Original Research

The role of web-based systems in improving business processes using simulation approach (Case study: Credit card)

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Abstract
Despite advances in information technology, many banks continue to carry out their business processes in a traditional, paper-based manner, using Internet-based tools can be a reliable and fast way to improve performance. Thus, the purpose of this paper is to investigate the influence of Internet-based systems on the work process using business process simulation. A case study is carried out on the Credit Card process in an Iranian bank. All the components of this process are modeled using the principles of business process simulation, and then it shows how different scenarios can be evaluated. The research reveals that using web-based systems in the process can improve the bank performance. The results reveal that indicators such as cycle time, waiting time in the operator's queue, and operators' desirability can all be improved. The data generated in the simulation process can be used in feasibility studies and the eligibility of the TO-BE situation. Also, the structure and approach of the presented method can be adopted in financial services and aid the decision-making process. Although several types of research on business processes and simulation have been presented, they rarely work on real examples with the application of web-based services.

Keywords - Business Process Management; Decision Support System; Discrete Event Simulation; Banking Service Process; Credit Card

1. INTRODUCTION

Businesses are in a state of rapid change, in the current competitive environment, the only organizations that can survive are the ones that have the necessary mechanisms to face these changes. One of the new approaches that can help the survival of organizations is process-based management. Processes are the core components of the organizations' business [1]. A business process is a series of work steps of business-related activities, which meet the ultimate goal of the process –ultimate customer satisfaction– by fulfilling customers' needs in proper conditions and time [2]. Although all organizations thrive to improve customer satisfaction and loyalty, they are faced with a lack of flexibility in their business and organizational processes; thus, they are constantly trying to find ways to achieve those goals [3]. It is important that we measure the amount of improvement through the relevant indicators. These indicators include the degree of success in work, increased job security, customer satisfaction, increased service promotion, increased revenue, sense of concentration, moving forward, and creating a sense of progress [4]. To make the process effective in satisfying the customers' needs and operationally efficient, it is essential to quantitatively assess the process [5]. To study the

process performance and improvement, Pyzdek [6] has recommended the work cycle time, quality, and cost indicators. It is crucial to define process boundaries; so that process improvement projects can have a clear goal [7].

Paying particular attention to the components of a business (data, organization, processes, etc.) can help all the shareholders and stakeholders in the organization to better know and evaluate it. A business model can lead to "AS-IS" or "TO-BE" situations. By comparing these two models, an analyst can determine the desirability of the current processes and make modifications to improve their performance in this regard. Hence, business processes modeling is a valuable tool to reform the administrative operations of organizations.

The term simulation means different things in different disciplines and encompasses various approaches, including Monte Carlo simulation, microsimulation, and role-play or "human-in-the-loop" simulations [8]. We can use simulation Approach for the business process modeling, resource and cost estimation of the proposed model, and financial constraints analysis [9].

Today's economy forces companies to improve their business performance by saving human resources and equipment; therefore, they need a proper combination of processes and activities [10]. Both in industrial and service systems process improvement is essential. Today, service affairs are the main pillar of economic and business activities [11]. Also in industrial environments with the growing rate of globalization and advancement of technologies, analyze, monitor, and improvements of their existing manufacturing systems and processes are compulsory [12]. It is possible to establish a logical connection between business process management and discrete event simulation [13]. According to a study on the management of business processes in the financial sector [14], banks have always been widely involved in modeling their processes. They are seeking to eliminate existing problems in creating value for their customers. Therefore, there are still weaknesses in the efficiency of processes, so modeling and analyzing processes more effectively and efficiently is necessary to identify the weaknesses. Based on market research conducted in the Bank in 2017, which carried out 2621 interviews with corporate clients regarding identifying their needs, it was found that there are some significant weaknesses and problems in providing various banking services [15].

Among the banking services of interest to customers, a credit card is associated with problems involving engagement in administrative matters, time spent on granting facilities, doing repetitive activities, receiving frequent inquiries, etc. In addition to reducing the bank process efficiency, the cases mentioned above, have also led to customer dissatisfaction in many aspects. In the following diagram (Figure 1), the main reasons for not using credit services, and their importance from the customer's perspective, are presented.

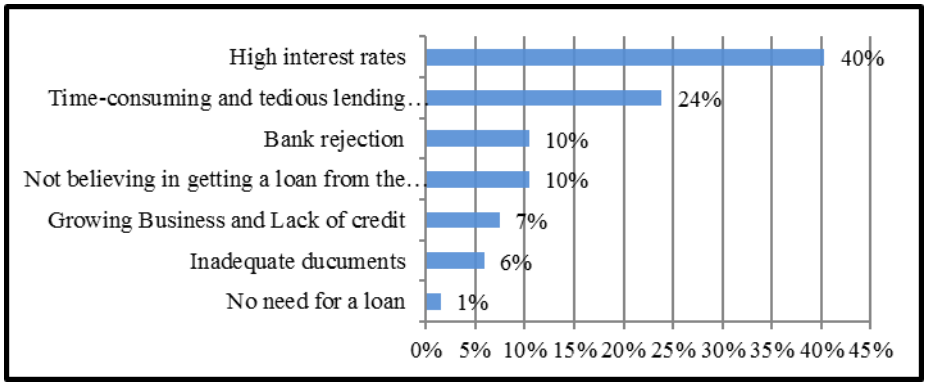

FIGURE 1
REASONS FOR NOT USING BANK'S CREDIT SERVICES

As shown in the above figure, among the seven main reasons for not using bank credit services, after high-interest rates, which is influenced by the economic conditions prevailing in the country and is considered as part of environmental factors, time-consuming and tedious lending process with 24% is the second and most crucial factor from the customers perspective, and this shows that there is a fundamental weakness in this regard in the Bank.

According to [16], factors that encourage SMEs to use P2P lending platforms in obtaining loans are loan processes, interest rates, loan costs, loan amounts, and loan flexibility affect. It is believed that the most critical factor of activity and income generation for banks is granting facilities (loan payment or financing). Therefore, banks must constantly update and improve their services through tools based on information technology. Otherwise, they may lose their profits in competition with Internet financing companies

(P2P or Third-party payment) and go bankrupt. With the growth of Internet financing companies, the number of deposits and loans paid by commercial banks their profitability have decreased [17]. Indeed, the rapid growth of Internet financing competes with conventional methods and challenges traditional banking conditions by eliminating monopolies [18]. We can conclude that not using web-based systems and, in other words, traditionally providing credit services is one of the leading causes of such a problem.

The case study evaluates the process of granting credit cards process in an Iranian bank. Therefore, the purpose of this study is to investigate and analyze the use of web-based systems in the credit card process with business process simulation approach and "what-if" analysis. The main interest of this paper is the simulation of proposed modifications in the process of banking services in a dynamic environment to do what-if analysis and, besides, evaluate the different results before final implementation.

The rest of the paper is organized as follows: in section 2, the literature of business process management in banking services and business process simulation is reviewed. Section 3 presents the proposed methodology and its details. In section 4, based on theoretical backgrounds, the case study is presented in addition to credit card and simulation models. Finally, the paper ends with a conclusion, limitation and outlines future research.

2. LITERATURE REVIEW

I. Business process management in banking services

The Business Process Modeling and Notation (BPMN) standard is to model business process flows and web services [19]. BPM tries to help the organizations to be competitively agile and cost-efficient to exploit opportunities in the marketplace [20]. Also, information technology is used to manage business processes and eventually evolved into what is known as BPM today [21]. Business processes, in general, can be classified into human-centric and system-centric, with a combination of person-to-person (P2P), person-to-application (P2A), and application-to-application (A2A) [22]. Considering rapid web growth during the last decades, many web applications were implemented. Complete and accurate description of web-based systems is an essential item in system design since it play a prominent role in the quality of service and customer attraction [23]. Digitalization of the financial services has transformed the credit behavior of customers and has changed the process of lending [24]. Islam and Ahmad [3] have studied the role of processes in improving the banks' service-providing systems. Their research is aimed at improving the efficiency and effectiveness of credit services in a bank. Using the proposed method of business process, the work cycle time is effectively reduced, and customer satisfaction is achieved through the proper use of organizational resources. In an article titled Business Project Management in the Banking System, the vital role of processes in customer experience and the positive implications of business process management are addressed through three crucial indicators: business agility, the efficiency of organizational processes, and the improvement of risk management compliance [25]. Leyer and Hollmann [26] have simulated the business process in the banking system. Their project is designed for a case study in a German bank. It demonstrates how business process simulation can evaluate the role of electronic documents in financial service processes. The result showed, not only the cycle time but the administrative costs and workload can also reduce. In a survey, the Monte Carlo simulation had been used to assess the risks of a credit card development project in a Thai bank. The researchers have facilitated decision-making for the project's execution by the Bank or the project's outsourcing using variables including the number of cardholders, net present value, net profit, and expected return on investment [27]. With the growth rate of internet penetration in developing countries, there is a tendency toward using web-based systems. The positive determinants of consumers' intention to use internet bank or web-based services are trust and the number of services provided [28]. Evidences showed when information and communication technology (ICT) is used in the process of assigning loans to customers, it significantly lowered the price of loans and increased the quantity of them [29]. Based on a study about bank clients in Pakistan, results showed that service quality plays a significant role in every condition, It has become the basis for how customers interpret online banking and, finally, how it interacts and operates with online services [30].

II. Business Process and Discrete Event Simulation (DES)

In Discrete Event Simulation, entities move through a series of queues or buffers, acquiring and releasing resources as they move through the model domain [31]. Simulation technique is used for many years in business process reengineering and logistics [32]. The activity of a system in the discrete event simulation is demonstrated as a sequence of events. Each event occurs at the moment in time and indicates a state of change in the system [33]. The primary purpose of the simulation model is to provide the testing mechanism, behavioral prediction, clarification of "what-if" questions, and learning in the studied system [34]. The simulation time is measured in the time unit of the studied system [35]. It is worth mentioning that there are significant differences between business process modeling and process simulation [36]. When we only intend to conduct a business process management or workflow management project, we

do not need any additional information such as the duration of activity and probability distributions [37]-[38]-[39]-[40].
Several studies have focused on business process simulation (BPS). Reference [41] analyzed one of the most common banking services –the ATM– by expressing the risks of traditional banking and the growing tendency of bank customers to use e-banking services. The research is conducted in a statistical environment and uses the Arena simulation software. The researcher is seeking to intelligently distribute customer use of the ATM to increase the productivity of the devices and reduce the customers' waiting time. In a study, the optimal combination of equipment and facilities in various bank branches has been determined. Researchers have simulated a feasible answer in each step and used it as the input to the simulated annealing of metaheuristic method with the application of a mathematical model consisting of two minimization objective functions [42]. In another research, [43] have focused on the queue length and waiting time for bank customers as important factors in the customer's perception of the quality of bank services. To this end, they used the simulation method as a high-performance tool in modeling and evaluation. Then they presented solutions to improve the working conditions of the bank by defining various scenarios. In a research with the application of discrete event simulation, [44] analyzed different scenarios that aim at reducing project duration and costs to improve the process to empower project managers. Also, in a study with the application of discrete event simulation, authors aimed to measure performance and improve healthcare service. They analyzed the current process of healthcare in Bahir Dar Clinic in Ethiopia and concluded that efficiency could raise 9.86% [45]. Reference [46] used discrete event simulation to estimate the production level for an industrial factory in an uncertain environment. The results were used in production planning process by factory experts and have had satisfying consequences. Reference [47] has focused on improving the banks' queue system based on the business process reengineering method. In this research, queue bottlenecks in a bank are analyzed along with the concepts, classification, and methodologies of business process reengineering. The result implies the improvement of the work process.
As shown by this literature review, the frequency of research studies in the field of business process management in recent years indicates the urgency of this phenomenon both in the scientific world as well as in today's business environment. As it seems, the main reason for using the business process management is to increase the efficiency of the work system, and the researchers have sought to enhance the performance of the techniques in a continuous effort. Therefore, they have tried to develop the technique by studying the process components, the priority and delay of the steps, and combining it with other methods. Based on an extensive literature review, most Internet banking articles pertained to consumer behavior or marketing [48] and less on web-based credit process management and simulation-type analysis. On the other hand, despite the recent efforts of banks to develop Internet banking, according to researchers' investigation, the main focus is on providing non-credit services, and less attention has been paid to this issue. Undoubtedly, one of the most essential reasons that prevented banks from this action and has caused decision-makers to look at it with skepticism is the uncertainty of the results. Thus, analyzing the role of web-based systems in improving the efficiency of banking processes and especially credit services with the application of simulation approach can be a suitable decision support system for decision-makers and significant help to banks.

3. RESEARCH METHODOLOGY

The suggested methodology has been based on the experience and previous works of business process simulation [49]-[50]-[51]-[52]-[53]. Figure 2 shows a high-level diagram of research methodology.

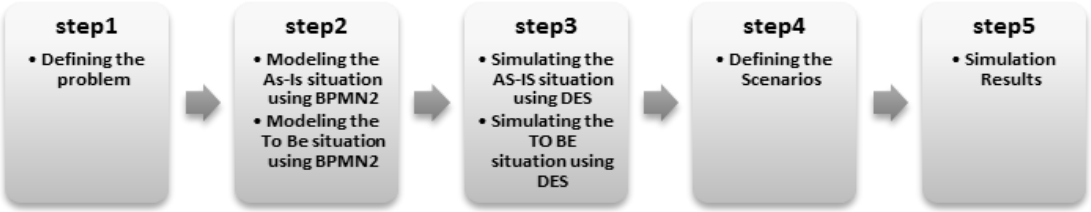

FIGURE 2
HIGH-LEVEL DIAGRAM OF RESEARCH METHODOLOGY

The first and the most critical step in solving a problem is defining it clearly with all related details. As mentioned before, the purpose of this article is to show how Business Process Simulation (BPS) can be used to evaluate the effects of the web-based systems in financial services, particularly credit card issuance. The Bank is an Iranian Bank with more than 23,000 employees.

The overall findings suggest that the language of business process modeling can display scenarios based on Discrete Event Simulation (DES); however, there are some cases indicate some drawbacks in this functional language. The BPMN2 method does not have the proper structure for displaying complex data, and basically, it is impossible to analyze various working conditions using this method. Based on previous studies [19], it is determined that the most vital problems in business process transformation projects are the inability to accurately predict the results of significant changes and the inability to detect the dynamic nature of the processes.

According to the presented explanations, a combination of process management and DES is used in this study; as indicated in Figure 3.

- Studying and analyzing all banking documents related to credit card service in the last ten years [54]
- Interview with four loan experts about the credit card process.
- Visit the branch and follow the steps to get a credit card as a customer two times to get the accurate picture of the process regardless of the documents and experts' knowledge.

After modeling the "AS-IS" process using BPMN2, we created the simulation model using discrete-event method to provide a simple representation along with the details of complex processes. The current status of the service is analyzed from different aspects such as employee desirability, cycle time, number of service recipients, etc. In the next step, the verification and validation of the simulation were carried out. To verify the simulation model, a comparison needs TO-BE done with the real-world. Obtaining the same results would mean that it is verified. Following the verification, a more sophisticated real case with real data was gathered to test the performance of the model and show the differences between real-world and the simulation model. Verification and validation were performed to have confidence in the model. Furthermore, the

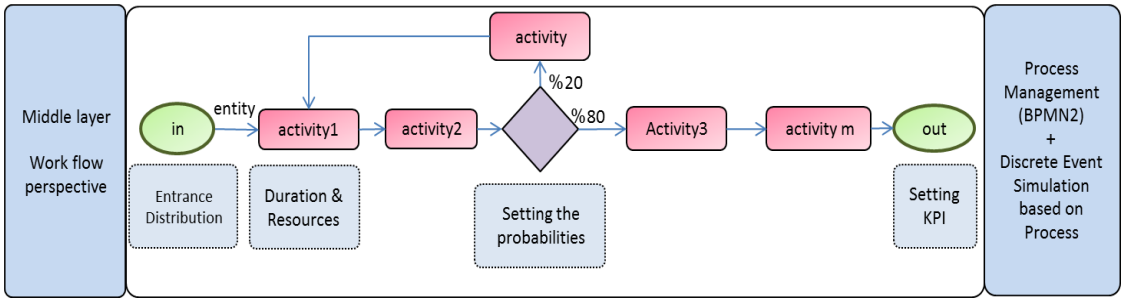

FIGURE 3
THE COMBINATION OF BUSINESS PROCESS MANAGEMENT (BPMN2) AND DISCRETE EVENT SIMULATION

With regard to the above figure, the process of the service is modeled using BMNN2 technique and then by the application of discrete event simulation approach and adding its requirement such as entrance rate, activities duration distribution and also paths probabilities, it would be possible to analyze the process and test different scenarios. In order to model the AS-IS situation using BPMN2, necessary information about the existing process in the current system is collected, the process of the studied bank service is mapped through the principles of business process management. The predefined AS-IS process forms the basis of the TO-BE process, and then the proposed changes are inserted to the process. These changes include the elimination or alteration of some of the activities, and then the new process is developed. The process of extracting knowledge and transforming tacit to explicit knowledge is given below:

proposed model based on the TO-BE situation is carried out in "Anylogic" software, and the necessary analyses were performed by defining different scenarios. Due to the possibility of future comparison of the operation between existing processes with the proposed process, the same scenarios are defined for both processes.

I. Modeling the "AS-IS" Situation

The case study is about credit card issuance in an Iranian bank. The proposed process has three parts: card issuance, loan usage, and loan payback. The focus of this paper is on the first part of the process.

In the current process, the customer should prepare and apply paper-based documents to the bank office. Also, there is an integrated system in the bank that connects all the branches,

and therefore files can be easily shared among different departments and some part of the process can be done using a web-based system. It is assumed that the use of a web-based system in credit card issuance contributes to improving performance.

In this section, the necessary steps are taken to study and analyze the credit card process. The primary process of the credit card begins with the client's request for the service. If the initial confirmation is requested by the deputy credit department of the branch (senior operator), the customer is obligated to take the necessary steps for the provision of the documents, by the received information.

Before the loan application is filed, documents are examined, and if there is any problem with the documents, the customer should provide the necessary documentation. Also, if the required documents are not valid, the request for a loan will cancel at this stage. Imagine that all stages are approved at this stage, so the request will take place. If the results are approved, the credit file is formed, and then the offer is set. This activity involves consideration of the customer's request and authentication, obtaining and reviewing the customer's documents and verifications, compliance of the documents and requests with the instructions, and copying and storing the system's documents. At this stage, the credit operator receives relevant inquiries, including customer credit balance from the "Franam" system, bad checks history from the Makna system, and a credit rating report from the Credit Ranking system. Faranam, Makna, and Credit Ranking are three external systems. If the answers are positive, the necessary steps will take to file the case, and otherwise, the result will inform to the client to take corrective action and submit them again. At this stage, the documents are controlled and, if completed, the issuance of the order is placed; otherwise, based on the latest bank rules and regulations regarding the loan request to the client, he is asked to make the necessary adjustments if the customer continues to work and comply with the bank's conditions, the activity will continue. Otherwise, the process will be close.

The decision on the loan has now been made, and if it is approved, the collateral will take and then the agreement will be set up, and registered. This activity includes sub-actions for registering a card application, signing a systematic contract, obtaining customer signatures in contract, obtaining fees, final registration of a contract in the system. Eventually, the card-issuing activity is followed by the customer receiving the card.

The steps taken to illustrate the logic of the model –in two levels of main process and sub-process– are presented in Figure 4 and Figure 5.

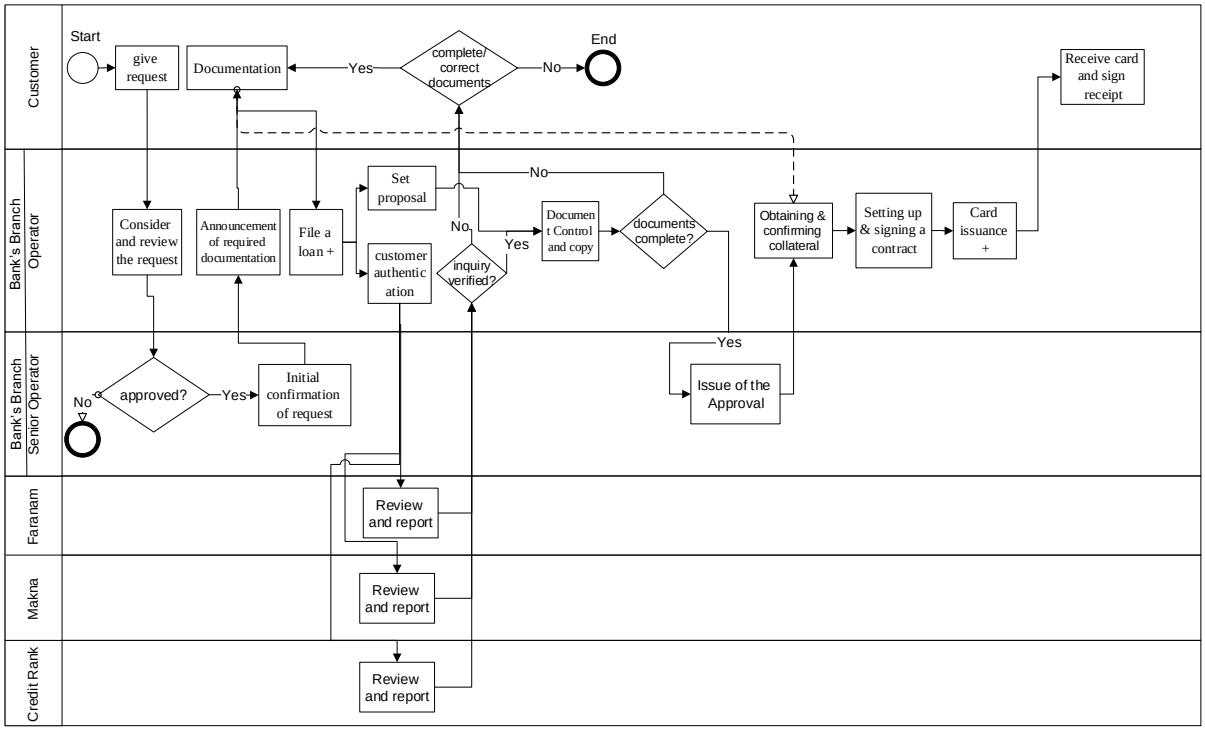

FIGURE 4
"AS-IS" MODEL OF THE CREDIT CARD PROCESS – MAIN PROCESS

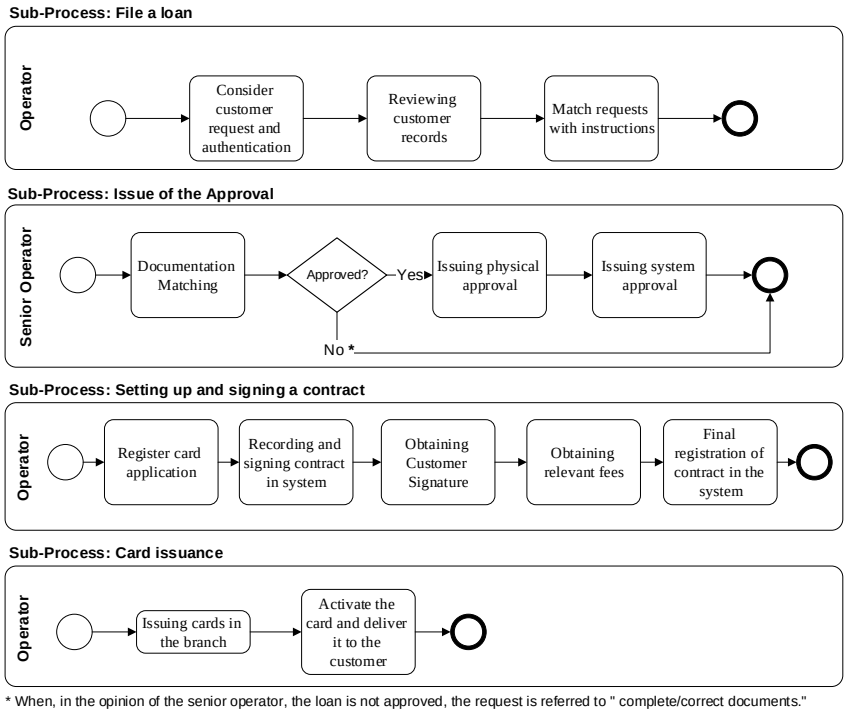

FIGURE 5
"AS-IS" MODEL OF THE CREDIT CARD PROCESS – SUB PROCESS

In this process, the credit card applicants are the most critical entity. Based on previous reviews, the model resources are the credit card service providers, which include the credit operator and the senior credit operator. Additionally, there are three more resources that are out of the branch system and the relation is through web services. They are Faranam, Makna, Iranian Credit Rank, and their primary duty is customer credit assessment.

II. "AS-IS" Simulation Model

In the following process, necessary steps are taken into consideration to develop a simulation model. The information regarding the model data, their collection method, and the determination of random number generator algorithms are extracted based on the researcher's timing in one of the bank branches. The results of this operation are the specification of activities and statistical distribution estimation of the observations based on a dataset obtained for each activity as detailed in Table 1. Also to report how well sample data represents the data we would expect to find in the actual population, the goodness of fit test is carried out using the Kolmogorov-Smirnov method and the P-Value (P-V) is given. As regards table 1, the phenomenon observed through the sample follows the distribution in question.

Other sections of the simulation model have also been completed with the following parameters:

1. Regarding the statistical distribution of customer login to the system, it is found that on average, the customers' login rate is two persons per day.
2. A loan application can have multiple paths depending on the process feature. The probability of paths is modeled by reports from banking systems and experts.
3. Based on information obtained from the operating system, one operator and one senior operator are working on the system.

The simulated model is implemented in "Anylogic" software. Figure 8 illustrates this process.

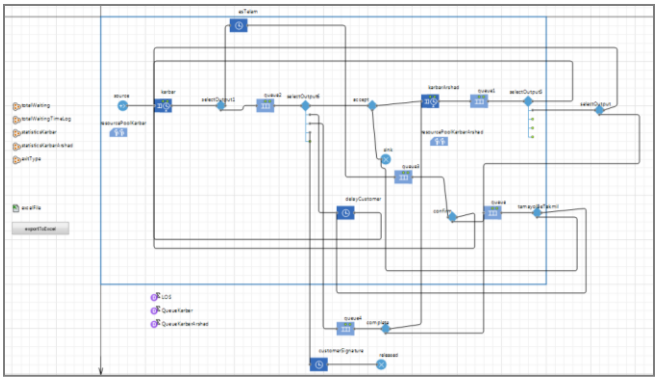

FIGURE 6
A PARTIAL VIEW OF THE EXISTING (AS-IS) CREDIT CARD PROCESS IN SOFTWARE - DISCRETE EVENT SIMULATION

III. Verification and Validation of the simulation model

The model ran correctly several times. The DES model is presented to branch officials and 4 credit experts, who have confirmed the model's logic with what is done.

For validation of the model, the two-sample t-test ($\alpha = 0.05$) is used to compare the cycle time of the actual data ($\mu 1$) and the model result ($\mu 2$).

H0: $\mu 1 = \mu 2$

H1: $\mu 1 \neq \mu 2$

In the following, a time is required for warm-up [55], and the random nature of the simulation model should be taken into consideration [56]. The highest latency in the customer's order was recorded for 23 days, indicating that the 4-week period is sufficient to meet the usual conditions. Therefore, to simulate a model over 6 months, one month is considered for warm-up. Then, the average cycle time of the multiple runs was equivalent to 16.53 days. On the other hand, the same indicator is also extracted in the natural environment. For this purpose, the data on the provided service in the entire banking system are collected; and the average waiting time in the system is calculated to be 15.05 days by applying the necessary calibrations and creating conditions similar to the system state.

The results are demonstrated in table 2 and indicate no significant difference between the average cycle time for customers in the natural environment and the model.

TABLE٢
THE RESULTS OF MODEL VALIDATION BY COMPARING THE ACTUAL DATA AND THE MODEL OUTPUT

P-Value	t-statistics	Model data	Real data		
0.066	1.84	16.53	15.05	Mean	cycle time
		6.17	6.5	Standard deviation	

IV. Modeling the "TO-BE" Situation

To model the proposed process, the data was used from the existing process. The following focuses on the proposed changes and their implementation in the simulation model. These changes include the elimination or alteration of some of the activities.

In the proposed process, based on findings in reviewing bank's documents and interviewing credit experts, it revealed that a part of activities in the process could be done through web-based services. Thus a new entity named "the system" is taken into consideration, and the number of activities

TABLE 1
THE STATISTICAL DISTRIBUTION OF THE ACTIVITIES AND SUB-ACTIVITIES OF THE CREDIT CARD SERVICE

Row	Place of Text	Type Styles	P-V	Row	Place of Text	Type Styles	P-V
1	Give request	Tra(3,5,7)m	0.97	16	Issuing the approval +	---	
2	Consider and review the request	Tra(3,5,7)m	0.92	17	Documentation matching Issuing	Tra(3,5,7)m	0.86
3	Initial confirmation of request	Tra(5,10,15)m	0.63	18	physical approval	Tra(3,5,7)m	0.9
4	Announcement of required doc	Tra(5,10,15)m	0.95	19	Issuing system approval	Tra(3,5,7)m	0.88
5	Documentation	Nor(2,1)d	0.95	20	Obtaining and collateral confirmation	Unif(10,30)m	0.99
6	File a loan +	---		21	Setting up and signing a contract +	---	
7	Customer request authentication	Tra(3,5,7)m	0.9	22	Register card application	Tra(5,10,15)m	0.61
8	Reviewing customer records	Tra(5,10,15)m	0.8	23	Recording and signing contract	Tra(5,10,15)m	0.73
9	Match requests with instructions	Tra(3,5,7)m	0.97	24	Obtaining customer signature	Tra(2,5,8)h	0.85
10	Set proposal	Tra(5,10,15)m	0.97	25	Obtaining relevant fees in the system	Tra(3,5,7)m	0.94
11	Customer authentication	Tra(10,15,20)m	0.99	26	Final registration of the contract	Tra(3,5,7)m	0.64
12	Review and report / Faranam	Normal(1,1)d	0.32	27	Card issuance +	---	
13	Review and report / Macna	Normal(1,1)d	0.07	28	Issuing cards in the branch	Tra(3,5,7)m	0.15
14	Review and report / Credit Rank	Normal(1,1)d	0.79	29	Activate card and deliver to customer	Tra(5,10,15)m	0.97
15	Document control and copy	Tra(5,10,15)m	0.55	30	Receive card and sign receipt	Tra(3,5,10)m	0.43

decreased. (The total number of activities is decreased from 30 to 24). Then the new process prepared again, and based on it, the simulation model was developed.

V. TO-BE Simulation Model

In this stage, the TO-BE process is modeled in software (Figure 7). Accordingly, it will be possible to tangibly and reliably compare and analyze the two existing (AS-IS) and proposed (TO-BE) processes.

4. Simulation Results and Scenarios

Due to the possibility of future comparison of the operation between the current and proposed processes, the same scenarios are defined for both processes. By modifying the process components in the simulation environment, the model can be analyzed. In this way, we determine the effect of applying these changes to input parameters on business process efficiency indicators. Given that the most essential part of this issue is applying the loan in the natural system, it is used as an analysis factor. The proposed scenario is 25% higher, and 25% lower in the number of requests and analyzes the effect on the following four indicators. As a result, there would be different outcomes.

- Cycle time
- Operator desirability
- Senior operator desirability
- Waiting time in the operator's queue

In addition to the above, as in the second scenario, we increase and decrease the number of requests in increments of 5% to analyze the trend of changes on cycle time to existing and proposed processes.

I. The Simulation Results

How do performance parameters change in the existing and proposed processes? To do this, we can extract the values of these parameters by separating both the existing and proposed paradigms and plot them into a comparative table. In the 100 simulation runs of the "AS-IS" process, an average of 290 requests is completed within 6 months (74'880 minutes). This number includes credit card requests, rejected requests, any requests approved by the Bank and rejected by the customer due to a competing offer. Under similar conditions in the proposed model, the number of requests that

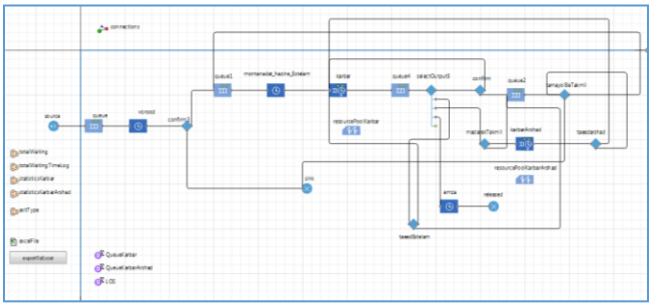

FIGURE 7
A PARTIAL VIEW OF TO-BE PROCESS IN SOFTWARE - DISCRETE EVENT SIMULATION

reach the endpoints is increased from 298 to 300, roughly a similar number. Nevertheless, operator desirability is 80% in the existing model (4% higher than the proposed model), which indicates a higher workload on the existing model. On the other hand, the cycle time in the "AS-IS" model is 4'171 minutes, which is 2'617 minutes more than the proposed model, indicating improvement in the model. Other performance parameters are given in Table 3.

TABLE 3
A COMPARATIVE TABLE OF THE "AS-IS" & "TO-BE" SITUATIONS DERIVED

Indicator	AS-IS situation	TO-BE situation	Variation
Cycle time	4'171 minutes (69.5 hours or 8.69 days)	2617 minutes (43.6 hours or 5.45 days)	↙
Average waiting time in the operator queue	272 minutes (4.53 hours or 0.6 days)	145 minutes (2.42 hours or 0.3 days)	↙
Average waiting time in the senior operator queue	25 minutes (0.42 hours or 0.1 days)	35 minutes (0.58 hours or 0.1 days)	↖
Number of customer logins to the system	312 customers (100 customers)	312 customers (100% of customers)	---
Number of service recipients	298 customers (95%)	300 customers (96%)	↖
Number of rejected customers (sink)	177 customers (59%)	164 customers (55%)	↙
Number of accepted customers (release)	121 customers (41%)	136 customers (45%)	↖
Operator desirability	80%	76%	↙
Senior operator desirability	22%	13%	↙

II. Effect of customers login on cycle time

The result of increasing and decreasing the rate of requests for the mentioned service by 25%, on cycle time which is studied as one of the most critical parameters of the model, is demonstrated in **Error! Reference source not found.**Figure 8. As the rate increases, the work cycle time in the existing model also increases by 54% concerning the initial state. However, this quantity only grows by 24% in the proposed model. Moreover, with a 25% reduction in login rates, there is still a significant difference between the values of the two cases under study.

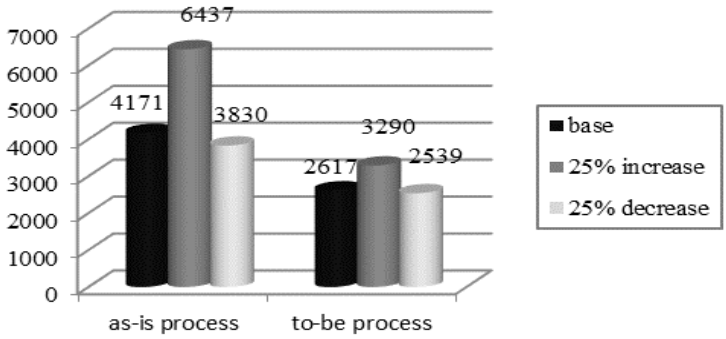

FIGURE 8
THE WORK CYCLE TIME

III. Effect of customers login on operator desirability

Regarding operator desirability, it is evident that with a 25% increase in the login rate, the credits operator desirability reaches a critical level of over 90% and creates a challenge for the system (Figure 9).

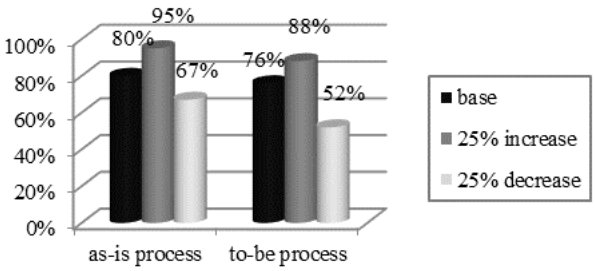

FIGURE ۱۰
OPERATOR DESIRABILITY

When analyzing the reduction in the login rate –as illustrated in figure 9, it is evident that 70% of the operator's capacity is used. At the same time, in the proposed model, this number is approximately equal to 50%.

IV. Effect of customers log in on senior operator desirability

According to Figure 10, the study results indicate that the senior operator desirability in the proposed model is lower in all examined scenarios. In other words, the studied source should spend more time and money on credit card facilities in the existing model. This is especially evident with an increase in the rate of requests.

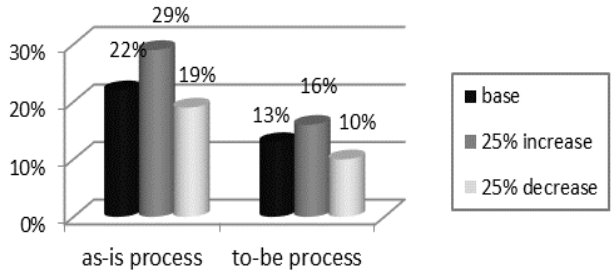

Figure 9
SENIOR OPERATOR DESIRABILITY

V. Effect of customers log in on waiting time in the operator's queue

Another critical indicator in the study and analysis of simulation models is the queue waiting time. In this paper, the purpose of this indicator is to measure the average waiting time of customers in the operator's queue.

As demonstrated in Figure 11, the average waiting time in the initial state is 272 minutes (4.5 hours), which is much higher than that of the proposed conditions (145 minutes or 2.4 hours). This indicator particularly undergoes a significant increase –1277 minutes (21 hours) – with a 25% increase in the rate of requests in the existing model. This indicates the weakness of the current system in providing desirable responses to requests. However, this number is 473 minutes (7.8 hours) in the proposed state.

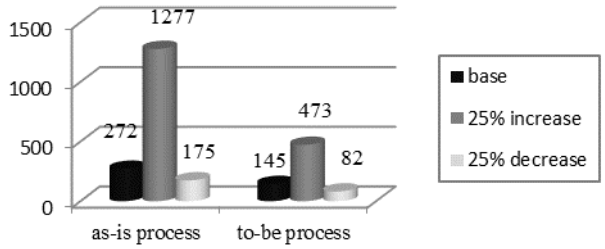

FIGURE 11
WAITING TIME IN THE OPERATOR'S QUEUE

The simulation results indicate a noticeable improvement in all criteria concerning the existing process.

VI. Trend Analyses

In this section, we increase the number of requests by a factor of 5%. Initially, one person entered the system every 240 minutes, starting with a decrease of 5% to 228 and then to 216, 204, 192, and 180, as shown in Figure 12.
Consequently, in each step, the number of customers is increased (for example, every 180 minutes, one customer will enter the system).

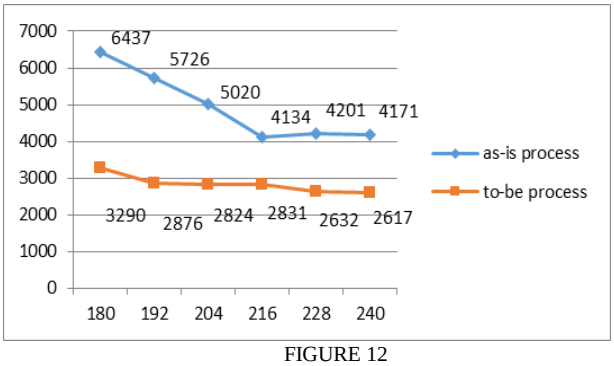

FIGURE 12
STEP-BY-STEP INCREMENT WITH 5% TREND

As shown in Figure 12, in the AS-IS process, the duration of stay in the system has a significant growth trend, while in the TO-BE process, it is almost stable.
Next, we decrease the number of requests by a factor of 5%. Initially, one person entered the system every 240 minutes, starting with an increase of 5% to 252 and then to 264, 276, 288, and 300, as shown in Figure 13. Consequently, in each step, the number of customers decreased (for example, every 300 minutes, one customer will enter the system).

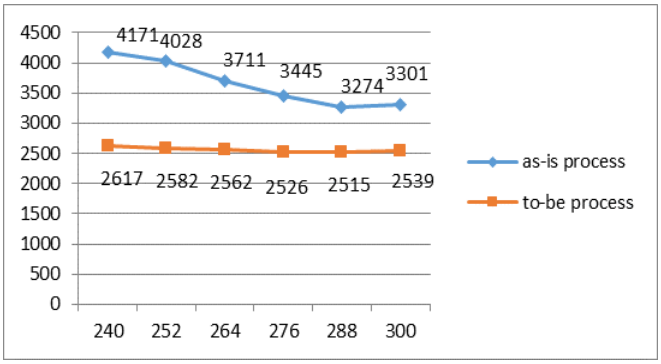

FIGURE 13
STEP-BY-STEP REDUCTION OF REQUESTS WITH A 5% TREND

As shown in the figure, in the AS-IS process, the duration of stay in the system has a significant growth trend. In contrast, in the TO-BE process, it is again almost stable and indicates a sustainable situation.
As shown in this paper, it is generally possible to transform some of the static aspects of the process into a dynamic state using the discrete event simulation method and create conditions close to what occurs by extracting statistical distributions. The most important factors that will be available through simulation are: creating a simulation environment along with the work process, adjusting activities and key performance indicators, determining flow control options (features and probabilities), the required resources and their consumption rate, the duration of activities, determining resource options (queuing and selection principles), and the number of resources per role. In this case study, all of these factors are extensively designed and applied.
The simulation process not only provides close-to-reality modeling conditions but also provides proper conditions to evaluate and compare the critical indicators in proposed scenarios. Studies' results indicate that the work cycle time in the proposed process decreases to 37% of the existing process. At the same time, the operator desirability is higher in the proposed state and its capacity increase is more reasonable. On the contrary, it is worth mentioning that the waiting time in the operator queue in the proposed state is almost half that of the existing state, even though many requests are answered.

5. CONCLUSION

In a competitive banking situation, there should be continued improvement in the quality of services. The growth rate of

Internet financing companies has raised the competition [15]. One of the significant ways that help banks to achieve a better position is improving the process of service delivery and it can be reached by Business Process Management and Simulation. This paper shows the role of web-based systems in credit card process performance using business process simulation in the banking sector. The credit services market is one of the most essential components of the financial sector, and the introduction of modern technologies in its operation is considerable. The research indicates that using web-based systems in the process of credit card can improve bank's performance. In addition to work cycle time, which is usually used, other criteria such as resource utility and operators queue should be considered

To show how the effects of changes in financial service processes can be assessed, one of the most complex banking services –the credit card service– is selected as a case study. Then based on the investigation of bank's internal documents and experts' perspectives, a part of the process through the launch of a web-based system had been modified and as a result, some activities were eliminated. Also the model was validated by real world case study in the process of credit card in real world.

The results show that Indicators such as cycle time, waiting time in the operators queue and operators' desirability will be improved in To-Be Process. The efficiency of the TO-BE process is higher and can be used by the Bank. The cycle time could decrease, and consequently, the working hours would also decrease. Hence one of the main bottlenecks in the process identified. Additionally, the desirability of operations has reduced, which shows they can handle more customers. The changes in the credit card process have positive effects. These results are only obtainable through the simulation model described.

The case study demonstrates how work process simulation can help analyze the process of applying corrective procedures. The data generated by the implementation of the simulation model can be used to make decisions and to use the existing resources in a better way. The finding presented in our paper will appeal to the banking personals who are interested in business process improvement and simulation.

The structure and approach of presented method can be adopted for other processes in the financial services and aid decision making process.

However, the method performed exceptionally well and appropriately described the overall system. Some limitations pointed out. In this paper, a real-time data and information system is used for simulation modeling. Due to the lack of a process management system in the studied Bank, there was no standard process with precise scheduling for credit card service, so the researchers extracted data by interviews and banking documents. Given the importance of financial issues, for future research, it is recommended that the cost-benefit analysis of the proposed process be evaluated to control financial justification in addition to operational efficiency.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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