

# Operations Research, Spring 2020 (108-2)

## Case Assignment 1

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There is a company providing life insurance services and products to local customers in Taiwan. In recent years, the company's business scale increases rapidly. Up to 2019, around 3,000 employees are hired to serve around 2.45 million policyholders.

On a cold Tuesday afternoon, Mikasa, the head of the company's customer service department, sat on her chair and mull over the mail she received from the head of the human resource department, Eren. According to Eren, the company was conducting a headcount streamlining program in order to reduce administrative and labor costs, and the manager of every department needs to address the labor proposal with rational explanations within a week. However, the senior assistant manager of the customer service department just informed Mikasa that the existing customer service representatives (CSRs) are suffering from working overtime due to the shortage of manpower. As a newly appointed manager, Mikasa is considering how to develop an appropriate staffing plan. While CSRs may be scheduled in an efficient way, an accurate number of CSRs needed may also be calculated.

## 1 CSR scheduling

### 1.1 Shift assignment

While there are CSRs being responsible for other types of services, the majority of CSRs receive phone calls and give instant responses to customers when they are on duty. There are forty CSRs doing the phone-answering work in the customer service department currently. The service time starts from 9:00 and ends at 21:00. By splitting each 12-hour service duration into 24 half-hour *periods*, the department assigns all CSRs to work using these half-hour periods as time units. The call center is open every day.

The CSR department defines fourteen *shifts*, which may be illustrated by the time table in Figure 1 (also in the sheet “shifts” in the MS Excel file). The green grids represent

working hours, and the gray grids stand for resting hours. For example, if a CSR takes shifts 1 in a day, she/he should start to work at 9:00, may leave the company at 17:30, and will take a rest between 12:00 and 13:00. While shifts 1 to 4 all share the same starting and ending times as shift 1, their resting times are different. Each CSR will know her/his working hours once she/he is assigned to a specific shift.

Shift Category	Shift	09:00 09:30	09:30 10:00	10:00 10:30	10:30 11:00	11:00 11:30	11:30 12:00	12:00 12:30	12:30 13:00	13:00 13:30	13:30 14:00	14:00 14:30	14:30 15:00	15:00 15:30	15:30 16:00	16:00 16:30	16:30 17:00	17:00 17:30	17:30 18:00	18:00 18:30	18:30 19:00	19:00 19:30	19:30 20:00	20:00 20:30	20:30 21:00
Morning	1																								
	2																								
	3																								
	4																								
	5																								
	6																								
Afternoon	7																								
	8																								
	9																								
	10																								
Night	11																								
	12																								
	13																								
Leave	0																								

Figure 1: Time table for the shifts

In Figure 1, we may see that the fourteen shifts are categorized into four categories: morning, afternoon, night, leave.<sup>1</sup> Shifts in the same category basically share the same beginning and ending times (except shifts 5 and 6) but have different resting times. The department uses the terms “the morning shifts,” “the afternoon shifts,” “the night shifts,” and “the leave shift” to denote shifts 1 to 6, shifts 7 to 10, shifts 11 to 13, and shift 0. For example, when someone says “we need to have at least five CSRs working in the afternoon shifts,” that means there must be at least five CSRs being assigned to shifts 7 to 10 (not shifts 1 to 4, 6, and 7 to 13, even though all the CSRs taking these shifts work in the afternoon).

By the end of each month, the managers of the customer service department do *CSR scheduling* to assign each CSR to a shift for each day of the next month. Note that this process will also determine when a CSR will have days off in the next month: One is having a day off if she/he is assigned to shift 0 on that day.

## 1.2 Demand for CSRs

Mikasa knows that the most important thing for CSR scheduling is to meet the demand for CSRs. Obviously, the number of incoming calls, frequency of incoming calls, time length of incoming calls (which mainly depends on the type of affairs that a customers

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<sup>1</sup>The terms “morning” and “afternoon” may be somewhat confusing. Nevertheless, they are just names and do not affect how you may solve this problem.

want to deal with), and patience of a caller may all be different from period to period. The minimum numbers of CSRs needed are thus also different in different periods.

According to a study that the company conducted previously, a computer program that may determine the minimum numbers of CSRs needed for each period has been constructed.<sup>2</sup> Take the next month March as an example, the number of CSRs required for every period is listed in Figure 2 (the complete demand table for the coming March is in the sheet “demand” in the MS Excel file). For example, there should be 29 CSRs working in 9:00-9:30 on March 1, 11 CSRs working in 17:30-18:00 on March 5, etc.

Time	1	2	3	4	5	6	7	8	9	10
09:00~09:30	29	20	21	29	20	21	17	29	20	21
09:30~10:00	24	20	18	24	20	18	18	24	20	18
10:00~10:30	25	21	20	25	21	20	17	25	21	20
10:30~11:00	24	22	20	24	22	20	18	24	22	20
11:00~11:30	24	19	22	24	19	22	20	24	19	22
11:30~12:00	24	18	19	24	18	19	17	24	18	19
12:00~12:30	17	12	13	17	12	13	12	17	12	13
12:30~13:00	13	14	11	13	14	11	12	13	14	11
13:00~13:30	17	14	14	17	14	14	11	17	14	14
13:30~14:00	23	18	17	23	18	17	15	23	18	17
14:00~14:30	21	20	20	21	20	20	18	21	20	20
14:30~15:00	23	20	21	23	20	21	17	23	20	21
15:00~15:30	21	18	18	21	18	18	16	21	18	18
15:30~16:00	18	20	18	18	20	18	17	18	20	18
16:00~16:30	20	17	17	20	17	17	14	20	17	17
16:30~17:00	20	17	15	20	17	15	15	20	17	15
17:00~17:30	16	11	15	16	11	15	13	16	11	15
17:30~18:00	11	11	13	11	11	13	11	11	11	13
18:00~18:30	10	8	8	10	8	8	9	10	8	8
18:30~19:00	8	8	6	8	8	6	7	8	8	6
19:00~19:30	8	9	6	8	9	6	8	8	9	6
19:30~20:00	8	8	8	8	8	8	7	8	8	8
20:00~20:30	9	8	7	9	8	7	7	9	8	7
20:30~21:00	8	7	6	8	7	6	6	8	7	6

Figure 2: Demands for CSRs (between March 1 and March 10)

How to determine each CSR’s shift for each day has always been a distressing problem for the company. Ideally, there should be enough CSRs working in each period. However, this may not be possible as CSRs need to take turns to take rests. When that happens in a period, we say the number of CSRs is *insufficient* in that period. For example, if there are only 25 CSRs working in 9:00-9:30 on March 1, the *lack amount* of CSRs in that

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<sup>2</sup>Such a computer program requires methodologies including statistics, queueing theory, system simulation, etc. While these methodologies are beyond the scope of this course, interested students are welcome to talk to the instructor for more information.

period is  $29 - 25 = 4$ . If there are 30 CSRs, there is no lack. Note that the number of lack is not  $-1$  in that case. As long as the number of CSRs is no fewer than the required number, the lack amount is 0.

For an upcoming month, the company evaluates a CSR schedule by calculating the *total lack amount* across all periods in that month. Among all feasible schedules, those that have the lowest total lack amount are preferred.

### 1.3 Rules that must be followed

When scheduling CSRs, there are too many rules for Mikasa to memorize. To get comprehensive information about the shift scheduling rules, Mikasa called a departmental meeting and invited all the managers to provide comments.

The most experienced manager, Armin, first listed out all the CSRs with their names, employee IDs, experiences (in years), and positions (in the sheet “CSRs” in the MS Excel file). The five possible ranks, from the lowest to the highest, are associate, specialist, senior specialist, assistant manager, and manager. He reminded everyone again that every CSR must be assigned to exactly one shift per day (if she/he will take a day off, she/he should be assigned to shift 0). According to the Labor Standards Act, every employee must have a predetermined number of days off per month. Otherwise, the company will be punished by the Taiwanese government. For this March this number is eight, i.e., each CSR should have exactly eight days off.

Noticing that Mikasa was paying attention to him, Armin made a further explanation. He mentioned that, by the middle of the previous month, every CSR is allowed to request a certain shift in a particular day of a month. For example, a CSR may request to take shift 0 on March 12 because the day is her birthday, another CSR may request to take shift 5 on March 29 for a health examination, etc. Armin is a nice manager and always tries his best to coordinate with everyone to accommodate as many requests as possible. The approved requests will be treated as given and fixed before CSR scheduling is initiated. A feasible schedule must satisfy all these requests. The sheets “shift requests” and “leave requests” in the MS Excel file record the requests for March.

In addition, the assistant manager, Sasha, suggested that from the perspectives of on-job training and emergency issue handling, for some specific periods in some specific weekdays a certain proportion of on-duty CSRs should be senior enough. The sheet “senior limit” in the MS Excel file records the weekdays as long as the associated limits.

For example, the first entry says that for each period within 18:30-21:00 on Monday, 45% of on-duty CSRs should have at least one year of experience. Similarly, the second entry says that for each period within 0:00-12:00 on Wednesday morning, 55% of on-duty CSRs should have at least two years of experience. The five requirements about the seniority limits that must be followed for the coming March.

As Sasha further explains, Mikasa realized that there is a similar yet different limit for managers. For a certain shift category on a specific day, there must be an enough number of managers on duty. The five requirements that must be followed in the coming March are recorded in the sheet “manager limit” in the MS Excel file. For example, the first entry says that on March 1 at least one CSR assigned to the night shifts must be an assistant manager or above, the second entry says that on March 10 at least two CSRs assigned to the afternoon shifts must be an assistant manager or above, etc.

Considering the work-life balance of each CSR, assistant manager Annie suggested that every CSR should be assigned to at most one night shift in every seven consecutive days. For example, if a CSR is already assigned a night shift on a Monday, her/his earliest next night shift will be on the next Monday. Similarly, a CSR should be assigned to at most two afternoon shifts in every seven consecutive days. “And, what’s the most important is,” Annie emphasized, “also due to the Labor Standards Act, a CSR must have at least one day off in every seven consecutive working days.” A CSR is not considered as having one day off if she/he is assigned shifts 5 and 6 on two consecutive days.

## **1.4 Rules that are nice to have**

Just as the discussion went on hotly and about to reach the conclusions, Richard walked in the meeting room. He first apologized for being late because he was trapped in the traffic jam this morning due to the freezing weather. He then proposed two suggestions. First, it is better to have similar extra on-duty CSRs (the number of on-duty CSRs minus the minimum number of CSRs required, if it is positive) for all periods. For example, instead of having five extra on-duty CSRs in one period and only one in the other, why not having three and three? Second, it is better to have similar numbers of night shifts for every CSR. For example, instead of having one CSR taking four night shifts while another taking only one, why not three and two? Though the comments that Richard proposed somewhat make sense, however, since the discussion was almost done, most of the others did not pay attention to his opinions. Therefore, Mikasa decided to put Richard’s suggestions at lower priorities.

## 2 Your tasks

You are the leader of the Operations Research team. Now, use whatever method you like, make a suggestion to Mikasa about how to assign shifts to CSRs for the next month (March) to complete CSR scheduling. You should consider all the opinions discussed in the departmental meeting *except those provided by Richard*. Make your proposal by completing three things: an executive summary for the head of CSR, a detailed schedule for March, and a description of your method. Please keep in mind that your method, which may or may not be based on any mathematical model, should be flexible and general enough for any number of CSRs, and future months, and any rule parameters.

1. (30 points) Write down a summary of your proposed plan in your report. In the report, do not repeat numbers that are already included in the spreadsheet. Instead, write an executive summary by summarizing relevant information that Mikasa, the head of CSR of your company, would be interested to know. Keep one thing in mind: A head of CSR is very busy! Summarize the outcome of your plan, but DO NOT include the detailed plan here. Limit this part to be no longer than one A4 page. The points you earn in this part depends on the relevance, clearness, and easiness-to-read of your executive summary.
2. (20 points) Write down your detailed schedule by filling in numbers into the MS Excel file OR108-2.case01.ans.xlsx. In that spreadsheet, you may modify only those gray cells. For each gray cell, please enter the shift number that you assign to the CSR on that particular day. For example, if you want to let Georgina Stevens takes a day off on March 6, please enter “0” in cell H2. Do not modify anything else. If you fail to follow this rule so that your submission cannot be graded automatically, you get no point in this part. If a plan is infeasible, it is possible that you earn no point. If your schedule is feasible, the grades of your schedule will be determined in the following way. Let  $z^*$  be the total lack amount of an optimal schedule,  $z$  be that of your schedule, and  $\bar{z}$  be that of the schedule generating the highest total lack amount all feasible submissions. Your grades for this problem is

$$10 + 10 \left( \frac{\bar{z} - z}{\bar{z} - z^*} \right).$$

if your schedule is feasible or 0 otherwise.

3. (50 points) Describe the method you design for this problem. Your description will be graded based on the logic of your method, extendability (e.g., can it still solve

the problem efficiently when there are 500 CARs for a seasonal shift scheduling?), and clarity. Limit this part to be no longer than two A4 pages.

This case assignment counts for 5% in calculating the semester grades.

### 3 Submission rules

- **Teams.** Students should form teams to work on this case study. Each team should have three to five students. Each team should make only one submission.
- **Things to submit.** Please submit an MS Excel spreadsheet (for Problem 2 above) and a PDF file (for Problem 1 and 3 above). Include the student IDs and names of all team members in the PDF file.
- **How to submit.** Please submit both files to NTU COOL. Each team should make only one submission, i.e., only one student should make a submission.
- **Deadline.** The deadline of this assignment is **21:00, March 9**. Works submitted between 21:00 and 22:00 will get 10 points deducted as a penalty. Submissions later than 22:00 will not be accepted.

### 4 Final note

As you have not really learned anything from this course, this case assignment is designed for you to understand this problem and experience the difficulties of real-world decision problems. We do not expect you to perfectly solve this problem. Therefore, as long as you provide a reasonable way to find a reasonable solution, you do not need to worry too much about your grades. Nevertheless, trying to solve challenging problems is always interesting. Maybe you may find an optimal solution! If you have some free time, why not give it a try?