Service Center Optimization

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1.Background

A chinese company has many Service Centers (SC) to acquire new customers and to serve existing customers. SCs income are the commissions given by the company. To manage the SCs effcientely, the company classsify them into 5 levels with their capability (in term of the number of new customers it acquire per year) and the cost (in term of commission rate it can get for one customer from company).

Now the company wants to adjust number of the SCs as well as their levels to decrease its annual cost on SCs.

2.Problems

(1)Can we modify the existing evaluation rules to classfy the Scs more reasonably?

(2)How to predict customer demand next period ?

(3)Based on the result of problem(2), get the optimal number of SCs for each level.

(4)Based on the result of problem(3), get the optimal increasment number of SCs in every service erea?

(5)How to consider the effect of price change on the result of the above problems?

3.Modelling and Algorithms

(1)Rough Set

quite different

		Level 5	Level 4	Level 3	Level 2	Level 1	备注
Ability	Location	<=2	<= 3	<= 3	<= 4	<= 4	城区核心商圈=1；城区重要商圈/乡镇核心商圈=2；城区外围商圈/乡镇重要商圈=3；乡镇外围商圈/村级商圈=4
	Area	>= 60	>= 40	>= 20	>= 10	>= 10	分层分级标准：五星级100平方或四个标准店面；四星级50平方或2个标准店面
	# of customers per month	>= 200	>= 120	>= 80	>= 40	>= 20	按照分层分级标准的2/3确定
	…						
	Long term customers ratio	>=60%					满足一票否决指标底线，进行范围得分评估
		[50%,60%)					直接降两个星级，不再进行范围得分评估
		<50%					直接降为一星级，不再进行范围得分评估
		基准值	每加/减1分步长				备注
Custom Value	,,,	2.08	0.8				基准值以统计平均水平为准； 以偏离平均水平高低为加减分基本步长； 基准值对应的得分为0，线性得分； 单项最高加3分，单项最低减3分；
	Customer value	55.83	5.27				
	…	70.25%	6.78%				
	…	18.23%	6.68%				
Level Change t	基准值	每升/降一个星级分数		备注			
	评估时点星级	3		不足升降级分数时不调整；一次升降一个星级，最高为五星级，最低为一星级；多次评估后，最低不低于实力排位指标下调两个星级；			

(2)Expectation of new customers

- **Notation**

U_t = number of the customers at time t

V_t = number of the residents

R_{in} = rate of new customers

R_{out} = rate of customers lost

r_t = increasing rate of residents

W_t = number of transient population

P_t = percentage of the popullation who are already using the service

S_t =market share

- **Model**

$$U_{t+1} - U_t = U_t(R_{in} - R_{out}) + (V_{t+1}P_{t+1} - V_tP_t)S_t$$

$$V_{t+1} = V_t(1 + r_t) + W_{t+1}$$

where

$$P_t = \frac{P_0}{P_0 + (1 - P_0)e^{-\lambda t}}$$:Logistic model

W_{t+1} can be modeled by AR or Linear Regress

(3)Optimizing the number of SCs with level 1-5

- **Notation**

  - N1，N2，N3，N4，N5: the current number of service centers of level 1-5 (known)
  - N’: the total number of service centers of competitor(known)
  - a1， a2， a3， a4， a5: the capability of service center of level 1-5 (known)
  - C1， C2， C3， C4， C5: the unit cost of the capability of service centers of level 1-5 (known)
  - [Dmin， Dmax]:the maxim and minimum demands based on the result of problem(2) (which is the expected value of the demand next year)
  - X1，X2，X3，X4，X5:the optimal number of SCs in the region of level 1-5

- **Model**

$$Min\begin{cases} a_1 C_1 X_1 + a_2 C_2 X_2 + a_3 C_3 X_3 + a_4 C_4 X_4 + a_5 C_5 X_5 \\ \sqrt{(\frac{X_1 - N_1}{N_1})^2 + (\frac{X_2 - N_2}{N_2})^2 + (\frac{X_3 - N_3}{N_3})^2 + (\frac{X_4 - N_4}{N_4})^2 + (\frac{X_5 - N_5}{N_5})^2} \end{cases}$$

$$D_{min} <= a_1 X_1 + a_2 X_2 + a_3 X_3 + a_4 X_4 + a_5 X_5 <= D_{\max}$$

$$P_{\min} N' <= X_1 + X_2 + X_3 + X_4 + X_5 <= P_{\max} N'$$

$$X_1 : X_2 : X_3 : X_4 : X_5 \approx p_1 : p_2 : p_3 : p_4 : p_5$$

To simplify the model above, set δ as the upper bound of the relative difference of X_i and N_i ($i = 1 \cdots 5$), the problem can be restated as:

$$Min \quad a_1 C_1 X_1 + a_2 C_2 X_2 + a_3 C_3 X_3 + a_4 C_4 X_4 + a_5 C_5 X_5$$

$$S.T. \quad -\delta \cdot N_i \le X_i - N_i \le \delta \cdot N_i$$

$$D_{min} <= a_1 X_1 + a_2 X_2 + a_3 X_3 + a_4 X_4 + a_5 X_5 <= D_{\max}$$

$$P_{\min} N' <= X_1 + X_2 + X_3 + X_4 + X_5 <= P_{\max} N'$$

$$0.8 p_i \sum_{i=1}^{5} X_i \le X_i \le 1.2 p_i \sum_{i=1}^{5} X_i$$

which is a single-objective linear programming problem.

(4) Optimizing the increasing number of SCs in sub-regions with different level

- **Notation**
  - N_{ij} :the current number of SCs with level i in subregion j(i=1,…,5,j=1,...,S) (known)
  - B_j :the demand of customers in subregion j(j=1,...,S) (known)
  - a_i, p_i: the same as in problem(3) (known) ,
  - $J = \{ j : \sum_{i=1}^{5} N_{ij} < B_j \}$
  - ΔN_{ij} :the optimal increasement number of SCs with level i in subregion j(i=1,…,5, $j \in J$)

- **Model**

$$\min \quad \sum_{j\in J}(\sum_{i=1}^{5}(a_i N_{ij} + a_i \Delta N_{ij}) - B_j),$$

$$\sum_{i=1}^{5}(a_i N_{ij} + a_i \Delta N_{ij}) \geq B_j,\ j \in J$$

$$0.8 p_i \sum_{k=1}^{5}\sum_{j\in J}(N_{ij} + \Delta N_{ij}) \leq \sum_{i}^{5}(N_{ij} + \Delta N_{ij}) \leq 1.2 p_i \sum_{k=1}^{5}\sum_{j\in J}(N_{ij} + \Delta N_{ij})$$

$$\Delta N_{ij} \geq 0,\ j \in J$$

$$\Delta N_{ij} \leq \frac{B_j}{30},\ j \in J$$

$$\Delta N_{ij} = 0,\ j \notin J$$

which is equivlent to

$$\min \quad \sum_{j\in J}\left(\sum_{i=1}^{5} a_{ij}\Delta N_{ij} - B_j^*\right)$$

$$S.T. \quad \sum_{i=1}^{5} a_i \Delta N_{ij} \geq B_j^*,\ j \in J$$

$$\sum_{j=1}^{S}\left(\Delta N_{ij} - 1.2 p_i \sum_{k=1}^{5} \Delta N_{kj}\right) \leq 1.2 p_i N - N_i$$

$$\sum_{j=1}^{S}\left(\Delta N_{ij} - 0.8 p_i \sum_{k=1}^{5} \Delta N_{kj}\right) \geq 0.8 p_i N - N_i$$

$$\Delta N_{ij} \geq 0,\ j \in J$$

$$\Delta N_{ij} \leq \frac{B_j}{30},\ j \in J$$

$$\Delta N_{ij} = 0,\ j \notin J$$

where $$B_j^* = \sum_{i=1}^{5} a_{ij} N_{ij} - B_j$$

THANK YOU！