Chapter 7
Running the model and Analyzing the Result

In the previous chapter, the inputs for the model have been already recognized, thus, in this chapter, we try to find out and identify the appropriate fixed and dynamic resources that conform to bank benchmarks, and management policies. Note that all of simulation running detail is illustrated in the appendix section. First, we try to find out the suitable fixed resources, the numbers of telephone line and IVR.

7.1 Fixed Resource Analysis

After interview with bank officers, we know that the number of customers, which require using call center service shouldn't exceed 2,000 calls per hour in case that there are no new services and no additional promotion. From bank forecasting, we run the model by using the interarrival distribution as exponential while its mean is 3600/2000. The summary result of simulation (70 telephone lines, 60 IVR ports, and 20 agents) is shown below:

```
                  ARENA Simulation Results
                     Pa - License #9400000

                 Output Summary for 10 Replications

Project:  Call Center Anal          Run execution date :   4/21/2001
Analyst:                            Model revision date:   4/21/2001


                           OUTPUTS

  Identifier          Average    Half-width Minimum    Maximum # Replications


  Avg IVR Q Time      1.5851      .27153     .92188    2.0701      10
  Avg Agent Q Time    49.147      19.213     15.735    88.811      10
  Busy Lines          6822.7      168.74     6426.0    7106.0      10
  Success Lines       11187.      152.38     10976.    11575.      10
  IVR Utilize         .95500      .03074     .86667    1.0000      10
  Telephone Utilize   .97714      .01760     .92857    1.0000      10
  Agent Utilize       .76500      .13225     .55000    1.0000      10
  Success Percent     62.120      .89736     60.729    64.301      10
```

Note: The detail of this and following result is shown in appendix section.

From this result, we found that the average waiting time before receiving the agent service and call success percentage are higher than bank expectation. Moreover, the telephone line and IVR port utilization are very high so we need to increase the telephone lines and IVR ports from 70 lines to 100 lines and 60 ports to 90 ports. The result of this incrementing is shown below:

```
              ARENA Simulation Results
                Pa - License #9400000

            Output Summary for 10 Replications

Project:  Call Center Anal          Run execution date :   4/21/2001
Analyst:                            Model revision date:   4/21/2001


                          OUTPUTS

Identifier          Average   Half-width Minimum    Maximum # Replications


Avg IVR Q Time      .04895    .02502    .00260     .10932      10
Avg Agent Q Time    309.96    38.115    234.36     382.97      10
Busy Lines          3783.9    296.00    2994.0     4418.0      10
Success Lines       14146.    252.18    13645.     14795.      10
IVR Utilize         .89667    .04170    .77778     .96667      10
Telephone Utilize   .96000    .02737    .90000     1.0000      10
Agent Utilize       .95000    .05474    .80000     1.0000      10
Success Percent     78.905    1.5900    75.541     83.169      10
```

From this result, the average waiting time before receiving the agent service is significantly higher than that of bank expectation (less than 10 seconds) because the utilization of agent is very high so we increase the number of agent from 20 to 27. The result of simulation is shown below:

```
              ARENA Simulation Results
                Pa - License #9400000

            Output Summary for 10 Replications

Project:  Call Center Anal          Run execution date :   4/21/2001
Analyst:                            Model revision date:   4/21/2001


                          OUTPUTS

Identifier          Average   Half-width Minimum    Maximum # Replications


Avg IVR Q Time      .07765    .02361    .02058     .12177      10
Avg Agent Q Time    15.877    4.4739    8.7036     29.336      10
Busy Lines          2103.3    118.99    1880.0     2453.0      10
Success Lines       15842.    47.931    15748.     15926.      10
IVR Utilize         .88556    .04442    .74444     .96667      10
Telephone Utilize   .92300    .04957    .76000     1.0000      10
Agent Utilize       .71481    .09935    .48148     .92593      10
Success Percent     88.285    .60427    86.524     89.439      10
```

From this result, we found that the call success percentage and average waiting time before receiving IVR service conform to the bank expectations but the average waiting time before receiving the agent service is still higher than that of bank expectation so we try to increase the number of agent from 27 to 28. The summary result of simulation is shown below:

```
                    ARENA Simulation Results
                     Pa - License #9400000

                 Output Summary for 10 Replications

Project:  Call Center Anal          Run execution date :   4/21/2001
Analyst:                            Model revision date:   4/21/2001


                           OUTPUTS

Identifier          Average    Half-width Minimum    Maximum # Replications

Avg IVR Q Time      .06893     .02140     .03175     .13209    10
Avg Agent Q Time    7.9150     4.1201     2.3191     20.464    10
Busy Lines          2102.8     105.85     1817.0     2467.0    10
Success Lines       15879.     97.705     15648.     16153.    10
IVR Utilize         .90778     .05268     .74444     1.0000    10
Telephone Utilize   .92600     .04336     .80000     1.0000    10
Agent Utilize       .62500     .09527     .42857     .82143    10
Success Percent     88.308     .56825     86.422     89.888    10
```

From this result, we may conclude that the appropriate number of telephone lines, IVR ports, and agent are 100, 90, and 28, respectively. Note that the number of agent represents the maximum number of agent in this system that means the number of agent should not exceed 28, and this result is only based on data in January 2001.

The roughly budget of incrementing telephone lines from 70 lines to 100 lines is equal to 280,000 Bahts (fixed) and 52,500 Bahts per month. The budget for incrementing IVR ports from 60 ports to 90 ports is equal to 2,300,000 Bahts (already include hardware and software). The budget for incrementing the number of agent from 20 to 28 is equal to 72,000 Bahts per month. The total budget for supporting 2,000 incoming calls per hour is 2,580,000 Bahts (fixed) and 124,500 Bahts per month.

7.2 Dynamic Resource Analysis

The simulation model for dynamic resource (agent) analysis is generated by using the agent service time distribution that can represent the most workdays, peak hour in January.

The expected number of customer that require contacting is approximately 200 per hour because the percentage of the customer who need contacting with the agent is equal to 10 that mean if the expected calls in the system is 2000 calls per hour, the calls transferred to the agent are 200 calls per hour. By using the existing resource (20 agent), the summary result of simulation is shown below:

```
ARENA Simulation Results
    Pa - License #9400000

Output Summary for 10 Replications

Project:  Call Center Anal          Run execution date :  4/21/2001
Analyst:                            Model revision date:  4/21/2001


                    OUTPUTS

Identifier        Average   Half-width Minimum     Maximum # Replications
_____

Agent Queue Time   72.357   23.354     30.796      130.95      10
Agent Utilize      .89497   .01907     .83879      .93637      10

Simulation run time: 0.68 minutes.
Simulation run complete.
```

From this result, we found that the average waiting time before receiving the agent service is considerably higher than that of bank expectation so we try to increase the number of agent from 20 to 22. The summary simulation result is shown below:

```
ARENA Simulation Results
    Pa - License #9400000

Output Summary for 10 Replications

Project:  Call Center Anal          Run execution date :  4/21/2001
Analyst:                            Model revision date:  4/21/2001


                    OUTPUTS

Identifier        Average   Half-width Minimum     Maximum # Replications
_____

Agent Queue Time   16.609   5.3812     5.9617      28.276      10
Agent Utilize      .81267   .02409     .76802      .87049      10
```

From this result, the average waiting time is still slightly higher than that of bank expectation so we try to increase the number of agent from 22 to 23. The summary result of simulation is shown below:

```
ARENA Simulation Results
    Pa - License #9400000

Output Summary for 10 Replications

Project:  Call Center Anal          Run execution date :  4/21/2001
Analyst:                            Model revision date:  4/21/2001


                    OUTPUTS

Identifier        Average   Half-width Minimum     Maximum # Replications
_____

Agent Queue Time   9.1328   6.2698     3.0731      34.758      10
Agent Utilize      .77674   .02145     .73568      .83805      10
```

From this result, we may conclude that the suitable number of agent, which can support 200 incoming calls (to agent) per hour, for regular workday in peak period (9:00 to 18:00) is equal to 23. The budget of incrementing the number of agent from 20 to 23 is equal to 27,000 Bahts per month.