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Service Time Reduction Through the Development of a Simulation Model in a Selected Bank

Choudhury Abul Anam Rashed, Syeda Kumrun Nahar* and Arindam Purohit Pritom
Department of Industrial and Production Engineering, Shahjalal University of Science and Technology, Sylhet, Bangladesh
*E-mail: rashed-ipe@sust.edu, syedaipe49@gmail.com

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Abstract - **Service time is an important element of the banking service. The time needed to wait in the queue makes the service receiver dissatisfied. To minimize the waiting time and improve the utilization rate, simulation-based analysis is a well-established technique. The objective of the current research is to investigate the current scenario of the service mechanism of the selected bank and suggest the best possible configuration for improving the service level. The research is based on a case study in which the operations of a specific bank were observed. A conceptual model of the studied bank has been developed first. It helps to realize how the entities move through the system. Then, an arena model was built according to the conceptual model following the collection and distribution of field data (arrival time, delay time at the aisle, and service time) via an input analyzer. The suggested model shows progressregardingthe average server utilization rate and waiting time customers spend in the queue. The proposed model shows a 30% improvement in waiting time and a 40% improvement in service time, or value-added time.**
Keywords: **Service Time, Conceptual Model, Simulation, Bank**

I. INTRODUCTION

Service quality improvement contributes to the increase in customer satisfaction, regarded as the key factor of the organization's success (Madadi, N., 2013). Service firms have prioritized various techniques to recognize customers' intelligence and to provide them with a higher level of service. In a service company, administrators are primarily anxious about the length of time consumers must wait to receive assistance. Customer behavior has a major and significant effect on effectively utilizing the service's resources. The individualities of a typical customer can be guided by the following requirements: the nature and class of demand, service precedence, queue length, the excusable waiting time, etc. Among various approaches that help assess various alternatives, simulation has shown its high competence in modeling and solving such situations. Even before starting a simulation, saving time and acknowledging the probable ways to reduce waiting time is necessary. This knowledge is especially useful for coming up with ideas for possible working layouts or other substitute changes (Hao and Yefei, 2011). The prime area of concern from our research is that customers have to wait in a long queue to make payment. For example, at the beginning of a month and on the deadline day for registration fees, they have to wait in a long line when many counters are unoccupied. This may lead to customer dissatisfaction. Using Arena simulation software, a simulation model is developed for the queuing system at the studied branch. The main objective of the research is to analyze the output of queue length with respect to average waiting time and the utilization rate of each individual teller. It is unwise to calculate a significant factor (e.g., utilization rate, queue length, average waiting time, etc.) without considering the correlation among all. So, after considering the factors and relations, we have introduced simulative research and proved improvement with 10%–17% where 10% improvement means the minimum succession level. The specific reduction and improvement will be discussed in later parts.

II. LITERATURE REVIEW

Many studies have been conducted on the banking sector. Some study considerations include service level enhancement, customer satisfaction, credit risk management, etc. In a study, Makinde *et al.,* (2017) explained the value of process improvement techniques for banking industry servicing operations optimization. They also signified that the main threats that restrict the effectiveness of service operations in the banking sector include queueing issues and other customer complaints. In another study, Beimborn (2006) outlined a simulation analysis approach for cooperative sourcing in the banking sector. The model simulates multiple scenarios and assesses their impact on key performance parameters, including cost, quality, and service level, to assist banks in optimizing their sourcing strategy. Shahabi *et al.,* (2020) conducted a case study on a selected bank in Iran and simulated the impact of the COVID-19 pandemic on the growth of branchless banking throughout the country. The study models the impact of the pandemic on different aspects, such as consumer behavior, technological readiness, and regulatory environment, that influence the acceptance and growth of branchless banking using a system dynamics approach.

Several studies highlighted the importance of queuing system modification. Wadi *et al.,* (2019), used queuing theory to describe the queuing system and analyzed several performance indicators, such as waiting time, queue length, and service usage. The authors highlight various elements that impact the queuing system, including the number of servers, the rate of customer arrival, and the service rate of servers. The investigation results indicate that increasing the number of servers and decreasing the service time can dramatically reduce waiting times and queue lengths and enhance service quality and customer happiness. The performance of different machine learning techniques in predicting credit risk was evaluated by (Chen *et al.,* 2011). According to the investigation results, all four models perform quite well in predicting credit risk, with the support vector machines exhibiting the highest accuracy and precision. The study also emphasizes the significance of establishing appropriate performance indicators and assessing the resilience and stability of models under varied inputs and assumptions. The discrete event simulation approach was used in a study to evaluate performance measures such as cost, service quality and customer satisfaction (Paisittanand and Olson, 2006). Suri *et al.,* (2007) developed a mathematical model based on the workload analysis methodology to predict the personnel needed to support technology-driven financial services such as online banking, mobile banking, and customer service automation. Corbae and D'erasmo (2013) identified numerous crucial variables, such as interest rates, loan default rates, and bank capital adequacy ratios, that substantially affect the business's behavior and outcomes. In a study, the author applied a stochastic frontier model to a sample of Chinese banks and found evidence of substantial technical and allocative inefficiencies and substantial variability and reliance between banks (Liu *et al.,* 2020). In another study on Chine's banking industry, the dynamic modeling approach was used to evaluate the influence of external factors such as macroeconomic conditions, regulatory policies, market competition, and technological innovation, and their feedback loops over time (Li *et al.,* 2021).

According to past research activity, we have also studied different researchers' activities and papers and journals that are related to this research purpose. So, some of the exclusive works are going to be introduced here. According to Hao and Yefei, (2011), the bottleneck creates WIP and saturation in the bank queuing system. Bank industries are analyzed and examined through the queuing system model optimization of dedicated banks based on BPR by dynamic enterprise simulation. At last, the results obtained by simulation are explained, and the optimum result is concluded. J.C. Odirichukwu *et al.,* (2014), in their paper, aim to reduce time to wait in queues by implementing optimum queue management and thereby maximizing output. When implemented, the proposed system will reduce blockage issues and ensure smooth service. This study found that queuing models can be used to achieve customer satisfaction at the lowest possible cost. In their paper, Afshar, J. *et al.,* intend to use computer simulation and statistical analysis to assess and analyze the effects of key factors on bank queuing systems in order to reduce waiting times. To attain this goal, three major criteria—inter-arrival time, service time, and number of counters have been selected to identify the optimal structure of these criteria. Madan, K. C. (1992) examined a single-stage queuing system with poisson arrivals and exponential service in batches of fixed size b (1) in his paper. Again, the service channel creates seasonal breakdowns randomly. For the operation and repair times, the service stage is assumed to be exponential. For the steady state condition, the probability function of the queue length is obtained. The steady-state solutions and average queue length for a specific problem, b = 1, have been clearly obtained. In addition, some well-known steady-state results have been obtained in another problem. According to Shahbazi *et al.,* (2014), effective management of projects in research and development centers is one of the key objectives of these centers. Regulating the optimal sequence of jobs affects group productivity, timeliness, and delay costs. NP-Hard is well known as one of the most deterministic variants. When arbitrary components are introduced, the complexity level rises. A multi-server queue system was examined in a study (Berhan, E., 2015) to boost the efficiency of the banking system. When doing his research, he considered both the Poisson probability distribution for arrival and the exponential probability distribution for service rate. Ghaleb *et al.,* (2015) utilized an arena process analyzer to identify the optimal scenario. If the bank uses a simulated approach to decide the number of open servers by referring to dynamic information, it will gain a great deal of flexibility and maximize the utilization of existing resources (Tian and Tong, 2011). From the customer's and service provider's perspectives, both the quality of service and the cost of providing service should be addressed while analyzing the many alternative system configurations. The banking industry relies heavily on satisfied customers and a competitive workforce, so it is crucial that service quality is constantly enhanced. Policymakers ought to give utmost consideration to the length of time clients must wait for service. Competitiveness in the market necessitates that leaders constantly monitor and enhance the quality of their services through measurement and management of performance (M. Mutingi *et al.,*) Ullah *et al.,* (2014) used a queuing model and simulation to optimize a banking system by changing the number of service counters.

Therefore, several researchers have put emphasis on the topic. It is clear that a simulation-optimization style could be used to form a better solution method. For project scheduling with arbitrary process periods and potential machine failures, a mathematical model is built first. After that, using Rockwell Arena 14, a simulation-based optimization technique is designed to pick among a list of essential guidelines. In conclusion, the authenticity of the model was quantified through numerical samples. Results show that LPT law reduces total early and late expenditures (Arena, 2016). Through their research, we have been able to do research on the banking sector through specific question generation and analytic focusing. The current research topic can be classified as a commercial service system, and the service is given in both FCFS and priority-based service. The developed model can also be defined as a model with poisson input, as we have an exponential time interval. To design a well-queueing structure, it is important to store sufficient information about the model. The characteristics of sufficient information are given below.

1. The arrival types
2. The service process
3. The queue service types- LCFS, FCFS
4. The number of service channels
5. Count of service stages

The queueing system may have only a single stage of service or it may have several stages.

III. RESEARCH METHODOLOGY

The current study is an in-depth case study-based research. A particular bank on the University campus was selected as the target sample. For the study, the research question was first identified after an extensive literature review. Then the existing condition of the studied bank was closely observed. After that, a direct interview was conducted with both the customer and the service provider. In the research work, we have used some common and effective tools like

1. Arena
2. Microsoft Excel

A. Questionnaire Formulation and Administration

This research paper answers some specific questions like
1. What is the percentage of server utilization?
2. How much time does a customer wait in the counter queue on average?
3. How much time do they spend in the bank on average?
4. Is there any option for improvement?

B. Assumptions

The concurrent system at the bank has been modeled to the best feasible extent, and there are some variations due to unscheduled or unavoidable situations and natural variations. There are some assumptions that were made on the above platform to exclude such occurrences. The assumptions are based on the observations made during the study period.

1. Every day, from 10:00 a.m. to 4:00 p.m., the bank is open for business.
2. There are working shifts between employees and a 1-hour lunch break for the employees.
3. Every facility has at least one, but no more than two servers.
4. Every entrant is served at least once.
5. The service time varies for different facilities.

IV. DATA ANALYSIS AND MODEL FORMULATION

We have taken a large sample size, (z = 400) and conducted the research. Our sample is small, as the replication is limited in ARENA because it is a student version.

TABLE I STATISTICAL SUMMARY OF RESEARCH

Total summary		Service Percentage
Total Sample	400	
Cash Credit (University)	200	50%
Cash Credit(General)	105	26.25%
Account Opening	20	5.0%
Cash Debit	75	18.75%

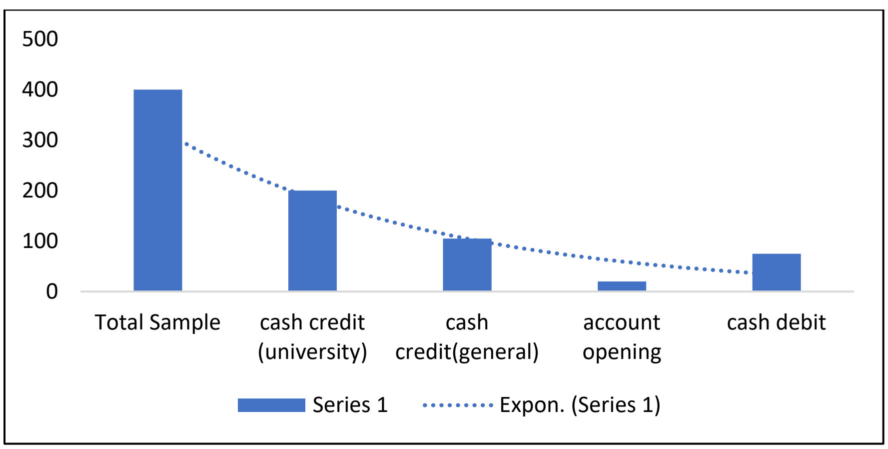

Fig.1 Service Ratio of Different Facilities

There were two main sections named "university" and "general," which signified and classified all other departments. Under the two main sections, there was a cash credit university section, a cash credit general section, an account opening section for both university and general, and a separately designated cash debit general and university section. So, here we will represent the model data table for the cash credit university section as the representation of all other sections.

TABLE II CASH CREDIT UNIVERSITY SECTION (PEAK SEASON)

Day-1-Peak Season-Cash Credit (University)									
Arrival Time (AM/PM)	**Inter Arrival Time (min)**	**Service Start Time (AM/PM)**	**Service Stop Time (AM/PM)**	**Waiting Time (min)**	**Service Time (min)**	**Queue Length**	**Average Queue Length**	**Average Waiting Time (min)**	**Average Service Time (min)**
10:01	0	10:01	10:05	0	4.07	5	9.1	27.65	3.49
10:01	0	10:05	10:09	04	3.37	6			
10:02	1	10:10	10:15	08	4.52	9			
10:04	2	10:15	10:17	11	1.22	9			
10:04	0	10:17	10:20	13	2.39	11			
10:05	1	10:20	10:23	15	2.26	12			
10:06	1	10:23	10:30	17	6.04	13			
10:07	1	10:30	10:33	23	3.13	12			
10:10	3	10:34	10:36	24	2.18	11			
10:11	1	10:37	10:41	26	3.14	10			
10:11	0	10:41	10:44	30	2.55	09			
10:13	2	10:45	10:51	32	5.27	08			
10:16	3	10:51	10:55	35	3.35	10			
10:19	3	10:55	10:58	36	2.41	12			
10:19	0	10:58	11:03	39	4.19	11			
10:20	1	11:03	11:08	43	4.23	10			
10:22	2	11:08	11:10	46	2.25	9			
10:23	1	11:10	11:16	47	5.5	8			
10:25	2	11:16	11:20	51	3.4	07			
10:27	2	11:20	11:25	53	4.32	10			
arrival rate	0.74								

A. Model Formulation for Present Scenario

We have developed the 1st model based onthe present situation and then tried to find the bottle neck through the input analyzer's statistical report. The statistical report was made through a simulation run, and we have done ten times replication to simulate the statistics. Now, we will show the current model.

1. Cash Credit University

Fig. 2 Cash Credit University Section

2. Cash Debit Section

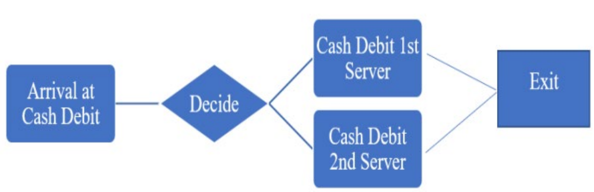

Fig. 3 Cash Debit Section

3. Cash Credit General Section

Fig. 4 Cash Credit General Section

4. Account Opening Section

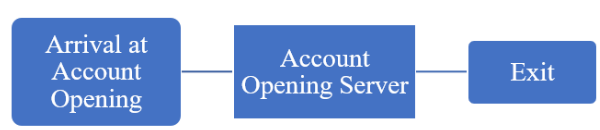

Fig. 5 Account Opening Section

5. Input Analyzer for Current Model

We will present sample of input analyzer for the present situation-based simulation model.

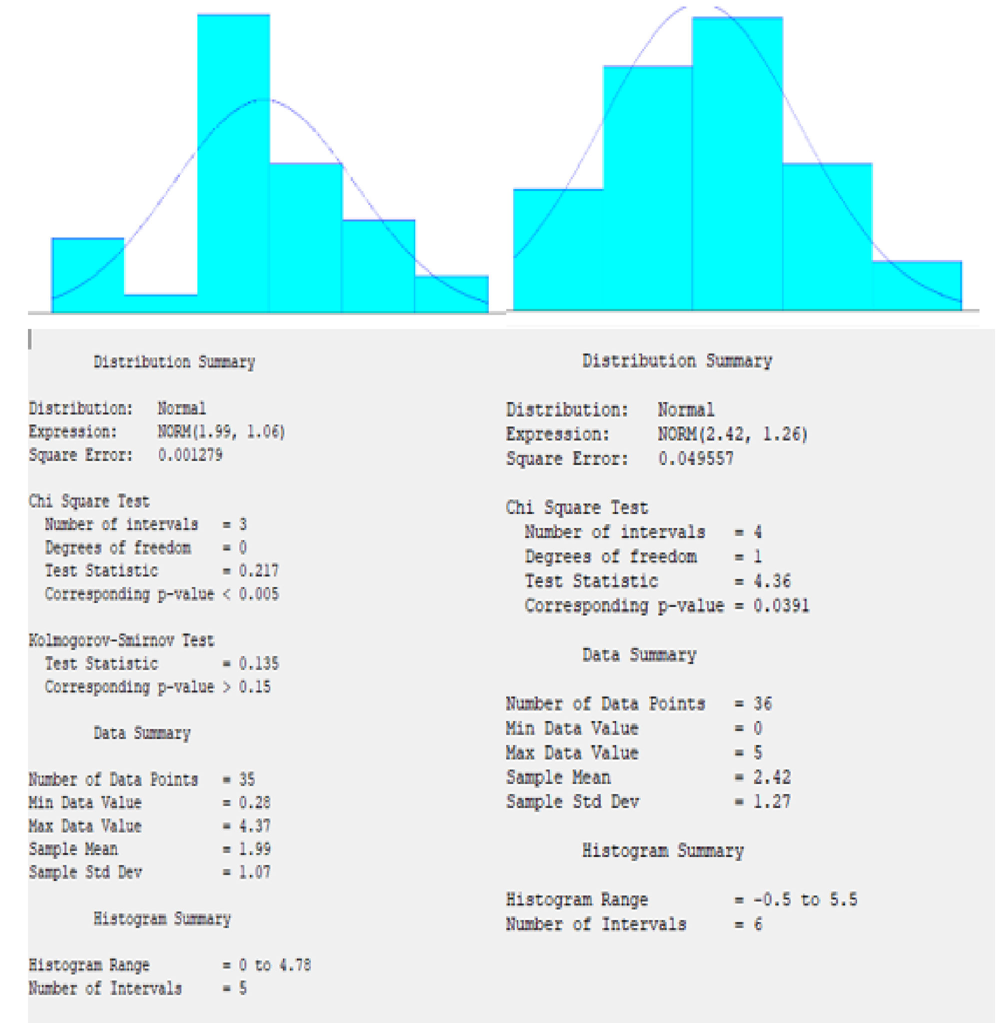

Fig. 6 Input Analyzer for Cash Credit General Section (Peak Season)

B. Proposed Simulation Model Based on Present Bottle Neck

After analyzing the results of the current service condition of our studied bank, it is observed that the waiting time and queue length are highest in the cash credit university section during peak hours. It is also noticed that the waiting time and queue length in the cash-debit section are lowest for both peak and off-peak times. The utilization rates of the first and second servers are also low.

So, we suggest using a single server for the cash debit section and two servers for the cash credit university section in our proposed model. That results in a reduction in the waiting time from 12.64 to 3.37 and in the queue length from 8.54 to 1.59 in the cash credit university section for peak time, and it also increases the utilization rate of the cash debit server from 0.36 to 0.59 in off peak time and from 0.54 to 0.70 in peak time because the whole service is provided by only one server instead of two servers.

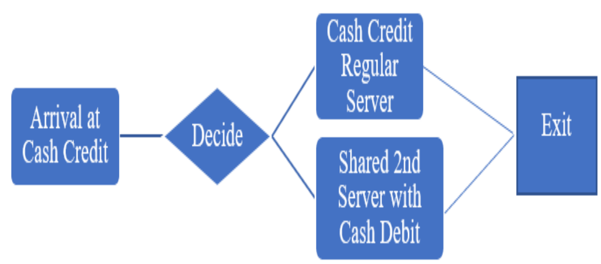

Fig. 7 Proposed Cash Credit University Section (Peak Time)

Fig. 8 Proposed Cash Debit Section (Peak and Off-Peak Time)

1. Input Analyzer for the Proposed Simulation Model

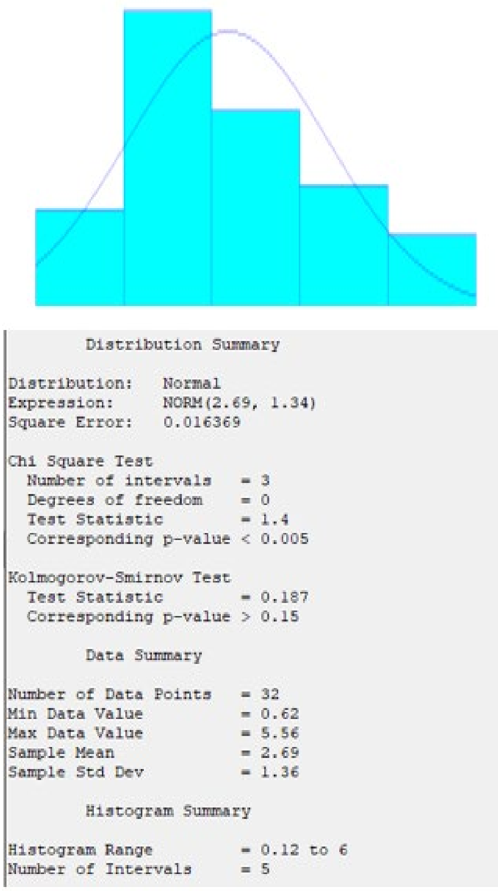

Fig. 9 Cash Debit Peak Time

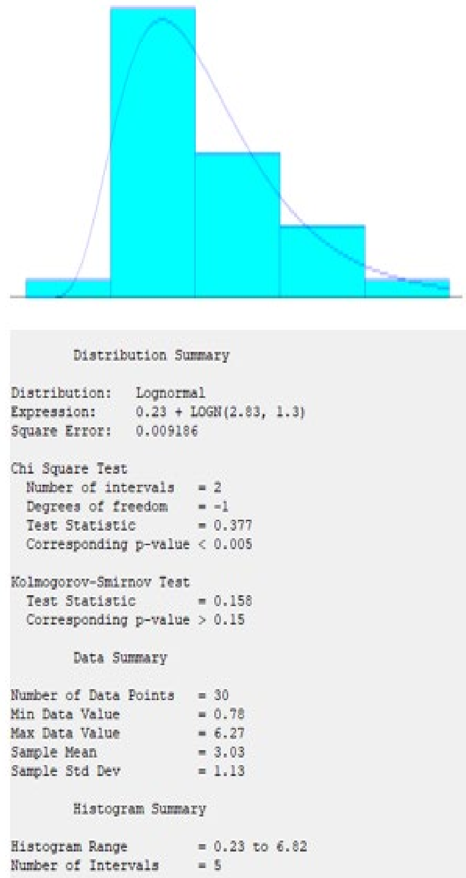

Fig. 10 Cash Debit Off-Peak Time

V. RESULTS

The software performed a total of ten replications. For 10 replications, the result will be built on queue length, average waiting time, utilization rate, and average service time. The output result will be shown for the Cash Credit University and general sections, the Account Opening section, and the Cash Debit section. We will present a sample replicated result for cash credit at the university section during peak season. All other sections' results will be represented like the presented sample result. The utilization rate for the cash credit university section is the highest of all servers at peak time, and the rate is 0.95 or 95%. The average value of the average waiting time is also high, and the rate is 12.64 minutes. The queue is 8.54, or 8 people long.

TABLE III CASH CREDIT UNIVERSITY SECTION PEAK TIME

Replication	01	02	03	04	05	06	07	08	09	10	Average value
Utilization Rate	0.95	0.90	0.99	0.94	1	0.99	0.85	0.97	0.92	0.95	0.95
Average Waiting Time	11.28	7.06	22.46	5.88	26.45	13.8	5.96	13.96	8.35	11.45	12.64
Average Value-Added Time	1.4136										
Queue Length	7.42	4.49	15.24	4	18.36	9.90	3.80	8.96	5.36	7.89	8.54

TABLE IV NEW ADDED SERVER

Replication	01	02	03	04	05	06	07	08	09	10	Average value
Utilization Rate	0.64	0.77	0.76	0.82	0.74	0.76	0.71	0.67	0.72	0.69	0.73
Average Waiting Time	1.82	6.08	3.17	4.40	4.21	3.21	3.36	2.92	2.69	1.94	3.38
Average Value-Added Time	2.00										
Queue Length	1.58	3.30	1.21	2.66	2.54	2.05	2.34	1	2.01	1.71	2.04

After observing the present situation, we have suggested a new simulation model, as shown in Fig 7. During peak season, we recommend rotating the cash credit section. Obviously, we have observed the availability of any empty teller. In our proposed model, two single servers are used at peak times for the cash credit university section to reduce the high waiting time and long queue length. The utilization rate of the first server is 0.71, and the average waiting time is down to 2.91 from 12.64. For the newly added server, the utilization of this server is 0.73, which proves its significance to use it as a single server for the cash credit university section during peak times.

A. Comparison Between Proposed and Current Model

Since the waiting time and queue length is highest in cash credit section during peak season, in our proposed model we use two single servers to mitigate the problem. Because the utilization rate in the cash debit section is lowest for both peak and off-peak time in our proposed model, we used this server as a cash credit single university server.That results in a reduction in the waiting time from 12.64 to 3.38 and in the queue length from 8.54 to 2.04 in the cash credit university section for peak time, and it also increases the utilization rate of the cash debit server from 0.36 to 0.59 in off peak time and from 0.60 to 0.73 in peak time because the whole service is provided by only one server instead of two servers. Though the waiting time in the cash debit section has been increased from 3.21 to 4.54 minutes during peak hours and from 1.18 to 2.10 minutes during off-hours,But in proportion to the reduction in waiting time, the reduction in the cash credit university section is insignificant. The overall goal of the study is to improve service level by reducing waiting times and increasing utilization rates. By comparing the present model and the proposed model, the utilization rate is much higher in the proposed model than in the present model, and the waiting time and queue length are also reduced.

B. Comparison Between Arithmetic and Simulative Utilization

TABLE V COMPARISON BETWEEN ARITHMETIC AND SIMULATIVE UTILIZATION

Particulars	Arithmetic utilization	Simulative utilization
Cash credit university peak time	0.89	0.95
Cash credit university off-peak time	0.50	0.52
Cash credit general peak time	0.81	0.85
Cash credit general off-peak time	0.39	0.43
Cash debit 1st server peak time	0.63	0.61
Cash debit 2nd server peak time	0.49	0.47
Cash debit 1st server off-peak time	0.35	0.36
Cash debit 2nd server off-peak time	0.28	0.25
Account opening	0.93	0.84

According to Table V, there is a 2%-6% difference between arithmetic and simulated utilization. The arithmetic utilization of a particular server is calculated from the collected sample of that particular server. But for simulative utilization, which we got from ARENA simulation software, the utilization is for 500 or more entities. Apart from the collected data, the rest of the entity is randomly generated by the software itself.

VI. DISCUSSION OF THE STUDY

At first, we studied the current service condition of four different servers (the cash credit university section, the cash credit general section, the cash debit section, and the account opening section) of the bank through direct observation. Then a simulation model is developed for the current scenario using arena simulation software. The utilization rate, the average time of service, the average time of waiting, and the average queue length of those 4 counters are obtained from the output result. After that, we suggest a proposed model in which we use an additional single server during peak time for the Cash Credit University section to reduce the long waiting time and queue length during that period. That server was previously used as a cash-credit second server.

That results in a reduction in the waiting time from 12.64 to 3.38 and the queue length from 8.54 to 2.04 during peak time for the cash credit university section. It also increases the utilization rate of the cash debit server from 0.36 to 0.59 in off-peak time and from 0.60 to 0.73 in peak time because the whole service is provided by only one server instead of two, that increases utilization and reduce the overall waiting time.

VII. CONCLUSION

A simulation-based service system for a specific bank has been described in this paper. A conceptual model of the studied bank has been developed first. It helped to realize how the entities move through the system. Then, an arena model was built according to the conceptual model following the collection and distribution of field data (arrival time, delay time at the aisle, and service time) via an input analyzer. Based on the obtained results, it can be concluded that30% improvement in waiting time and a 40% improvement in service time are achieved.

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