

Operations Research, Spring 2019 (107-2)

Case Assignment 0 (In-class Challenge)

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Founded in 1983, NEC Taiwan is a subsidiary company of NEC Japan (originally Nippon Electric Company, now NEC Corporation). While it has many businesses, one major business of NEC Taiwan is to provide information system solutions for organizations and companies in Taiwan. Its customers include convenience stores, Taiwan Railways, Chunghwa Post, local financial institutes, etc. For example, many POS (point-of-sales) systems in convenience stores and all the ticketing gates and ticket-selling machines at Taiwan Railways stations are manufactured and maintained by NEC Taiwan.

To service around 15,000 customer operating locations (including stores, stations, post offices, etc.; for ease of exposition we will call them stores in the sequel), the Technical Support (TS) Division of NEC Taiwan operates twelve technical support facilities in Taiwan. Around 140 engineers are hired and distributed to these twelve locations to ensure the 24-hour services of the information systems in all the stores. Each store is assigned to one facility so that all the maintenance and repair works are done by the engineers in that facility. Table 1 lists the addresses, number of engineers, and the number of assigned stores of all the twelve facilities, Figure 1 marks all the facility locations on a map, and Figure 2 marks store locations on a map and colors them according to their facilities.¹

1 Shutting down and merging facilities

Ms. Janice Lai took the position of CEO of NEC Taiwan in 2018. At this moment, she is examining the facilities and engineers of the TS Division, whose current setting has been used for many years without adjustment. She finds something. For example, the Kaohsiung and Pingtung facilities are quite close to each other, and the Tamsui facility

¹All information provided in this case, unless further noted, is retrieved in 2018. NEC Taiwan also has customer stores at outlying islands of Taiwan. Because all the services for these stores are not provided by the twelve facilities, in this case we consider only stores in the main island of Taiwan.

is also somewhat close to those in Nangang and Taoyuan (cf. Figure 1). It makes sense to ask whether all these facilities are needed. As the rents and fees of operating all the twelve facilities summed up to about 50 million dollars per year (cf. Table 2; all monetary values in this case are in New Taiwan Dollar), it would be nice if merging or adjusting some facilities may reduce operating costs. At the same time, however, Ms. Lai also observed that the service costs (including the cost of gasoline, depreciation of company cars, etc.) summed to about 40 million dollars. Obviously, if some facilities are shutdown, the total driving distance for serving customers will increase. As reducing operating cost will increase service cost, it may not always be worthwhile.

There are more issues other than costs that need to be considered. First of all, if any facility is shutdown, some facilities must be assigned more stores, which require more engineers. How to redistribute engineers at the same time? Whether a facility is big enough to accommodate redistributed engineers is also a concern. Moreover, NEC Taiwan signs service level agreements (SLA) with all its customers to guarantee that once any store calls NEC Taiwan to repair something, an NEC Taiwan engineer should arrive the store and complete the repair work within certain hours. For example, government agencies require eight hours, convenience stores require 24 hours, post offices require four hours, and local financial institutes require eight hours. A facility cannot be assigned to serve a store that is too far from it. Finally, to avoid complaints, no engineer may be fired even if some facilities are shutdown.

To help her analyze this problem and make a better decision, Ms. Lai collects some more data that may be relevant. Table 3 lists the numbers of engineers at each facility location and annual number of services from 2015 and 2017. Note that a store may call for services for multiple times in a year. Moreover, the driving times between all facility-store pairs are obtained through Google Maps API. Her staff estimates that driving one minute costs the company about twelve dollars, including everything. Finally, the numbers of service calls made by all stores in 2015 to 2017 are collected.²

Ms. Lai understands that this problem cannot be easily solved. However, she feels that finding a better way to set facility locations, distribute engineers, and assign stores may save NEC Taiwan millions of dollars per year. She remembers that in the course “Business Decision Making” that she took in NTU EMBA, the professor mentioned about “Operations Research” as a powerful tool to solve a problem like this. She decides to create a team of operations researchers to work on this problem.

²The last two sets of data will be provided in MS Excel files.

Facility location	Address (omitting floor)	Office area (m ²)	Number of assigned customers
Nangang	No. 3-2, Park St., Nangang Dist., Taipei City	3216.57	4609
Tamsui	No. 27, Sec. 2, Zhongzheng E. Rd., Tamsui Dist., New Taipei City	284.94	748
Taoyuan	No. 117, Longan St., Taoyuan Dist., Taoyuan City	380.19	1511
Hsinchu	No. 282, Beida Rd., East Dist., Hsinchu City	735.02	1001
Taichung	No. 169, Fuhuiyuan Blvd., Xitun Dist., Taichung City	758.10	2401
Chiayi	No. 353, Zhongxing Rd., West Dist., Chiayi City	368.75	793
Tainan	No. 425, Zhonghua Rd., Yongkang Dist., Tainan City	623.48	1110
Kaohsiung	No. 6, Siwei 3rd Rd., Lingya Dist., Kaohsiung City	915.56	1379
Pingtung	No. 58, Rende Rd., Pingtung City, Pingtung County	161.37	414
Yilan	No. 366, Minzu Rd., Yilan City, Yilan County	261.17	318
Hualien	No. 41, Guolian 1st Rd., Hualien City, Hualien County	244.64	286
Taitung	No. 63, Lianhang Rd., Taitung City, Taitung County	202.66	196
Total		8152.46	14766

Table 1: Technical support facility information of NEC Taiwan

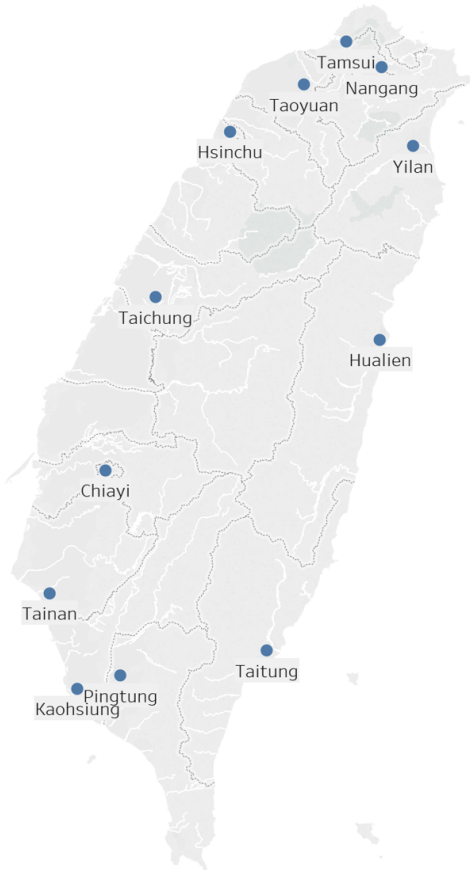


Figure 1: Facility locations

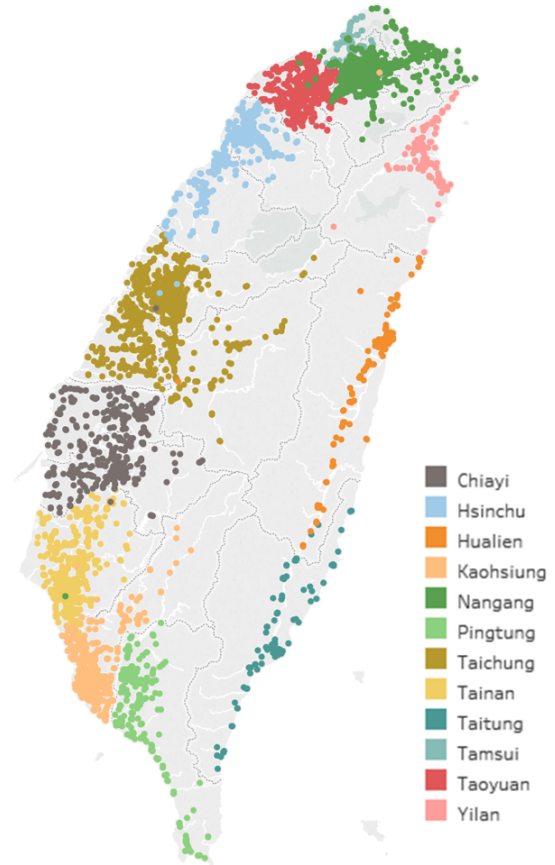


Figure 2: Store locations

Facility	Service cost	Office rent	Utility fee	Total
Nangang	\$9,671,712	\$30,086,232	\$7,607,526	\$47,365,470
Tamsui	\$1,611,300	\$1,553,897	\$207,843	\$3,373,040
Taoyuan	\$2,715,840	\$1,314,286	\$149,107	\$4,179,233
Hsinchu	\$2,926,584	\$3,255,720	\$886,615	\$7,068,919
Taichung	\$7,668,960	\$4,861,392	\$2,075,182	\$14,605,534
Chiayi	\$2,831,340	\$1,351,896	\$317,184	\$4,500,420
Tainan	\$3,676,620	\$2,454,120	\$614,917	\$6,745,657
Kaohsiung	\$3,159,336	\$4,671,624	\$1,930,277	\$9,761,237
Pingtung	\$1,619,364	\$378,840	\$194,952	\$2,193,156
Yilan	\$1,188,036	\$864,720	\$207,648	\$2,260,404
Huanlien	\$1,722,012	\$681,792	\$328,176	\$2,731,980
Taitung	\$1,007,124	\$432,000	\$2,832	\$1,441,956
Total	\$39,798,228	\$51,906,519	\$14,522,259	\$106,227,006

Table 2: Technical support facility information of NEC Taiwan

Facility	Number of engineers			Number of services		
	2015	2016	2017	2015	2016	2017
Nangang	53	50	47	35,755	35,475	35,287
Tamsui	6	5	6	6,164	6,213	6,444
Taoyuan	9	12	14	11,944	12,576	12,299
Hsinchu	9	9	9	10,244	10,632	10,134
Taichung	20	21	21	22,670	23,586	22,361
Chiayi	7	7	7	7,795	8,819	8,536
Tainan	10	10	10	10,796	11,257	11,418
Kaohsiung	12	12	11	12,511	12,863	11,923
Pingtung	4	3	4	3,502	4,453	4,257
Yilan	4	4	4	2,913	3,803	3,846
Huanlien	3	3	3	2,601	3,558	3,842
Taitung	3	3	3	1,912	2,291	2,488
Total	140	139	139	128,807	135,526	132,835

Table 3: Numbers of engineers and services of all facilities in 2015 to 2017