ATM NETWORK STUDIES

Department of Industrial and Systems Engineering

IE3100R System Design Project

NUS National University of Singapore

Problem Description

The Bank aims to delivers a comprehensive range of innovative banking services and financial solutions to individuals through its ATMs. One problem faced by the Bank's ATM network is long waiting time and queue length.

However, there are problems with the current method of manual on-the-ground collection of data through outsourced vendors:

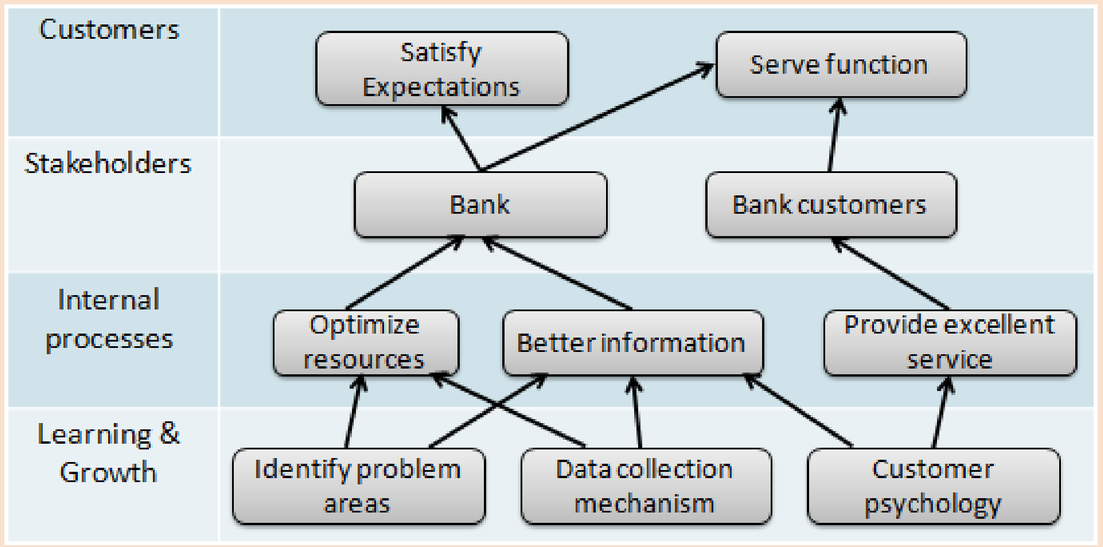
1. Costly
2. Time consuming
3. Limited in scale

Objectives

Improve customer satisfaction through

- Gaining a better understanding of the ATM system performance using cost effective methods
- Providing feasible action plans to improve the performance of the system.

Strategy Map



Project Approach

To achieve an understanding of the ATM system using cost effective methods, measure and track tools were developed for:

1. Individual ATM location (Queue Pattern Model)
2. ATM network system dynamics (Cluster Simulation)

Queue Pattern Model

SERIAL_NO	TRANSACTION_DATE	TRANSACTION_TYPE	TRANSACTION_TIME	Hour	Minute	Second	Time (Sec)	Idle Time (Sec)	Time Stamp of customer arrival (Sec)
183-80931-3	10/04/2010	CARD EJECTED	00:00:03	0	0	3	3	0	0
183-80931-3	10/04/2010	CARD TAKEN	00:00:08	0	0	8	8	0	0
183-80931-3	10/04/2010	PRESENT	00:00:08	0	0	8	8	0	0
183-80931-3	10/04/2010	CASH OUT	00:00:11	0	0	11	11	0	0
183-80931-3	10/04/2010	CASH TAKEN	00:00:12	0	0	12	12	0	0
209-26019-0	10/04/2010	CARD INSERTED	00:05:16	0	5	16	316	304	316
209-26019-0	10/04/2010	CARD EJECTED	00:05:54	0	5	54	354	0	0
209-26019-0	10/04/2010	CARD TAKEN	00:05:58	0	5	58	358	0	0
209-26019-0	10/04/2010	PRESENT	00:05:58	0	5	58	358	0	0
209-26019-0	10/04/2010	CASH OUT	00:06:01	0	6	1	361	0	0
209-26019-0	10/04/2010	CASH TAKEN	00:06:02	0	6	2	362	0	0
276-88739-0	10/04/2010	CARD INSERTED	00:06:18	0	6	18	378	16	378
276-88739-0	10/04/2010	CARD EJECTED	00:06:30	0	6	30	390	0	0

(For illustration purposes only)

Idle Time Sum	Total Time	Time Stamp (Sec)	Time Stamp (hr:mins:sec)	Utilization Rate	Average Service Time	Variance of Svc Time	Average IAT	Average Queueing Time (s)	Average Queue Length (ppl)	Grand AQT	Grand AQL
1200	1279	1279	0:21:19	0.061767	26.33333	310.3333	426.3333	1.254722	0.002943	119.09	1.96
3804	3883	5162	1:26:02	0.020345	26.33333	25.33333	1294.333	0.28343	0.000219		
1112	1389	6551	1:49:11	0.199424	92.33333	4772.333	463	17.93765	0.038742		
11954	12058	18609	5:10:09	0.008625	34.66667	156.3333	4019.333	0.170417	4.24E-05		
1701	2067	20676	5:44:36	0.177068	122	14371	689	25.79806	0.037443		
111	236	20912	5:48:32	0.529661	41.66667	341.3333	78.66667	28.07357	0.356867		
294	501	21413	5:56:53	0.413174	69	3775	167	43.55102	0.260785		
337	473	21886	6:04:46	0.287526	45.33333	1012.333	157.6667	13.65331	0.086596		
822	976	22862	6:21:02	0.157787	51.33333	1302.333	325.3333	7.185118	0.022085		
300	486	23348	6:29:08	0.382716	62	1261	162	25.525	0.157562		

(For illustration purposes only)

Key Points of Model:-

1. Microsoft Excel Spreadsheet using VBA
2. M/G/1 Queuing Model using P-K formula
3. Backward Induction Algorithm using Little's Law

$$\overline{X} = \mathrm{E}[X] = \frac{1}{\mu} = \text{Average service time}$$

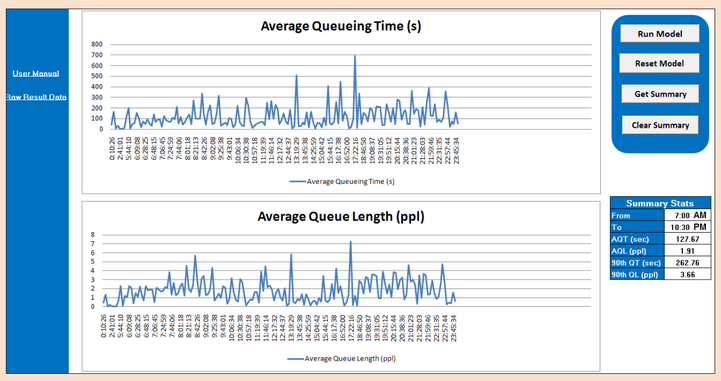
and

$$\overline{X^2} = \mathrm{E}[X^2] = \text{Second moment of service time}$$

The P-K formula is then:

$$W = \frac{\lambda \overline{X^2}}{2(1-\rho)}$$

Using the ATM card-in card-out log for a particular ATM machine of one day, the Queue Pattern Model would be able to generate the graphs of estimated queue time and length throughout the time span of the particular day.



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This allows users to:-

- Observe the trends throughout the day from the time-series plots.
- Obtain summary data between any two time points within the day and identify the peak hours and non-peak hours.
- Achieve significant cost & time saving for the Bank in measurement & tracking

Model Validation

	Location A Wed	Location A Wed	Location A Sat	Location A Sat	Location B Wed	Location B Wed	Location B Sat	Location B Sat	Location C Wed	Location C Wed	Location C Sat	Location C Sat
From	7:00	7:00	7:00	7:00	7:00	7:00	7:00	7:00	7:00	7:00	7:00	7:00
To	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
AQT (Sec)	82.08	59	79.22	60	65.73	78	58.88	66	72.89	100	59.64	160
AQL	1.63	1	1.5	2	1.4	2	1.34	2	1.5	2	1.38	4
90th QT (Sec)	179.583	150	153.789	142	129.562	210	101.901	150	129.117	253	102.312	387
90th QL	3.30121	3	2.89327	3	2.49851	5	2.26911	4	2.65621	5	2.24837	7

(For illustration purposes only)

MG1 Model
External Data

The results of our model were validated against selected data available from the outsourced manual study done.

Remodelling with Consideration of Multiple-Card-Insertion Customers

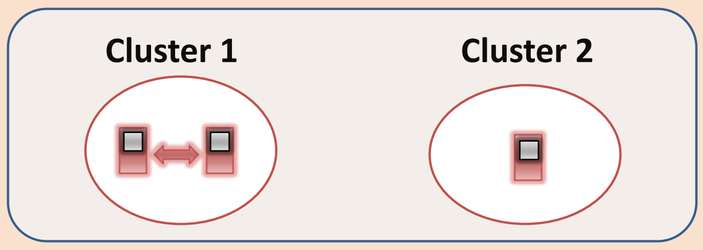
	Location B Wed	Location B Wed	Location C Wed	Location C Wed	Location C Sat	Location C Sat
From	7:00	7:00	7:00	7:00	7:00	7:00
To	10:00	10:00	10:00	10:00	10:00	10:00
AQT (Sec)	130.5	59	159.4	100	120.0	160
AQL	2.0	1	2.3	2	2.0	4
90th QT (Sec)	247.6	150	315.3	253	230.2	387
90th QL	3.4	3	4.6	5	3.6	7

(For illustration purposes only)

Cluster Simulation using iThink

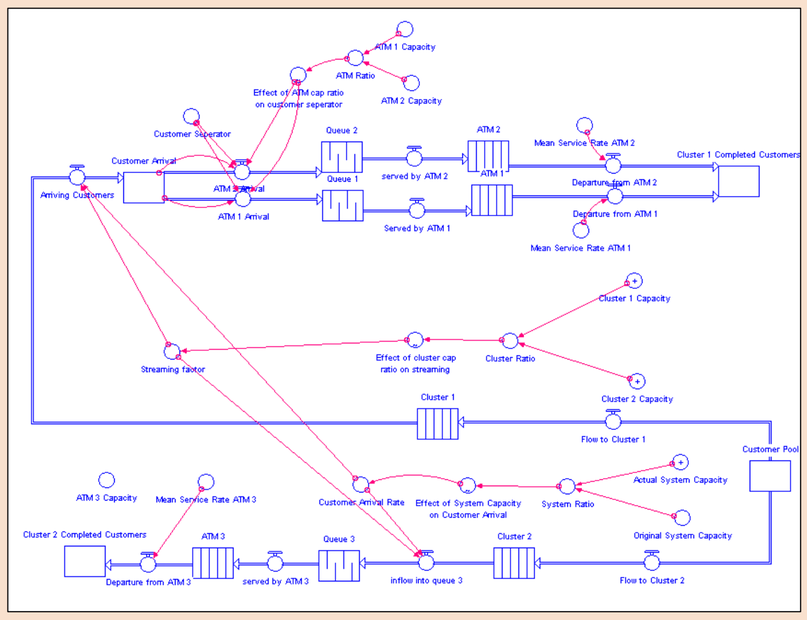
A scenario analysis is conducted to investigate the ATM network system dynamics.

ATMs within a geographic area can be considered as an ATM network system. An ATM system can comprise of several ATM clusters. In between clusters, the customer arrivals are independent of each other, while within a cluster, the performance of one ATM is related to that of another in the same cluster.



The customer arrival into the entire system follows a Poisson process and then streamed to different clusters through partition of Poisson process.

In doing the scenario analysis, we focused on a simplistic ATM system consisting of two clusters. Cluster 1 has two ATMs while Cluster 2 has one ATM. We used iThink to model the complexity involved in the ATM system dynamics.



Heuristic algorithms were incorporated into the iThink model to account for the customer queuing behaviour. The customers queuing behaviour was modelled based on survey responses of ATM users in the cluster area as well as past data records for this case study.

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