for Super Chip.

With its current production policy, Super Chip follows a production policy where each facility produces each of the 30 types of chips at levels that are proportional to the facility's total portion of production capacity. This means that if a facility has y% of the total production capacity across all facilities, then it currently produces y% of every chip's total demand.

After analyzing the data provided by Super Chip, it is recommended that the company should adopt a new production policy where the share of each facility for each chip is different from the current policy. The new policy is based on the optimization model that Super Chip can use to minimize their total costs. The optimization model calculates the minimum cost of producing and shipping the computer chips to each sales region by assigning the production of each chip to the facility that has the lowest cost of production for that specific chip.

The formulation of the optimization model is started by defining the decision variables. If we denote with x_{ijk} the number of chips produced at facility i (i = Alexandria(1), Richmond(2), Norfolk(3), Roanoke(4), Charlottesville(5)), for sales region j (j = 1,..23) and type of chip k (k = 1,..30), we are able to write the following constraints:

$$1)\ \ \sum_{j=1}^{23} \sum_{k}^{30} x_{ijk} \leq C_i$$

Here, the total number of chips produced at facility i for all sale regions and types needs to be lower or equal to the production capacity of the very same facility (C_i).

$$2)\ \ \sum_{i=1}^{5} x_{ijk} = D_{jk}$$

Here, the total number of chips produced at all facilities for a sale region j and type k needs to be equal to the demand of the very same region and type of the chip (D_{jk}).

$$3)\ \ x_{ijk} \geq 0$$

In the end, the production needs to be larger or equal to zero. Let's also define the objective function as:

$$f = \vec{c} * \vec{x}$$

The objective function is defined in an aggregated way, combining the cost for production and distribution in one element for each facility and sales region.

The results obtained from the optimization model show that the recommended policy can lead to cost savings for Super Chip. The cost of the current policy is $ 5.6133+07 while the cost after optimization is $4.9083e+07. This means that Super Chip could potentially save $7.05+06 in costs by adopting the recommended policy.

Investment Policy

Based on the recommended policy, Super Chip should invest in expanding the production capacity at the facility that has the lowest cost of production for the chips that would be produced with the additional equipment. According to the optimization model, the facility that should obtain the additional equipment is the one in Roanoke. This facility has the lowest cost associated with the recommended policy, with a total cost of $9.172e+06.

Expanding the production capacity at the Roanoke facility would likely decrease the cost of production due to the acquisition of more efficient equipment. However, it is important to note that the cost of distribution would increase due to the higher number of manufactured chips. Therefore, the total impact on costs would depend on the magnitude of the cost reductions in production and the cost increases in distribution. It is important to note that the total impact on costs would depend on the specific details of the expansion and how it affects production and distribution costs.

Increase in demand

The third strategic-level question was whether Super Chip had sufficient capacity to handle the estimated increase in demand of 10% across all sales regions for the next year. This new constraint thus can be formulated as (compared to the original optimization formulation).

$$\sum_{i=1}^{5} x_{ijk} = 1.10 * D_{jk}$$

After reformulating the optimization problem to increase the demand by 10%, the results showed that Super Chip had enough capacity to adapt to this new demand plan. The associated costs for filling new demand were $ 4.9410e+06.

Decrease in Production Cost

It is important to note that the implementation of this new manufacturing technology will have a significant impact on the overall production and distribution costs for Super Chip.

While the production costs will decrease by 15%, there will be additional costs associated with the implementation of the new technology such as training and equipment upgrades. Furthermore, the distribution costs may also be impacted due to changes in production output and shipping logistics. Therefore, it is important for Super Chip to conduct a thorough cost-benefit analysis before making a decision on the implementation of this new technology in any of its facilities. We need to formulate five different optimization problems (each associated with a 15% decrease in production cost at the respective facility). The constraints of the optimization problem are not the subject of change, so only the objective function is changed:

1) $c_{1jkpost} = 0.85 * c_{1jkpre}, c_{ijkpost} = c_{ijkpre}, i = [2,3,4,5]$
2) $c_{2jkpost} = 0.85 * c_{2jkpre}, c_{ijkpost} = c_{ijkpre}, i = [1,3,4,5]$
3) $c_{3jkpost} = 0.85 * c_{3jkpre}, c_{ijkpost} = c_{ijkpre}, i = [1,2,4,5]$
4) $c_{4jkpost} = 0.85 * c_{4jkpre}, c_{ijkpost} = c_{ijkpre}, i = [1,2,3,5]$
5) $c_{5jkpost} = 0.85 * c_{5jkpre}, c_{ijkpost} = c_{ijkpre}, i = [1,2,3,5]$

Based on the results of the optimization, it is recommended that Super Chip should evaluate the new manufacturing technology in the Alexandria facility. This is because implementing the new technology at this facility results in the lowest overall cost of production. The estimated 15% reduction in production costs for all of the chips translates to significant cost savings for Super Chip, which could lead to increased profits and competitiveness in the market. However, it is important to note that there may be additional costs associated with implementing the new technology, such as training and equipment costs. These factors should be taken into consideration when making the final decision. The total cost associated with this change at Alexandria is $4.6682e+07.