ATM filling problem

Problem description

ATM refilling during weekend time problem should be solved using simulation technique. At the end of the working week, on Friday at 5 p.m., ATM is filled with a particular amount of cash. The next time of ATM refilling is scheduled only on Monday at 8 a.m.

Problem task is to determine the following variables the most appropriate values:

1. Initial cash amount; banknotes amount which is delivered for ATM on Friday evening.
2. Breakpoint: in case if the cash amount in ATM goes down to the breakpoint (run low), ATM pays out a reduced cash amount. This decision is taken in order to serve as many clients as possible instead of satisfying a scant number of clients by paying out demanded cash in a full.
3. Limited cash amount: that is maximal cash amount paying by ATM if available cash getting smaller than breakpoint. Initially, limited cash amount is set as 20 Eur.

Model structure

Time unit in the model – one hour.
Clients arrival is a random variable that depends on the time period and is specified by cumulative distributions.
Period A = active period from 9 a.m. till 9 p.m.

Number of clients	Probability
0	0
1	0.12
2	0.3
3	0.5
4	0.84
5	0.95
	1

Period B = silent period from 9 p.m. till 9 a.m.

Number of clients	Probability
0	0
1	0.3
2	0.66
3	0.96
	1

Demanded cash amount is random variable as well and is specified by a cumulative distribution:

Cash amount	Probability
20	0
50	0.4
100	0.75
200	0.93
	1

Searching for the most appropriate solution of the problem

To determine the most appropriate values of the variables (initial cash amount, breakpoint, and limited cash amount) it is necessary to find a trade-off between clients satisfaction and risk by implementing the following goal function:

$$\text{Goal function} = 0{,}015 * \sum_{\text{satisf\_full}} Dc - 0{,}02 * \sum_{satisf\_partly} Dc - 0.05 * \sum_{unsatisf} Dc - 0{,}01 * initial\_cash$$

where

Dc – demanded cash amount.

Following facts are taking into consideration:

- Satisfied clients: +1.5% of demanded (in this case already received) cash amount.
- Unsatisfied clients: - 5% of demanded cash amount.
- Partly satisfied clients: - 2% of demanded cash amount.
- Most of the banks consider that 1% of risk estimation is adequate. It is associated with the initial cash amount input. The risk includes safety risk (against criminals) and loss of income since the money inputted in ATM could not be used for other purposes (blocked funds).

Use the „What-If" analysis to solve the problem (not less than 10 experiments should be performed).