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Applying Simulation Method in Determining the Queue Service Capability: Empirical for ATM

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Abstract: This research aims to systematize some basic theories of simulation methods, to apply simulation methods in defining the queue service and empirical study for ATM facility. One of the main findings of the research is: (i) Establishment of a general model for defining queue service capacity, (ii) Establishment of a simulation program of capacity utilization through the assessment of parameters: the number of customers using the service, the number of customers leaving; the waiting time of customers; the idle time of facility, and (iii) formulating a suitable simulation technique which will reduce idle time of servers and waiting time of customers for any bank having ATM facility. This simulation technique will be helpful for any company improving and enhancing customer's satisfaction.

Key words: service capability; simulation; ATM
JEL codes: O

1. Introduction

Along with the development trend in the direction of deep integration, a queue service system with high-tech elements are really necessary for modern civilized society. This has opened up many promising business opportunities for businesses. Lavenberg (1989) stated that simulation has been found as an effective tool for studying complex queue models. The estimation of probabilities in the queue network has received considerable attention in the simulation literature. Queuing theory has been applied to many business situations in practice. All queue situations are related to the appearance of customers (Hira & Gupta, 2004). In general, customers expect a certain level of service from businesses while businesses use capacity to meet customer needs and try to keep costs to a minimum (Vasumathi & Dhanavanthan, 2010). Therefore, companies are always interested in an effective queue service capacity system.

There are many activities to provide products and services in which the characteristics of the queue system appear (customers wait to be served) such as: waiting for medical treatment, waiting for check-in at the airline, waiting for payment at the supermarket, waiting to fill up the gas, ... This article focuses on the case study of ATM services to determine the ATM capacity in the relationship to meet the customers demand. There are many methods that can be used in ATM network layouts such as intuitive methods, profit-cost analysis, scoring methods, transportation problems, load distances and optimal mathematical models (Jacobs & Chase, 2008). We can apply

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these methods to identify a network of suitable locations to place ATMs (Ho Tan Tuyen & Nguyen Huy Tuan, 2014). However, the remaining problem is that at each designated location, how many ATMs are located at that location. One method that can be used to solve this problem is a simulation method (Vasumathi & Dhanavanthan, 2010; Zhang et al., 2018). As an outstanding method, through a simulation program is set up, the bank will decide quicly how many ATMs are best to put together at the same place, this help reduce costs for banks (Vasumathi & Dhanavanthan, 2010).

2. Literature Review

This study approaches the queue system with three major components: (1) the inflow of system, (2) the servicing system, and (3) outflow of system (Gross & Harris, 1974; Jacobs & Chase, 2017). The inflow of system is expressed through the source population and the way customers arrive at the system, the source population can be finite or infinite. The servicing system is expressed through factors such as manpower, premises and equipment used in the customer service process. The scale of the system reflects the queue servicing capacity of businesses. The outflow of system reflects the number of customers served/ not served, customer satisfaction, and the benefits of business.

Jacobs and Chase (2017) showed specific parameters in four queue models, including three queue models with infinite source population (Single channel-Single phase; Single channel-Multi phase; Multi channel-Multi phase), and one queue model with finite source population. Specifically, (i) the queue model with Single channel-Single phase: the source population is infinite, the distribution of arrival is exponential, the servicing rule is first come first served, and the length of waiting line is unlimited. (ii) The queue model with Single channel-Multi phase: the source population is infinite, the distribution of arrival is constant, the servicing rule is first come first served, and the length of waiting line is unlimited. (iii) The queue model with Multi channel-Multi phase: the source population is infinite, the distribution of arrival is a Poisson type, the servicing rule is first come first served, and the length of waiting line is unlimited. (iv) The queue model with the finite source population: the distribution of arrival is a Poisson type, the servicing rule is first come first served, and the length of waiting line is unlimited. Jacobs and Chase (2017) also said that in addition to these queue models, there are many other queue models but the calculation formulas and solutions are quite complicated, so it is necessary to use simulation tools on the computers. This topic considers solving queue models with Single channel-Single phase and Multi channel-Single phase in which the distribution on arrival is the random probability distribution with the estimated probability density function based on the observed data from the practical system.

Considering the operation of ATM systems in banks, there are two queue models: (i) Single channel-Single phase (in a specific location, there is only one ATM), and (ii) Multi channel-Single phase (in a specific location, there are tow or more ATMs). The inflow of these systems has an infinite source population (there are many customers and each customer can come to use the service many times), the arrival time of the customer usually has a power distribution form (Vasumathi & Dhanavanthan, 2010), the servicing rule is the first-come first served. The criteria used to evaluate the queue service capacity system include: (i) the number of customers using the system, (ii) the number of customers leaving, (iii) the time waiting of customers, (iv) The idle time of service capacity system (Jacobs & Chase, 2008).

3. Study Research

There are many different methods in determining service capacity needs, such as qualitative analysis methods, customer scale analysis methods, and experience-based methods, through operational experience, the capacity to wait for the queue is determined, and then evaluate the efficiency of using the queue service capacity to make adjustments to suit the changes in uncertain conditions (Cliff & Jonathan, 2013). In addition, businesses can use simulation methods by using simulation techniques in order to determine queue capacity needs to find results. Activities that need to be performed in the simulation method include: (i) observing customer happenings, integrating initial data, processing data, setting up simulation program on computer, running simulation program, analysing and making the decision (Anderson, 2014). The greatest benefit of this method is that there is no need to renovate the real system, so there are no additional costs; it does not take much time to wait for the evaluation of effectiveness; and it help make decisions quickly to use the queue service capacity (Zeng, Ma, & Qi, 2010). The results extracted from simulations are reliable based on large number rules. Furthermore the simulation results are clear, scientific and persuasive (Kimita, Tateyama, & Shimomura, 2012). Through the simulation method, enterprises can avoid unforeseen circumstances and make adjustments to make decisions with better expected results. Discovering probability distribution rules of events is a key factor in using simulation methods (Kos, Hess, & Hess, 2006). Objectively, the simulation method are evaluated as a modern method, in accordance with the continuous development of information technology.

3.1 The General Simulation Model

The general simulation model is described in Figure 1, accordingly:

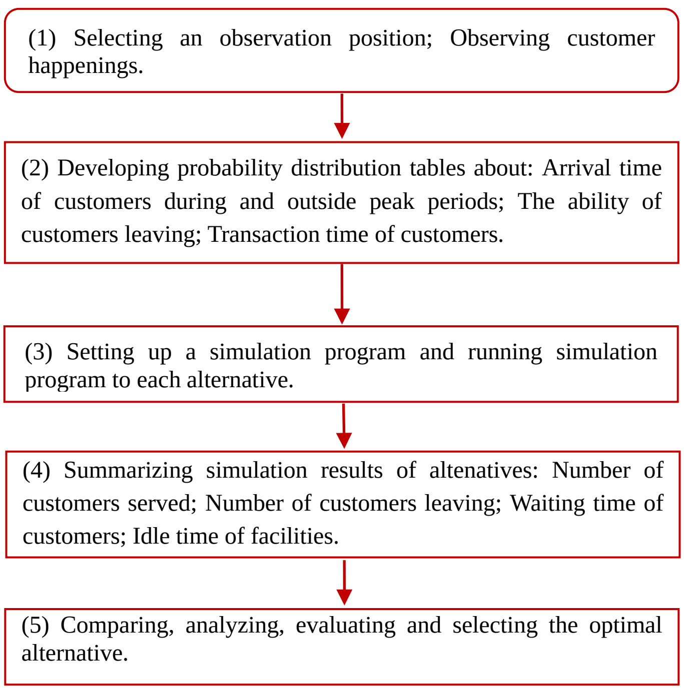

Figure 1 The General Simulation Model

(1) Selecting an observation location, observing customer happenings to get initial primary data: Arrival time of customers during and outside peak periods; the ability of customers leaving; Transaction time of customers. (2) From the initial primary data, developing probability distribution tables about: Arrival time of customers during and outside peak periods; the ability of customers leaving; Transaction time of customers. (3) With each alternative, setting up a simulation program and running simulation program (performing in repeating many times)

by using Microsoft Excel software. Increase reliability of simulation results by performing multiple simulations. (4) Summarizing simulation results of alternatives: Number of customers served; Number of turns of customers leaving; Waiting time of customers; idle time of facilities. (5) Comparing, analyzing, evaluating and selecting the optimal alternative.

3.2 Setting Up a Simulation Program

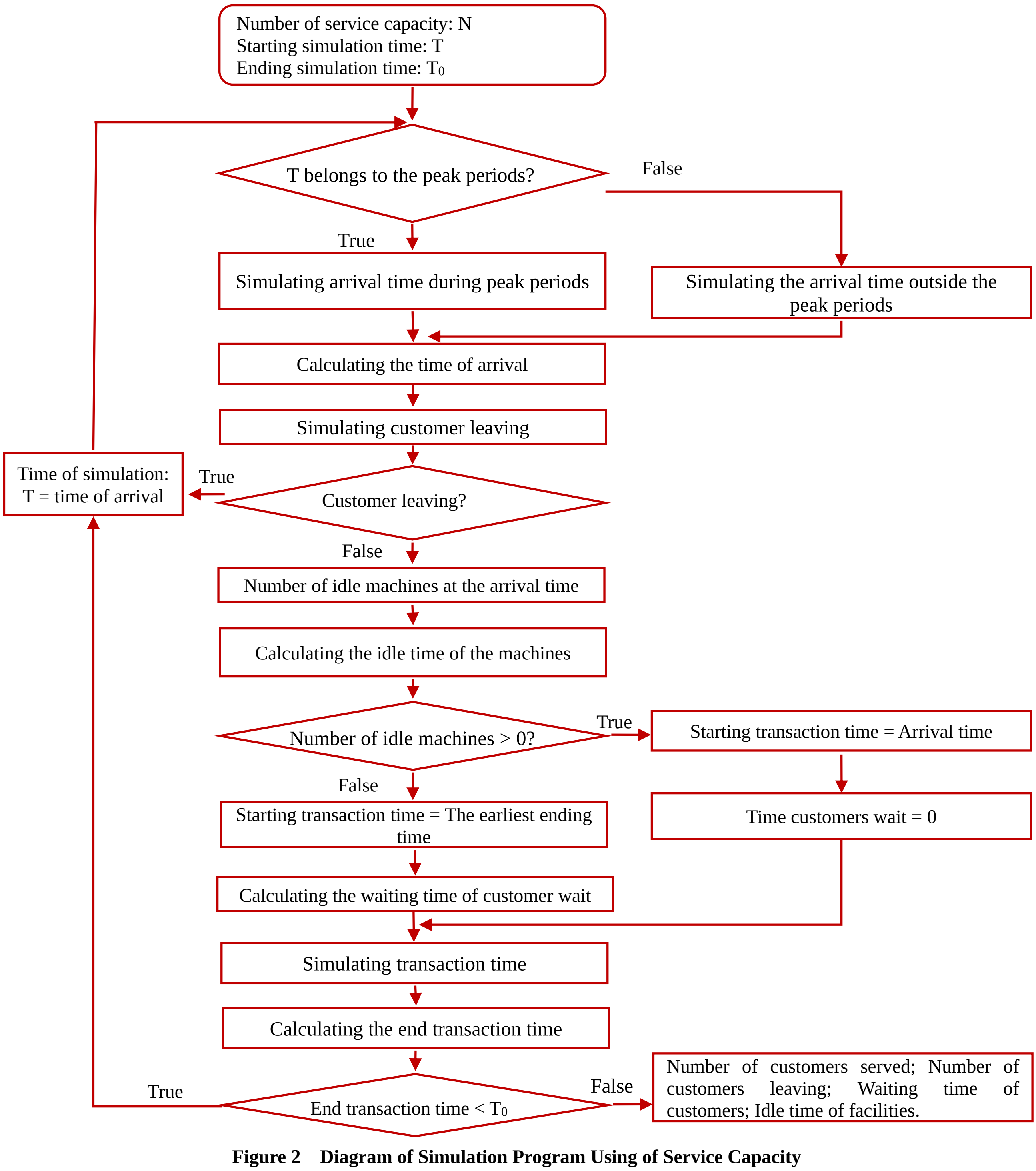

Figure 2 Diagram of Simulation Program Using of Service Capacity

Figure 2 shows diagram of simulation program using of service capacity. This simulation program is built to apply for many alternatives of capacity at the same position, generalizing with the capacity of N units, this helps determine the optimal service capacity demand.

4. Empirical Research for ATM

4.1 Scope of Experimental Application

The common weekly working period of Vietnamese organizations (including banks) is from Monday to Saturday (six days per week), so the decision on the number of adjacent ATMs at the same location will depend on the use of ATM services during that period. In other words, Weekends (Sunday) are less dominant in decision making. Therefore, in the application of the simulation program, this article only shows the observed contents in the days from Monday to Saturday in order to form research data. Because of similarities of working days in the week, the simulation program will be implemented in one day from 7:00 AM to 18:00 PM and simulation results reflect the situation of the days within that review period (Monday to Saturday). In order to ensure reliability, the author will perform 30 different simulations, then calculating the average parameters such as the number of customers using ATM services, the number of customers leaving, the waiting time of customers. And the idle time of ATMs.

4.2 Location of Research and Observation of Customer Happenings

The model of simulation program (Figure 2) can be applied to perform at any location where the bank chooses to place ATMs. The location selected in this study is location of ATMs at 23 Phan Dinh Phung Street, Hai Chau I Ward, Hai Chau District, Da Nang City. There are 03 adjacent ATMs at this location. In order to ensure representation, 936 customers are reviewed within 6 days. The observation time in each day is classified into two ranges: outside the peak periods (from 7:00 AM to 11:00 AM or from 12:15 PM to 17:00 PM) and during peak periods. The peak period has the high density of customers using ATM system, usually the time when customers finish working hours from 11:00 AM to 12:15 PM or from 17:00 PM to 18:00 PM.

Table 2 shows that the arrival time of each customer is observed in the order of appearance in time. Moreover, the customers leaving, the transaction time of customers is also recorded specifically. The arrival time in minutes is the result of the difference between the arrival time of two consecutive customers. Customers can leave for many reasons such as not continuing to implement the transaction because of waiting too long or for other reasons. The transaction time is the time from the start of the transaction to the end of the transaction (Exiting the ATM system).

4.3 Probability Distribution of Arrival Time

Using the results of observing the situation of using customers' ATM services (Table 1), the probability distribution tables are developed in Table 2, Table 3 and Table 4.

The distribution rule of arrival time inside and outside the peak period and the distribution density function is estimated respectively (Figure 3). The arrival time of customers is a random quantity with a probability distribution table including 21 events. Table 2 shows: The outside the peak period, the arrival time of 0-minute with a probability of 0.023, this means that the probability of two customers arriving at the same time outside the peak period is 2.3%. The inside the peak period, the arrival time of one minute with a probability of 0.056, this means that the probability of the customer appearing after a minute from previous customer is 5.6%.

Table 1 Observed Data in Brief About the Situation of Using ATM System

No.	Arrival time	Arrival time (minutes)	Leave (×)	Transaction time (minutes)
Outside the peak period: From 7:00 AM July 10th, 2018				
1	7:08	8		4
2	7:12	4		2
3	7:16	4		4
4	7:21	5		8
5	7:29	8	X	3
6	7:32	3		3
7	7:34	2		5
8	7:39	5		5
9	7:41	2		9
10	7:42	1		5
11	7:43	1		6
12	7:47	4		3
13	7:51	4		1
14	7:54	3		7
15	7:57	3		4
16	8:02	5		9
17	8:09	7		4
18	8:13	4		9
19	8:18	5		3
20	8:25	7		8
21	8:30	5		4
…	…	…	…	…
936	18:04	5		2

Source: Extracting from observation results at the ATM location.

Table 2 Table of Distribution Probability of Arrival Time

No.	Arrival Time (minutes)	Probability	
		Outside the peak period	During the peak period
1	0	0.023	0.116
2	1	0.082	0.056
3	2	0.114	0.129
4	3	0.109	0.185
5	4	0.212	0.198
6	5	0.202	0.233
7	6	0.038	0.052
8	7	0.156	0.030
9	8	0.038	0.000
10	9	0.006	0.000
11	10	0.006	0.000
12	11	0.000	0.000
13	12	0.000	0.000
14	13	0.000	0.000
15	14	0.001	0.000
16	15	0.001	0.000
17	16	0.001	0.000
18	17	0.000	0.000
19	18	0.001	0.000
20	19	0.001	0.000
21	20	0.007	0.000
Tổng		**1.000**	**1.000**

Source: Processing results from observation data.

Table 3 Table of Distribution of Probability of Leaving Ability (Arriving But Not Transacting)

No.	Customer status		Probability
1	X	Leaving	0.036
2		Not Leaving	0.964
Total			**1.000**

Source: Processing results from observation data.

The leaving ability of customers is a random quantity with a probability distribution table including two events (leaving, not leaving). The probability of leaving customers of 3.6%, not leaving 96.4%.

The transaction time of customers is a random quantity with a probability distribution table including ten events (Table 4). The probability of transaction time in one minute is 4.6%. The probability of transaction time in two minutes is 2.9 %. The probability of transaction time in three minutes is 14.5 %. Reviewing similarly, the probability of transaction time in ten minutes is 3.0 %.

Table 4 Table of Distribution Probability of Transaction Time at ATM

No.	Transaction time (minutes)	Probability
1	1	0.046
2	2	0.029
3	3	0.145
4	4	0.161
5	5	0.182
6	6	0.119
7	7	0.081
8	8	0.143
9	9	0.064
10	10	0.030
Total		**1.000**

Source: Processing results from observation data.

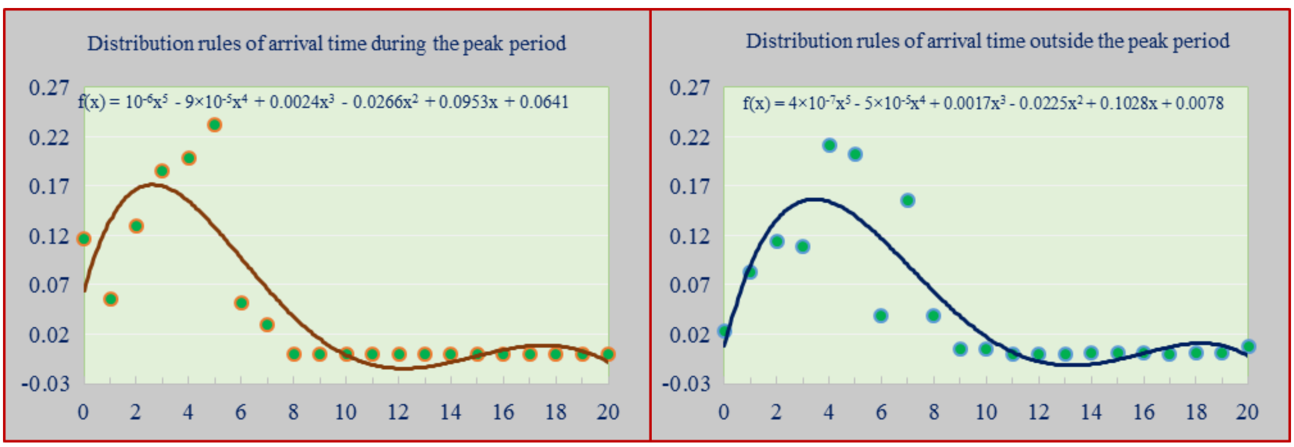

Figure 3 Distribution Rules and Estimating the Distribution Function of Arrival Time

4.4 Simulating the Situation of Using ATM Services for Alternatives

By setting up the simulation program as shown in Figure 2 on the computer (programming is done by using Visual Basic and Macro tools in Microsoft Excel software), the situation of using the service is stimulated for each different alternative, each alternative corresponds to each assumption of the number of ATMs located in adjacent at 23 Phan Dinh Phung Street, Hai Chau I Ward, Hai Chau District, Da Nang City. The study reviews three alternatives including: (i) For one ATM; (ii) For two ATMs; and (iii) For three ATMs. The alternative of three ATMs is the current layout and may not need to run a simulation. However, in order to ensure uniformity of the method and calculate the results for comparison among alternatives, the simulation for the alternative of three ATMs still done. The results of the simulation program for the alternatives are shown in Tables 5, Tables 6 and Tables 7.

Table 5 Summary of the First Simulation Result of Alternative 01 ATM

No.	Simulation of arrival time (minutes)	Arrival Time	Machine status at the arrival time	Number of idle machines	Customer leaving	Machine used	Time to start using	Time customers wait (minute)	Simulation of transaction time	End time	Time of idle machine (minutes)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	2	7:02	Idle	1		M1	7:02	0	7	7:09	2
2	3	7:05	Busy	0		M1	7:09	4	3	7:12	0
3	1	7:06	Busy	0		M1	7:12	6	5	7:17	0
4	7	7:13	Busy	0		M1	7:17	4	4	7:21	0
5	7	7:20	Busy	0		M1	7:21	1	7	7:28	0
6	5	7:25	Busy	0	X						0
7	4	7:29	Idle	1	X						1
8	4	7:33	Idle	1		M1	7:33	0	3	7:36	4
9	2	7:35	Busy	0		M1	7:36	1	3	7:39	0
10	1	7:36	Busy	0		M1	7:39	3	9	7:48	0
…	…	…	…	…	…	…	…	…	…	…	…
154	3	17:59	Busy	0		M1	20:14	135	6	20:20	0
Total					**5**			**9520**			**18**

Source: Extracting from the results of the first simulation

Table 6 Summary of the First Simulation Results of Alternative 02 ATMs

No.	Simulation of arrival time (minutes)	Arrival time	Machine status at the arrival time		Number of idle machines	Customer leaving	Machine used	Time to start using	Time customers wait (minute)	Simulation of transaction time	End time	Time of idle machine (minutes)		
			M1	M2								M1	M2	Total
(1)	(2)	(3)	(4a)	(4b)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12a)	(12b)	(12c)
1	8	7:08	Idle	Idle	2		M1	7:08	0	6	7:14	8	8	16
2	3	7:11	Busy	Idle	1		M2	7:11	0	2	7:13	0	3	3
3	3	7:14	Idle	Idle	2		M2	7:14	0	5	7:19	0	1	1
4	6	7:20	Idle	Idle	2		M1	7:20	0	3	7:23	6	1	7
5	4	7:24	Idle	Idle	2		M2	7:24	0	3	7:27	1	4	5
6	5	7:29	Idle	Idle	2		M1	7:29	0	6	7:35	5	2	7
7	3	7:32	Busy	Idle	1		M2	7:32	0	9	7:41	0	3	3
8	2	7:34	Busy	Busy	0		M1	7:35	1	5	7:40	0	0	0
9	3	7:37	Busy	Busy	0		M1	7:40	3	3	7:43	0	0	0
10	7	7:44	Idle	Idle	2		M2	7:44	0	6	7:50	1	3	4
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
163	2	18:00	Busy	Busy	0		M2	18:03	3	10	18:13	0	0	0
Total						**7**			**124**			**232**	**235**	**467**

Source: Extracting from the results of the first simulation

Table 7 Summary of the First Simulation Result of Alternative 03 ATMs

No.		(1)	1	2	3	4	5	6	7	8	9	10	...	139	**Total**
Simulation of arrival time (minutes)		(2)	4	7	19	3	4	7	0	6	5	7	...	4	
Arrival time		(3)	4:04	7:11	7:30	7:33	7:37	7:44	7:44	7:50	7:55	8:02	…	17:57	
Machine status at the arrival time	M1	(4a)	Idle	Idle	Idle	Idle	Idle	Idle	Idle	Idle	Idle	Busy	…	Busy	
	M2	(4b)	Idle	Idle	Idle	Idle	Idle	Idle	Idle	Idle	Idle	Idle	…	Idle	
	M3	(4c)	Idle	Idle	Idle	Busy	Busy	Idle	Idle	Idle	Idle	Idle	…	Idle	
Number of idle machines		(5)	3	3	3	2	2	3	2	3	3	2	…	2	
Customer leaving		(6)											…		**4**
Machine used		(7)	M1	M2	M3	M1	M2	M1	M3	M2	M1	M3	…	M3	
Time to start using		(8)	4:04	7:11	7:30	7:33	7:37	7:44	7:44	7:50	7:55	8:02	…	17:57	
Time customers wait (minute)		(9)	0	0	0	0	0	0	0	0	0	0	…	0	**3**
Simulation of transaction time		(10)	1	3	8	3	5	5	6	4	8	3	…	9	
End time		(11)	7:05	7:14	7:38	7:36	7:42	7:49	7:50	7:54	8:03	8:05	…	18:06	
Time of idle machine (minutes)	M1	(12a)	4	6	19	3	1	7	0	1	5	0	…	0	**445**
	M2	(12b)	4	7	16	3	4	2	0	6	1	7	…	0	**425**
	M3	(12c)	4	7	19	0	0	6	0	0	5	7	…	4	**438**
	Total	(12d)	12	20	54	6	5	15	0	7	11	14	…	4	**1308**

Source: Extracting from the results of the first simulation

The Tables include 12 columns marked from column (1) to column (12). The columns (2) onwards are explained as follows:

(2) Simulation of arrival time:

Based on the arrival time probability distribution (Table 2) and using random command "Rand ()" in Microsoft Excel Software to simulate the arrival time with results showed in Table 8, Table 9.

(3) Arrival time: the time when the customer arrives at the ATM location with the intention of using ATM service. The arrival time of a certain customer is determined by taking the previously defined arrival time plus the simulated arrival time.

(4a), (4b), (4c), (5) State of the first machine (M1), second machine (M2), third machine (M3). The status of each machine in either case "idle" or "busy", thereby identifying the number of idle machines.

(6) Customer leaving: In some situations, customers will leave, even when the machines are available at the time of arrival.

(7) Machine used: the machine with the earliest available time, in case there are many machines available at the same time, customers can choose to use one of those machines.

(8) Time to start a transaction: is the time from when the customer starts trading on an ATM.

(9) Waiting time for customers: is the period of time from the time the customer arrives until the time of commencement of the transaction.

(10) Simulating the time to start using: the transaction time of customers on ATM based on the probability distribution table of the transaction time (Table 11).

(11) End time: the time when the customer finishes the transaction is determined by taking the time of starting the transaction plus the transaction time.

Table 8 Simulation of Arrival Time Outside Peak Periods

No.	Simulation results of arrival time (minutes)	Probability		Conditions for simulation results
		Outside the peak period	Accumulation	
1	0	0.023	0.023	Rand() ≤ 0.023
2	1	0.082	0.105	0.023 < rand() ≤ 0.105
3	2	0.114	0.219	0.105 < rand() ≤ 0.219
4	3	0.109	0.328	0.219 < rand() ≤ 0.328
5	4	0.212	0.540	0.328 < rand() ≤ 0.54
6	5	0.202	0.742	0.54 < rand() ≤ 0.742
7	6	0.038	0.780	0.742 < rand() ≤ 0.78
8	7	0.156	0.936	0.78 < rand() ≤ 0.936
9	8	0.038	0.974	0.936 < rand() ≤ 0.974
10	9	0.006	0.980	0.974 < rand() ≤ 0.98
11	10	0.006	0.986	0.98 < rand() ≤ 0.986
12	11	0.000	0.986	Not occur
13	12	0.000	0.986	Not occur
14	13	0.000	0.986	Not occur
15	14	0.001	0.987	0.986 < rand() ≤ 0.987
16	15	0.001	0.988	0.987 < rand() ≤ 0.988
17	16	0.001	0.989	0.988 < rand() ≤ 0.989
18	17	0.000	0.989	0.989 < rand() ≤ 0.989
19	18	0.001	0.990	0.989 < rand() ≤ 0.99
20	19	0.001	0.991	0.99 < rand() ≤ 0.991
21	20	0.007	1.000	0.991 < rand() ≤ 1

Table 9 Simulation of Arrival Time During Peak Periods

No.	Simulation results of arrival time (minutes)	Probability		Conditions for simulation results
		During the peak period	Accumulation	
1	1	0.116	0.116	Rand() ≤ 0.042
2	2	0.056	0.172	0.116 < rand() ≤ 0.172
3	3	0.129	0.301	0.172 < rand() ≤ 0.301
4	4	0.185	0.486	0.301 < rand() ≤ 0.486
5	5	0.198	0.684	0.486 < rand() ≤ 0.684
6	6	0.233	0.917	0.684 < rand() ≤ 0.917
7	7	0.052	0.969	0.917 < rand() ≤ 0.969
8	8	0.030	0.999	0.969 < rand() ≤ 0.999

Table 10 Simulation of Customer Ability to Leave

No.	Simulation results	Probability	Accumulation	Conditions for simulation results
1	Leaving	0.036	0.036	Rand() ≤ 0.036
2	Not leaving	0.964	1.000	0.036 < rand() ≤ 1.00

Table 11 Simulation of Customer Transaction Time

No.	Simulation results	Probability	Accumulation	Conditions for simulation results
1	1	0.046	0.046	Rand() ≤ 0.042
2	2	0.029	0.075	0.046 < rand() ≤ 0.075
3	3	0.145	0.220	0.075 < rand() ≤ 0.22
4	4	0.161	0.381	0.22 < rand() ≤ 0.381
5	5	0.182	0.563	0.381 < rand() ≤ 0.563
6	6	0.119	0.682	0.563 < rand() ≤ 0.682
7	7	0.081	0.763	0.682 < rand() ≤ 0.763
8	8	0.143	0.906	0.763 < rand() ≤ 0.906
9	9	0.064	0.970	0.906 < rand() ≤ 0.97
10	10	0.030	1.000	0.97 < rand() ≤ 1
Total		1.000		

4.5 Results of Synthetic Simulation, Evaluating and Selecting the Optimal Alternative

In order to ensure the reliability in the simulation results, the study carried out 30 simulation times for each alternative (Showed in Table 12).

From the results of 30 simulation times for each alternative, Statistical parameters are calculated as showed in Table 13.

Through the simulated statistical results in Table 13, an average of approximately 156 to 159 customers per day intending to use ATM services. However, for some reason, there are about 5 to 6 customers leaving per day on average, so there are about 153 customers transacting at ATMs. The total of time that customers have to wait because due to busy machines is difference between the alternatives (75.36 minutes for alternative of one ATM, 0.77 minutes for alternative of two ATMs, and 0.04 minutes for alternative of three ATMs). Thus, for the alternative of one ATM, the waiting time of customers is very large and this will not be possible in the practice. Considering another aspect of the idle time of ATMs, the average idle time of the alternative of three ATMs is very large, up to 1179.6 minutes per day, equivalent to 6.55 hours per day per ATM. For the alternative of two ATMs, the idle time of the machine is lower than 4.14 hours per day per ATM.

The results showed that although the brank currently has 03 adjacent ATMs at 23 Phan Dinh Phung Street - Hai Chau I Ward - Hai Chau District - Da Nang City has reduced the average waiting time of a customer (about 0.04 minutes) but did not exploit the efficiency of using ATMs due to the large idle time of ATMs, nearly 6.55 hours per day per ATM. Meanwhile, for alternative of one ATM, the average waiting time of a customer is very large (over 75.36 minutes), so customers may not be acceptable. So, the optimal number of ATMs should be the two adjacent ATMs. For this alternative of two ATMs, the average waiting time of a customer is low (0.04 minutes) and acceptable. The average idle time per day per ATM also is low in comparing with the current layout. Moreover, the bank will save the cost of investing in machinery and equipment due to reducing one ATM from current ATMs system.

Table 12 Simulation Results of Alternatives

No.	Alternative of 01 ATM				Alternative of 02 ATM				Alternative of 03 ATM			
	Number of Customers	Number of Customers leaving	Waiting time (minutes)	Idle time of ATM (minutes)	Number of Customers	Number of Customers leaving	Waiting time (minutes)	Idle time of ATM (minutes)	Number of Customers	Number of Customers leaving	Waiting time (minutes)	Idle time of ATM (minutes)
1	154	5	9520	18	156	6	12	595	139	4	3	1308
2	150	7	7950	7	151	9	1	573	168	7	4	1129
3	152	3	6991	14	153	4	14	602	167	7	1	1146
4	165	5	21844	5	166	4	9	486	152	6	3	1191
5	131	3	2445	21	144	3	7	566	163	8	5	1159
6	147	4	6936	28	166	4	4	486	155	4	10	1205
7	172	7	23794	3	163	5	14	462	162	4	2	1158
8	165	1	21371	5	149	2	6	589	162	4	2	1158
9	168	5	14997	13	152	3	0	559	156	5	3	1219
10	163	8	15454	10	155	3	4	560	149	6	6	1209
11	149	4	9600	8	161	5	9	534	160	3	25	1100
12	167	6	14634	10	149	5	6	584	150	4	1	1200
13	154	3	11408	3	147	3	4	580	160	6	9	1164
14	159	5	12299	6	145	6	7	616	156	3	4	1157
15	149	4	12908	7	144	5	6	650	165	5	2	1158
16	153	13	6826	4	159	6	11	516	153	3	11	1175
17	158	7	12990	6	161	10	3	581	164	7	1	1125
18	150	6	11374	5	161	2	8	525	151	1	8	1182
19	158	9	10951	10	166	4	13	500	161	4	14	1144
20	157	6	10905	7	161	4	7	522	168	10	12	1147
21	150	6	9776	19	162	6	4	511	143	5	3	1246
22	162	10	8630	12	155	7	21	569	151	7	2	1218
23	160	8	8975	13	152	7	1	590	152	9	9	1199
24	149	5	4723	8	160	5	7	557	155	7	8	1162
25	167	4	22470	4	150	7	9	626	159	3	4	1179
26	166	4	10176	23	156	2	4	492	148	5	0	1245
27	157	6	15158	18	148	7	7	573	146	4	3	1233
28	158	1	15935	4	158	5	0	582	156	9	1	1184
29	148	6	5451	17	146	6	3	602	176	5	27	1064
30	144	5	6359	9	167	6	7	517	142	8	5	1224

Table 13 Statistical parameters of Alternatives

Criteria	Unit	Alternative		
		01 ATM	02 ATMs	03 ATMs
Average number of customers using ATM services	Times/day	156.07	159.10	156.30
Standard deviation of the number of customers using ATM	Times/day	8.77	7.64	8.58
Average number of customers leaving	Times/day	5.53	5.27	5.43
Standard deviation of the number of customers leaving	Times/day	2.50	2.05	2.13
Average waiting time of a customer	Minutes/day	75.36	0.77	0.04
Standard deviation of waiting time of a customer	Minutes/day	30.98	0.39	0.04
Average idle time of ATMs	Minutes/day	10.57	497.30	1179.60
Standard deviation of the idle time of ATMs	Minutes/day	6.56	57.05	48.10
Average idle time of an ATM	Hours/day	0.18	4.14	6.55
Standard deviation of the idle time of an ATM	Hours/day	0.11	0.48	0.27

5. Conclusion

The simulation method is considered as one of the methods which reflects quite clearly the happenings of real-world situations. This method can be applied fully in the field of providing ATM services of banks. However, in order to successfully apply this simulation method, it is necessary for the researcher to make efforts in collecting observational data - not only to ensure the accuracy but also to ensure representations in order to reflect fully activities in practice. This study has built a general model and established a block diagram for simulating the use of capacity to help businesses determine their capacity to serve in the queue system. The article also concretized the application of general model and simulation program by studying a ATM system at 23 Phan Dinh Phung Street, Hai Chau I Ward, Hai Chau District, Da Nang City. Accordingly, the banks can use the simulation method to evaluate and make decisions the number of ATMs be used at the same location. In summary, not only in the banking sector, general businesses can apply the simulation method and see it as an effective tool in making decisions. In particular, the simulation method becomes more efficient and necessary for service-oriented production systems such as the ATM services, the gas stations, the medical system, the airline service and many other service systems.

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