THE REPUBLIC OF TURKEY
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EFFECTS OF RECENT IVR APPLICATIONS ON CALL CENTER PERFORMANCE IN BANKING SECTOR

M.S. Thesis

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THE REPUBLIC OF TURKEY
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INDUSTRIAL ENGINEERING

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ABSTRACT

EFFECTS OF RECENT IVR APPLICATIONS ON CALL CENTER PERFORMANCE IN BANKING SECTOR

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Being efficient in every area of the economy has become increasingly important in order to have competitive advantage. Especially, service sectors' increasing involvement in the world economy addresses people's attention to the service sectors. Service sectors are getting much more important in the wealth of countries. Banking sector is one of the major areas in the service industry. As it is known, Call Center activities have a crucial effect on the overall performance of operations. Interactive Voice Response (IVR) System applications are one of the main functions of these activities.

IVR has a main role in the Call Center operations of any business. Thus, Call Center and IVR performance have direct influences in the firms' success. In this thesis, an IVR and Call Center operation of a bank has directly been worked on. Three new IVR applications; *Recognize Caller by ANI*, *Call Steering* and *Voice Verification* are analyzed and their effect on Call Center performance have been executed.

Keywords: Banking Sector, Interactive Voice Response, Call Center, Simulation

ÖZET

GÜNCEL IVR UYGULAMALARININ BANKACILIK SEKTÖRÜNDE ÇAĞRI MERKEZİ PERFORMANSI ÜZERİNDEKİ ETKİLERİ

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Ekonominin her alanında etkin olmak, rekabet avantajı elde etmek için giderek daha önemli hale gelmiştir. Özellikle hizmet sektörlerin dünya ekonomisinde artan katılımı, bu sektörlere dikkat çekmektedir. Hizmet sektörleri ülkelerin güçlenmesi için de büyük önem arz eder. Bankacılık sektörü hizmet sektöründe önemli alanlarından biridir. Bilindiği üzere, Çağrı Merkezi faaliyetleri genel operasyon performansı üzerinde önemli bir etkisi vardır. IVR (Sesli Yanıt Sistemi) uygulamaları bu faaliyetlerin temel işlevlerinden biridir.

IVR'ların tüm sektörlerdeki Çağrı Merkezleri için önemli bir rolü vardır. Bu nedenle Çağrı Merkezi ve IVR performanının firmaların başarısında doğrudan etkileri bulunmaktadır. Bu tezde, bir bankanın IVR ve Çağrı Merkezi operasyonu doğrudan incelenmiştir. Üç yeni IVR uygulaması olan *Recognize Caller by ANI, Call Steering* ve *Voice Verification* analiz edilmiştir. Ayrıca bu uygulamaların Çağrı Merkezi performansı üzerindeki etkileri incelenmiştir.

Anahtar Kelimeler: Bankacılık Sektörü, Sesli Yanıt Sistemi, Çağrı Merkezi, Simülasyon

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SYMBOLS

ε	:	Accuracy level
μ	:	Agent service rate
$\overline{x}$	:	Average of utilizations
C	:	Cost
c	:	Count of servers
λ	:	Customer arrival rate
D	:	Discipline of the queue
θ	:	IVR service rate
p	:	Probability
K	:	Queue capacity
S	:	Size of the jobs
α	:	Significance level
N	:	Staffing level
A	:	Time between arrivals to the queue

ABBREVIATIONS

ACD	:	Automatic Call Distribution
AHT	:	Average Handling Time
ANI	:	Automatic Number Identification
ASA	:	Average Speed of Answer
ATT	:	Average Talk Time
BMAP	:	Batch Markovian Arrival Process
CLI	:	Caller Line Identification
CRM	:	Customer Relationship Management
CTI	:	Computer Telephony Integration
DNIS	:	Dialed Number Identification System
DTMF	:	Dual-tone Multi-frequency
FCFS	:	First Come First Served
FIFO	:	First in First Out
ID	:	Identification
IVR	:	Interactive Voice Response
LAN	:	Local Area Network
LCFS	:	Last Come First Served
LIFO	:	Last In First Out
MAP	:	Markovian Arrival Process
MMPP	:	Markov Modulated Poisson Process
NOC	:	Network Operations Center
PH	:	Phase-type Distribution
PIN	:	Personal Identification Number
PNPN	:	Priority Service
PS	:	Processor Sharing
SIRO	:	Service In Random Order
VRU	:	Voice Response Unit
XML	:	Extensible Markup Language

1. INTRODUCTION

Service sectors' increasing involvement in the world economy addresses people's attention to the service sectors. Service sectors are getting much more important in the wealth of countries. Banking sector is one of the major areas in the service industry. In last decades, competition between banking companies increasingly raised. Many of these companies service to their customers via Call Centers to increase customer satisfaction. Unfortunately, cost of answering customers directly by call center agents (customer representatives) is fairly high.

ContactBabel, a leading analyst firm for the contact center industry, compared the average costs of an Interactive Voice Response (IVR) session and a live agent call. They revealed that the average cost of an IVR self-service session is 65p, compared to £3.87 for a live agent call. At this point, answering customers by an IVR system and giving service to customers as much as possible with IVR system noticeably decreases service cost.

With this perspective, Call Center managers try to serve customers by IVR systems with numerous IVR services. However 3 main requirements come up for all IVR systems with far-reaching services, as described in Chapter 4 of this thesis;

a. Customers are required to recognize themselves to system,
b. They are required to authorize themselves with a customer specific code as a password,
c. They are required to enter to related IVR menu by dialing menu numbers as commands.

Banking companies have customers with different background and different technical adequacy. IVR requirements may reduce usability of IVR systems for some of these customers. When a customer cannot use IVR for his or her need, this may end up with loss of customer satisfaction or need of an agent for service.

Many of third parties that focus on call center and IVR services, produce new IVR applications to help increasing IVR usage and to reduce the need of an agent indirectly.

Three of these IVR applications noticeably come to the forefront; Recognize Caller by ANI, Call Steering and Voice Verification. These applications are mostly used in telecommunication sector and also being popular in banking sector day by day.

Recognize Caller by ANI application searches customer database for customer's caller ID and tries to authenticate the customer without requesting any customer ID.

Call Steering application requests customer to command IVR by talking instead of dialing IVR menu numbers. Application resolves the voice command and matches the command with an IVR service.

Voice Verification application uses customer's voice as a password application and authenticates the customer without entering any customer specific password code.

Though there are many articles and theses about IVR systems and call centers, there is no academic resource to reveal how recent IVR applications affect IVR and call center performance. This thesis is written to inform readers about recent IVR applications and their effect on IVR and call center performance.

Customers' daily arrival pattern, distribution times and customer behavior (usage counts) in call center are taken from database records of a bank which are set in simulations. Five simulation models are built to analyze effect of proposed applications to the recent call center performance. Simulation models in this thesis are;

a. Model for current call center workflow
b. Model with Recognize Caller by ANI
c. Model with Call Steering
d. Model with Voice Verification
e. Model with Recognize Caller by ANI, Call Steering and Voice Verification

Agent utilization, counts of call ending point, average durations, utilization of IVR and agent ports, counts of successful processes are leading performance criteria which are used for comparison of simulation results.

Chapter 2 of this thesis gives the literature survey about analytical solution practices and

simulation practices. Chapter 3 gives some background information about queueing systems, call center, IVR, definition of jargons and performance metrics, Recognize Caller by ANI, Call Steering and Voice Verification. The problem is defined in Chapter 4. Recent call center workflow is simulated in Chapter 5. Call center workflow with proposed applications are simulated in Chapter 6. Chapter 7 includes results and discussion and Chapter 8 contains conclusion.

2. LITERATURE REVIEW

Previous research on call centers has focused on different areas. However, there is a need for research in the area of new IVR applications to improve IVR and total call center performance. This thesis provides a comparison between standard IVR model and IVR with new applications such as Recognize Caller by ANI, Call Steering and Voice Verification with a focus on processes done in IVR.

Previous researches for IVR and call center performance are summarized in sections below. First section contains analytical solution practices and second section contains simulation practices.

2.1 ANALYTICAL SOLUTION PRACTICES

Gans et al. (2003) provide information about call centers that come out with operational problems. Mathematical models for call center management are in focus. Analytical models that support capacity management are also revealed. Models of single type customers and single skill agents, models with busy signals and abandonment, skill based routing, call blending and geographically dispersed call centers are examined.

Khudyakov (2006) analyses the case with homogeneous customers and homogeneous agents. To make the model analytically tractable, it is assumed that arrivals are Poisson, service times are exponential and there are no retrials. With these assumptions, the underlying stochastic processes are one-dimensional Markov processes. As given the present state, it is assumed that the future behavior is independent of the past conditionally.

Borst et al. (2004) produce a framework for a queueing system's asymptotic optimization. The staffing problem of large call centers is in focus. It is modeled as M/M/N queues with N, the number of agents in a large call center. Optimal staffing level is searched which trades off agents' costs with service quality. As an alternative to this optimization, an approach for constraint satisfaction is developed which links to a given constraint on waiting cost. In both ways, three regimes of operation are found:

a. Service quality is on the focus in quality-driven regime,
b. Agents' costs are emphasized in efficiency-driven regime,
c. A rationalized regime which balances and unifies the other two.

The utility of the approach revealed is also demonstrated by revisiting the square-root safety staffing principle.

Salcedo-Sanz et al. (2010) obtained service trees which are near-optimal and figures the structure of the desired call center by presenting an evolutionary algorithm based on Dandelion encoding. To be able to adapt original Dandelion encoding to particular service tree design problem, they modified it. Systematic experiments have been analyzed to show the performance of their approach:

a. Different synthetic instances were analyzed for various aspects of the proposed evolutionary algorithm,
b. A real application was analyzed; the design of an Italian telecommunications company call center.

In all carried out experiments, their approach was compared with a lower bound based on information theory for the problem, and also with Huffman algorithm results.

Johan Joubert du Preez (2008) implemented a model for a call center. The implementation resulted successfully. In the whole model; Workforce Management, staffing model, forecasting model and scheduling model were covered.

Massey et al. (2004) developed formulas and algorithms to find the minimum number of call center agents and telephone lines required to provide a supply the service level needed. They also indicated Erlang C-Formula. Number of agents asymptotically derived and number of spaces waiting in the buffer are found by a fixed point equation which is solved iteratively.

Brandt et al. (1997) focused on finding optimal parameters for automatic call distribution (ACD) systems. An ACD system is a device or system which distributes incoming calls to specific agents. Customer needs, customer types, and agent skill set

are in focus, which also usually are a part of computer telephony integration (CTI) system. The model is based on a multi-server combined loss/waiting system with impatient customers. In the ACD model is considered, an announcement is given before entering the service. During the announcement, approximations for all performance characteristics are provided. With a flexible ACD cost model, finding cost optimized ACD system parameters under pre-defined service quality constraints is possible.

Srinivasan et al. (2002) revealed and analyzed a flow controlled network model. Voice Response Unit (VRU) and the agents are involved as resources. Poisson arrivals and exponential processing time at the VRU and exponential talk time are assumed. The number of agents and trunk lines required are simultaneously determined. A second $M|M|S|N$ queueing model which ignores the role of the VRU, where S is the number of agents and N is the number of trunk lines, determines the optimal S and N subject to constraints.

Robbins et al. (2006) showed that the arrival rate assumptions highly effect call center staffing models. Call centers with lower volume suffer equal or greater disruption from shifts in call volume. When arrival rates' variable is high, theoretical models that assume a known arrival rate are suspect.

Robbins et al. (2007) revealed that reducing operating costs by partial pooling depends on different project combinations. In some cases, adding more agents to agent pool allows improvement on efficiency in service level but in other cases pooling causes redundant capacity.

Parwan Electronics Corporation (2009) released a write up about IVR systems. It is mentioned that an IVR only can be as good as how it is designed. A poor design may cause more harm because of decreased customer satisfaction based on an IVR implementation. Three main criteria are highlighted:

a. Scalability: An IVR should be easy to modify to support changing needs.
b. Performance: IVR should be able to handle incoming lines at maximum capacity.
c. Customer satisfaction: IVR should be designed considering the customer needs.

Menus should be logical and the options should be easy to understand.

Raju (2002) mentioned that by using tools such as Voice XML, servlets and Java Speech Grammar Format; he created voice application that supplies efficient speech user interface and user friendly environment. He established improvements in the following aspects;

a. Minimizing fetching delays,
b. Grammar development,
c. Email reader.

Tezcan et al. (2012) inspected an optimization problem. They focus on minimizing total cost associated with staffing and customer abandonments when the arrival rate is large, the solution method proposed is asymptotically optimal.

Kim et al. (2013) revealed that queue systems which work as tandem systems are utilizable for call centers with IVR systems. There are limited service lines in the first stage while the second stage has a limited buffer and limited service lines. Calculation is done for the main performance measures.

Duder et al. (2001) mentioned that abandonments might be experienced if service level is close to 100 percent and additional agents should be supplied to decrease abandonments to decrease costs originated from losing customers. A linear regression between average speed of answer and percent abandonment (R-squared value > 0.9).
In order to approximate the number of agents required to attain different values of average speed of answer, given expected call volumes and average turnaround time for a particular quarter hour, a standard M/M/c queueing model is used in commercial call center staffing systems.

2.2 SIMULATION PRACTICES

Bapat et al. (1998) revealed that the simulation is a very strong tool for call center management. The two main reasons for using simulation tools for call center management are; call centers' widely complex environment and the need of simulation before integration of technological changes. Simulation technology also extends the

capability of existing tools. Simulation brings the ability to study the impact of change in call centers without trial-and-error. The risk of making poor decisions and dissatisfaction of customers are minimized. By simulation, proactive planning gives better results than reactive decision-making. It is more likely to respond to the sudden changes and decrease the level of unpredictability in caller behavior. They also inspected call center entities and resources. The trunk lines, IVR and agents are resources for the customers calling. Customers enter and navigate through the system, seizing available resources when needed, often requiring several resources at once, and eventually releasing the seized resources upon exiting the system.

Kungle (1999) presented that by simulation improves the performance and makes the visualization, analysis and enhancement of call center processes possible. It is a far good approach that prevents many difficulties of analytical models and assumptions.

Franklin (2010) examined Erlang-C based estimation formulas. Number of agent positions and queue parameters are set. However, recent trends such as Skill Based Routing (SBR), electronic channels and interactive call handling demand more sophisticated techniques. He or she revealed that Erlang-based calculations are restrictive and sometimes incapable of analyzing call center business needs. They indicated the advantages of simulation in call center modeling such as simultaneous queueing, customer abandonment patterns, priority in queueing and agent schedules.

Mehrotra et al. (2003) focused on call center simulation and evaluated sixteen scenarios. They emphasized that, with simulation it is possible to produce many detailed statistics and different parameters to examine any number of other cases by simulation modeling of call center. Within the call center industry, it is determined that there are 3 major methods for utilization of simulation:

a. Traditional Simulation Analysis: With inputs obtained from a variety of data sources, a specific operation is analyzed within this model.
b. Embedded Application – ACD/CTI Routing: ACD and CTI applications which contain a routing simulation to provide the impact of different decisions.
c. Embedded Application – Agent Scheduling: Optimal call center agent scheduling which both calls and agents are nonhomogeneous.

Kuhl et al. (2006) revealed that, with inputs taken from a variety of data sources, simulation fits to be the most viable option for subsequent decision support and accurate performance measurement. They informed that skill staffing, arrival-rate uncertainty and time dependence, control, performance analysis and skill based routing are main criteria for analytical models.

L'Ecuyer et al. (2014) presented a wider investigation of service times for a call center which has different agent groups and different types for incoming calls. It is seen that for a particular call, competences of agents influences service times. Service times may change by different times. Stochastic models are built which consider these factors.

Macal et al. (2013) introduces Modeling & Simulation Grand Challenges from an Operational Research/Management Science (OR/MS) point of view and negotiates topics including simulation analysis, worthiness of information, data modeling, stochastic modeling and optimization.

3. BACKGROUND

This chapter contains background information about this thesis. Sections of this chapter are respectively; Queueing Systems, Call Center, Interactive Voice Response and Definitions of Jargons and Performance Metrics.

3.1 QUEUEING SYSTEMS

Queueing system involves customer's waiting for service, leaving the queue when the server is ready for him or her, getting the service, and leaving the service his or her service completes.

Kendall (1953) evolved the standard notation throughout the queueing literature. A queueing process is described as x/y/a/b/c, where x represents the arrival-time distribution, y represents the service model, a represents the number of server lines, b represents the restriction on capacity and c represents the discipline of the queue.

Customer impatience can be defined by three conditions; balking, reneging and jockeying. When the queue is full with waiting customers or waiting time is at its highest level possible etc. a task may not be accepted in queue. In this case, that task balks. When task owner leaves the queue before the server is ready for a new customer, the task reneges. In a multiple service line system, the task may switch to another server. In this case, the task is jockeying.

3.2 CALL CENTER

A call center typically is built of telephone trunk lines, a distributor machine known as the Automatic Call Distributor, an IVR and agents to handle the calls.

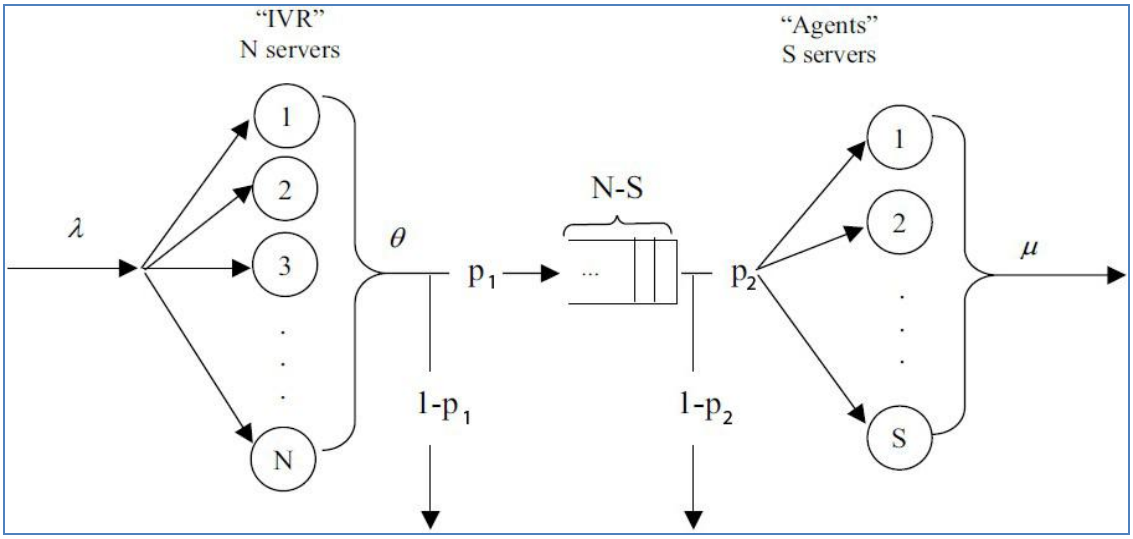
An inbound call center is a work place used for responding incoming calls. Outbound call centers are operated with agents who call customers for telemarketing, market research or debt collection.

Usually, each agent has a telephone set and/or headset which is connected to a corporate network. Mostly calls are managed by a system called Computer Telephony Integration (CTI).

Company's customer relationship management (CRM) usually directs call center oparations.

Incoming call flow of a standart IVR and call center is given in Figure 3.1.

Figure 3.1: Incoming call flow of a standard IVR and call center



Source: Polina, K., 2006. Designing a Call Center with an IVR.

Definitions of symbols given in schema:

λ: arrival rate

θ: Service rate of IVR

μ: Service rate of agent

p: Probabilities

N: Number of IVR trunk lines

S: Number of agents

3.3 INTERACTIVE VOICE RESPONSE (IVR)

IVR is the system which uses caller's voice and dual-tone multi-frequency (DTMF) tones as inputs via keypad, to interact with humans.

IVR's are able to;

a. Transfer calls to the most related agent or function depending on customers' IVR input. As calls are directed to agents, the probability that the caller will be transferred to the wrong agent or department will be significantly reduced.
b. Collect information about customer's needs.
c. Obtain the information for customers without need of any agent.
d. Replace a receptionist who directs calls to customer representatives.
e. Prioritize the calls based on the customer's value.

IVR's usually service for calls with high volume and reduce costs. IVR is also used to be able to service in out of working hours of a day.

History of IVR Systems is given in the Table 3.4.

Table 3.1: History of IVR systems

Year	**Development**
1962	Bell Systems unveiled the first telephone that could dial area codes using DTMF technology.
1970	Deployment of IVR technology started to automate tasks in call centers.
Early 1980s	First cost effective IVR was implemented by Perception Technology
Late 1990s	Speech recognition started to be implemented in IVRs

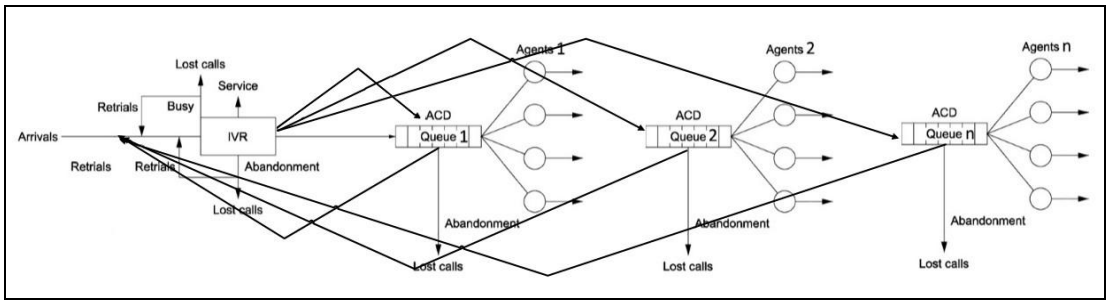
History of IVR Systems in Turkey is given in the Table 3.5.

Table 3.2: History of IVR systems in Turkey

Year	**Development**
1991	The first interactive voice response systems in Turkey were implemented at Pamukbank.
2001	First speech recognition application was implemented in Global Menkul Değerler

A schema of an inbound call center is given in Figure 3.2. There are ‘n’ agent groups who serve to ‘n’ types of customers. Even it is in IVR or in servers' pool, a call occupies a trunk line. As shown, calls are distributes to ‘n’ queues and an impatient customer may leave before call is answered by an agent. An abandoning or blocked caller might try once more (retrial).

Figure 3.2: Schema of a call center with IVR trunk lines, queue and agents



3.4 DEFINITION OF JARGONS AND PERFORMANCE METRICS

In this thesis many jargons and performance metrics are being mentioned. In this section, definitions of jargons and performance metrics mentioned in this thesis are respectively given in the Table 3.3 and Table 3.4.

Table 3.3: Definitions of jargons mentioned in this thesis

Jargon	Definition
Interactive Voice Response (IVR)	IVR is the system that interacts through the use of voice or keypad dial tones as input.
Trunk/Trunk Lines	A communication line between two switching systems. Determines how many callers are able to get into the call center whether it's directly to an agent or through the call center's IVR.
Queue	A line or sequence of people or vehicles awaiting their turn to be attended to or to proceed.
Agent	Someone who handles telephone calls in a call center, also referred to as an operator or customer service representative.
Available Status	Agent status, which means that agent is waiting for the next call.
Busy Status	Agent status, which means that agent is busy with a call and will not be available until current call is over.
Number of idle-available agents	Number of idle-available agents who are waiting for the next call in 'available' state.
Call duration	The time duration of the call in agent.
After Call Work (ACW)	The duration of a work required for an ended call, after the call is over and before a new call is taken.
Time in Call Center	The time span from when a call enters the center until the call is completed.
Call Termination	Call's being disconnected as of the end of the replication.
Abandoned call	An incoming call which is terminated by the person originating the call before it can be answered by an agent.
Network Operations Center (NOC)	A team responsible for handling system wide/company-wide issues such as Power Outages, TV outages, Internet Outages, etc.
Retrial	A retrial occurs when a customer re-dials into the center after having encountered a busy signal or having abandoned.
Schedule	A record specifying when an employee is supposed to be on duty.
Scheduling	Making the timetable of agent hours/shifts for a call center.
Wait Time Before Abandonment	The time passed before impatient customer leaves the system.

Table 3.4: Definitions of performance metrics mentioned in this thesis

Performance Metric	Definition
Average Talk Time (ATT)	The average amount of time the agent spends talking to a caller, starting from time caller reaches an agent until the call is released. Also known as Average Call Duration.
Average Handling Time (AHT)	How long on average an agent spends on each call. AHT includes the work done after the call is released and before a new call is taken.
Average Speed of Answer (ASA)	How long on average the caller waits on hold before the call is answered by an agent. Also known as Average Wait Time.
Average Agents with Available Status	The average number of agents available throughout the timeslot. In simplest term; Average available agents = Total available time * Scheduled Agents / Total time
Average Agents with Busy Status	The average number of agents busy throughout the timeslot. In simplest term; Average busy agents = Total busy time * Scheduled Agents / Total time
Ratio of idle-available agents	Ratio of idle-available agent number who are waiting for the next call in 'available' state, compared to total number of agents.
Agent Utilization	The average utilization of agents throughout the timeslot. The percentage of time, call center agents are on calls or in after-call work, divided by the time they are logged in. This metric also can be calculated by average busy agent count divided by average of total agent count in a time slot.
Ratio of Abandoned call	Ratio of abandoned calls to total calls.
Average of Total Time in Contact Center	Average of Total Time in Contact Center is the sum of averages of Time Spent in IVR, Time Spent in Queue (which is also mentioned as Speed of Answer) and Handle Time of Agent.
Port Utilization	The average utilization of ports (trunks) throughout the timeslot. The percentage of time, ports are ready to service customers, divided by the time they are busy. This metric also can be calculated by average port count divided by total port count in a time slot.
Ports Blocked	Average number of ports (trunks) which are blocked by other customers and caused not accepting new customers to the system.

4. PROBLEM DEFINITION

Inspected operation is a bank's IVR and call center, which receives 63.650 call in average per day. Because of incoming call number is rather high, IVR has a very important role in meeting customers' needs and decreasing costs of call services by terminating calls in IVR as much as possible.

As it is known that IVR and agent port count is high enough to answer 100 percent of the calls in any time of the day, there is no risk of getting busy signal because of port unavailability.

To complete a call in IVR, it is required to serve customer the functionality he or she need in IVR. 3 main requirements for customers to make a transaction with needed functionality in IVR are;

a. Customer identification,
b. Indication of the functionality desired to system,
c. Authorization of the customer to reach the functionality desired for security purposes.

This thesis aims to define improvable points of IVR which meet these requirements, propose suggestions and reveal effects of these suggestions.

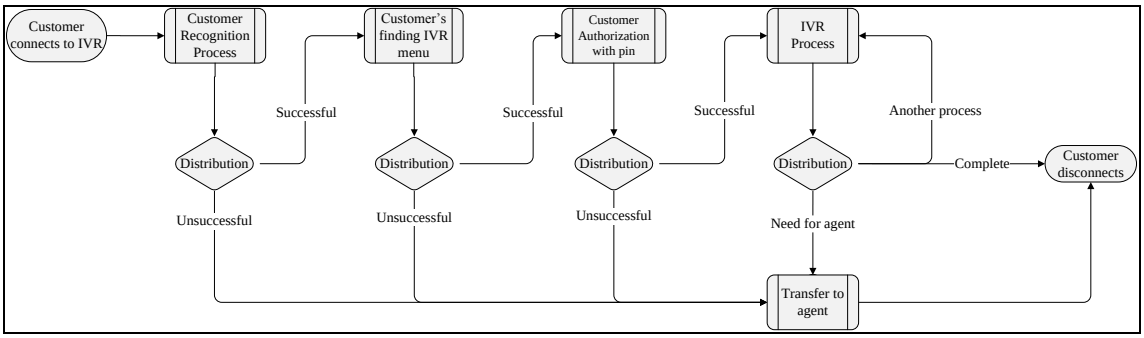
4.1 CURRENT FLOW

There are 4 main steps in the IVR flow as given below;

a. Customer recognition (identification) process,
b. Customer's finding IVR menu (indication of the functionality desired to system),
c. Customer authorization with PIN (authorization of the customer to reach the functionality desired for security purposes).
d. Running the IVR functionality desired.

Though IVR is enriched with many self-service functionalities for customers, lack of usability in first 3 requirements above, may cause IVR functionalities not to be used at maximum level. In this case customer will be transferred to an agent. Even IVR functionality is run as fourth requirement, customer may still need help of an agent. Current IVR process flow is given in Figure 4.1.

Figure 4.1: Current IVR process flow



4.2 IVR MENU TREE

Banking IVR inspected has a large number of IVR menus which are categorized by their transaction type in Table 4.1.

Table 4.1: Menus of Banking IVR

Menu Address	Menu-Functionality Name	Menu Level
1.	Banking Transactions	1
1.1.	Account Transactions	2
1.1.1.	Account Balance Info	3
1.1.2.	Account Balance Receipt by Email	3
1.2.	Money Transfer	2
1.3.	Investment Info	2
1.4.	Bill Payment	2
2.	Credit Card Transactions	1
2.1.	Credit Card Receipt Transactions	2
2.1.1.	Credit Card Receipt Info and Payment	3
2.1.2.	Credit Card Receipt by Email	3
2.3.	Credit Card Limit Info	2
2.4.	Credit Card Campaign Info	2
3.	Password Transactions	1
4.	Internet and Mobile Banking Support	1
5.	Other banking services	1

4.3 CALL CENTER AGENT CLASSIFICATION

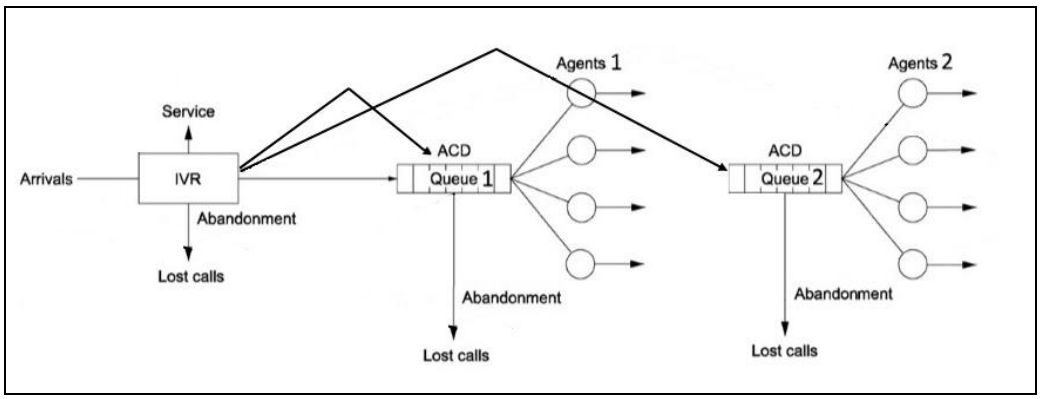
There are 2 classification of agents based on their skills:

a. Agents with Basic Skill: These agents are newly employed agents. They are supposed to answer calls of customers who successfully enter their PIN in IVR. These agents don't do the security check to customers and directly service customers.

b. Agents with Basic+Security Skill: These agents are experienced enough and skilled in security check of customers based on bank's procedure. They are supposed to answer calls of customers who don't have PIN or couldn't enter their PIN in IVR. These agents are able to do the security check to customers before satisfying their needs.

A schema of an inbound call center is given in Figure 4.2. The figure depicts a schematic model of an inbound call center with 2 agent groups, serving to 2 class of customers as in simulation model. As shown, calls are distributes to 2 queues and an impatient customer may leave before call is answered by an agent. To make the simulation models analytically tractable, it is assumed that there are no retrials, queues are separate and a customer cannot be transferred to one queue from the other.

Figure 4.2: Schema of a call center with IVR trunk lines, queue and agents



4.4 IMPROVABLE POINTS

As mentioned before, 3 main requirements for customers to make a transaction with needed functionality in IVR are;

a. Customer identification,
b. Indication of the functionality desired to system,
c. Authorization of the customer to reach the functionality desired for security purposes.

4.4.1 Customer Identification

At the beginning of IVR session, after the greeting announce, customer is requested to enter his customer number to be recognized. Unfortunately some of customers may not remember or enter their customer numbers as quick as requested. This may cause identification process to get longer than expected or may fail.

4.4.2 Indication of the Functionality Desired

Banking IVR menus usually have a large number of IVR menus which are categorized by their transaction type. By categorization, serving customers with unlimited IVR functionalities is made possible. However, an IVR tree with three or more branches may be confusing depending on the complexity of IVR tree.

Customers are expected to get to IVR functionalities by dialing menu numbers until they reach to the functionality which will satisfy their need. When a customer is not

capable to find IVR functionality which will satisfy his or her need, or if the IVR tree is not reasonably simple; customer may be lost in menus. In this situation indication of the functionality desired gets longer than expected or may fail.

4.4.3 Authorization of the Customer

For security purposes, customers have to be authorized to reach the functionality desired.

Customers are usually not willing to create a numerical password or they enter wrong passwords for authorization process, even they created a password before. Because of legal obligations, banking companies have to push their customers to create difficult to guess and complex passwords, which usually causes customers to avoid to create one or to forget their passwords because of not using so often. Not having or not entering a password to system cause customer to connect to an agent for authorization process and this situation avoids the need to be satisfied by IVR functionality.

For authorization process agents doing security check with customer also increases agents total talk time and decreases performance of call center.

4.5 PROPOSED APPLICATIONS

This section contains information about Recognize Caller by ANI, Call Steering and Voice Verification which are proposed as solutions for improvable points explained in the previous section.

4.5.1 Recognize Caller by ANI

Recognize Caller by ANI is an IVR application which allows company to recognize its customers by customers' registered phone numbers in company's database. When a customer calls call center, ANI of the caller is searched through customer database and when it matches with a customer's registered phone number, caller is identified as

potential matched customer.

After recognizing the customer, the next step is announcing customer's name and surname with Text to Speech technology to customer. Customer is requested to make a selection if he or she is recognized customer or not;

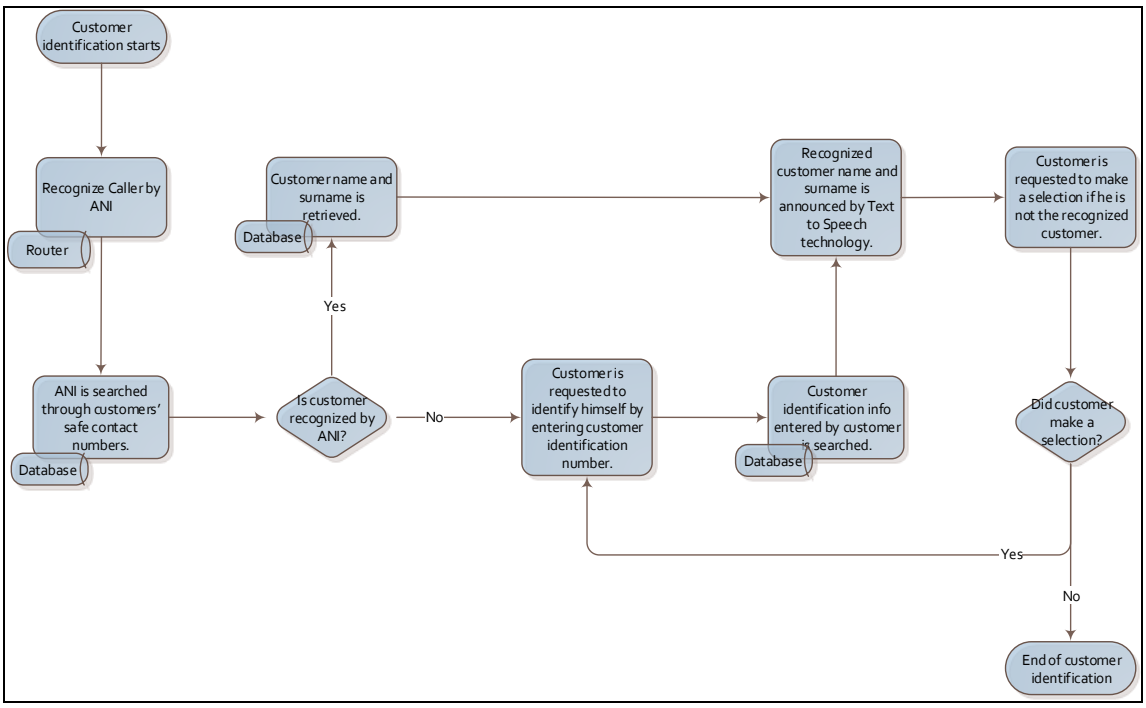
a. If customer denies recognized customer info (if the customer is somebody else) then the customer is requested to enter his or her customer identification number for recognition process.
b. If customer does not deny that he or she is the recognized customer, recognition process becomes completed.

Recognize Caller by ANI strengthen IVR functionality. It purposes to;

a. Impress customer by recognizing him or her without entering any customer info,
b. Decrease time spend in authentication process,
c. Minimize number dialing in IVR session.

The whole process is described with a flow chart in Figure 4.3.

Figure 4.3: Recognize Caller by ANI flow chart:



4.5.2 Call Steering

In the simplest term, Call Steering is an IVR application which directs customer to IVR functionalities by voice command instead of dialing telephone keypad.

Call Steering;

a. Requests customer to give his or her command with voice,
b. Listens to customer's speech,
c. Comprehends the command,
d. Converts voice to text,
e. Matches text with related IVR menu or IVR functionality.

Call Steering strengthens IVR functionality. It purposes to;

a. Prevent customer to be lost in IVR menus,
b. Decrease time spend in IVR for searching for IVR functionality,
c. Prevent customer to need getting familiar to IVR menu tree,
d. Minimize number dialing in IVR session,
e. Decrease the level of abandonment of lost customers in IVR menus.

4.5.3 Voice Verification

Voice Verification is a service which authorizes a person from his or her voice, by comparing recently recorded voice's model to existing voice model if they match in an acceptable level.

Customers need to authorize themselves to be able to receive customer specific info or make a financial transaction. Account Balance Info and Investment Info may be examples for IVR menus which supplies customer specific info. Money Transfer, Bill Payment and Credit Card Receipt Payment may be examples for IVR menus which makes financial transactions.

One of most common problems in service channels like IVR systems and call centers is customers' unwillingness to create a numerical password or entering wrong passwords for authorization process. Because of legal obligations, many service industry companies push their customers to create difficult to guess and complex passwords, which usually causes customers to avoid to create one or to forget their passwords because of not using so often. At this point, companies evaluate new authorization applications such as Voice Verification.

Prior condition of Voice Verification is customer's creating his or her voice signature. After customer recognition process is completed, system checks if customer has a voice signature. If not, customer is requested to create one. If customer accepts the offer, for once, he or she is verified with manual security check. Then system records customer's voice signature model.

In next call, after customer recognition process is completed, system finds voice signature ownership for that customer. Then, application requests customer to authorize himself or herself by voice signature. After customer's recent voice record is taken, application compares recent voice model with existing voice model.

When recently recorded and existing voice model matches in an acceptable level, system authorizes customer without any further security check process or customer password.

Voice Verification strengthens IVR functionality. It purposes to;

a. Impress customer by authorizing him or her with his or her voice signature,
b. Eliminate the need of a PIN for authorization,
c. Decrease time spend for authorization process.

5. SIMULATION MODEL FOR CURRENT CALL CENTER WORKFLOW

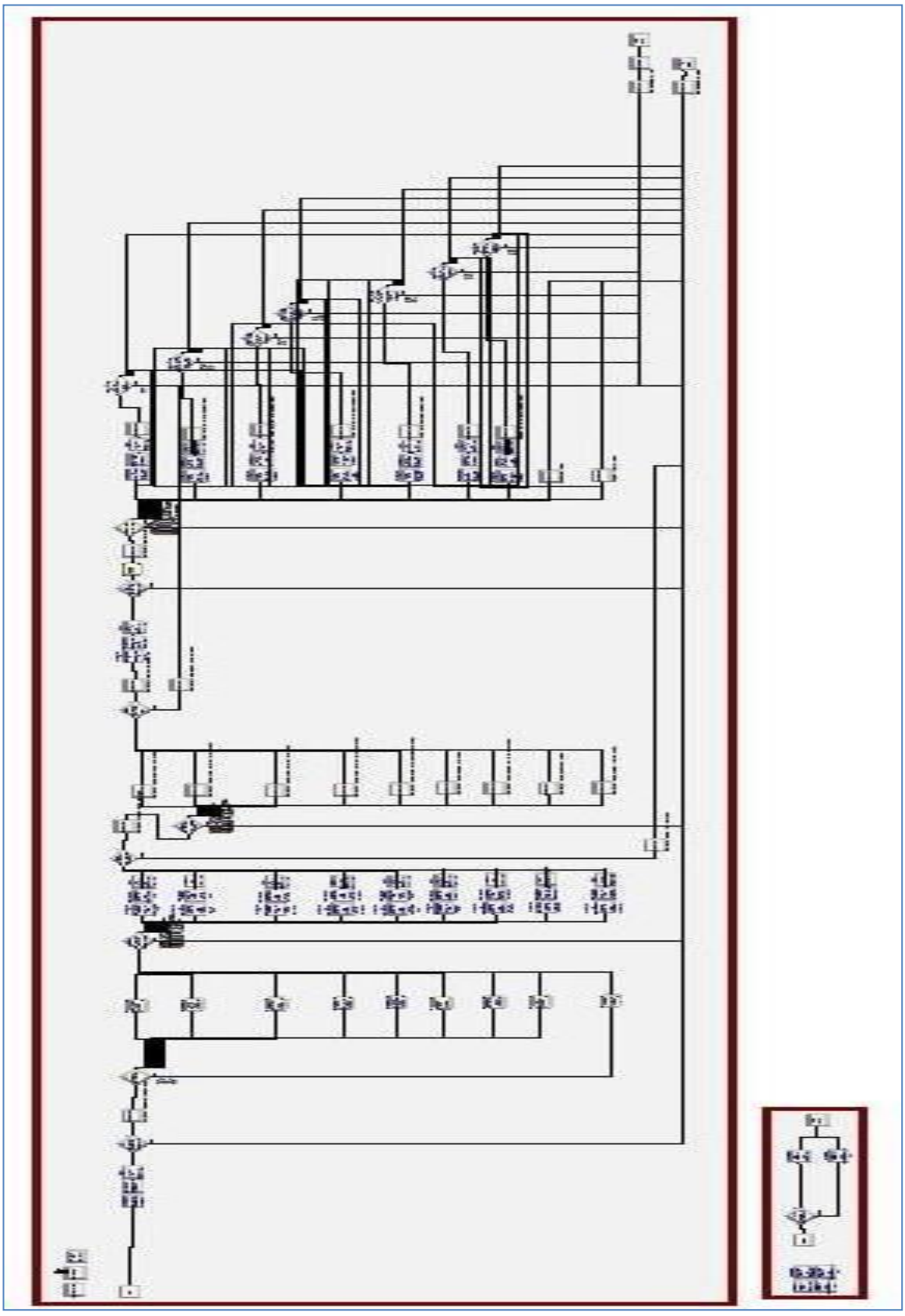
Because of the complexity of the system, simulation is used instead of other analytical models in this thesis.

A discrete-event simulation simulates the system as a discrete sequence of operations in a specific period. Operations mark a status change in the system. Between sequential operations the simulation may proceed from one operation to following one.
Banking IVR and call center inspected is simulated with *Arena Simulation Software* by *Rockwell Automation, Inc.* as a discrete-event simulation.

The whole simulation model had to be complex due to variation of possible customer experience scenarios In IVR as in Figure 5.1.

Time values in simulation are taken from Table 5.1.

Figure 5.1: The whole simulation model



In this thesis, IVR operations were investigated deeply. First scenario box above contains IVR operations. The second scenario box contains calls directed to agents. Because of this thesis focuses on improvements on IVR, average talking values for two main agent groups are calculated and distribution values for these two agent groups weren't disintegrated. This obtained agent scenario box to be a simple flow.

5.1 ACQUIRING OF DISTRIBUTION TIMES

Distribution time values are calculated by analyzing a 100 sample set for each process. Sample values of a regular day are exported from database records as a text file and imported to *Arena Input Analyzer* software.

Distribution expression values are in second format and divided by 60 to be converted to minute format while importing to *Arena*.

Distribution time value results acquired from *Input Analyzer* using Chi Square Test are given in Table 5.1. All goodness of fit results have P-value greater than 0.05, so we can use the related distributions in the simulation.

Table 5.1: Distribution time value results

Process Name	Distribution	Expression	P-value	Square Error
Customer Recognition	Beta	5.5 + 30 * BETA(1.6, 2.81)	0.0879	0.012848
Enter to Account Balance Receipt by Email Menu	Normal	NORM(25.3, 8.28)	0.39	0.008913
Enter to Account Balance Info Menu	Beta	7.5 + 29 * BETA(2.73, 1.46)	0.068	0.015207
Enter to Bill Payment Menu	Poisson	POIS(14.1)	0.0771	0.012469
Enter to Credit Card Campaign Info Menu	Beta	6.5 + 20 * BETA(1.5, 2.01)	0.106	0.010680
Enter to Credit Card Receipt by Email Menu	Beta	7.5 + 46 * BETA(2.83, 4.17)	0.274	0.013524
Enter to Credit Card Receipt Info and Payment Menu	Normal	NORM(21.7, 7.58)	0.056	0.012955
Enter to Credit Card Limit Info Menu	Beta	9.5 + 30 * BETA(1.19, 1.67)	0.0641	0.011967
Enter to Investment Info Menu	Beta	7.5 + 35 * BETA(3.83, 3.14)	0.0998	0.014169
Enter to Money Transfer Menu	Beta	6.5 + 23 * BETA(1.95, 1.98)	0.0836	0.012339
Pin Entry	Beta	14.5 + 36 * BETA(1.5, 2.7)	0.345	0.007818
Credit Card Receipt Info and Payment Process	Beta	12.5 + 44 * BETA(1.47, 2.37)	0.127	0.007221
Credit Card Limit Info Process	Beta	12.5 + 44 * BETA(1.47, 2.37)	0.127	0.007221
Credit Card Receipt by Email Process	Beta	24.5 + 45 * BETA(1.5, 3.49)	0.0668	0.007722
Credit Card Campaign Info Process	Triangular	TRIA(35.5, 82, 95.5)	0.0576	0.010412
Account Balance Info Process	Beta	32.5 + 35 * BETA(1.36, 1.21)	0.0808	0.013001
Account Balance Receipt by Email Process	Beta	22.5 + 57 * BETA(1.32, 1.33)	0.46	0.009035
Investment Info Process	Beta	28.5 + 47 * BETA(1.3, 1.5)	0.0722	0.008483
Agent Talk Time	Normal	NORM(75, 18.9)	0.0947	0.007508
Wait Time Before Abandonment	Normal	NORM(166, 30.4)	0.0619	0.011321

5.2 GENERAL OVERVIEW OF IVR

There are three configuration boxes in the simulation of IVR flow as given in Figure 5.2.

Figure 5.2: Configuration boxes in the simulation

5.2.1 Configuration

IVR has a 400 IVR trunk capacity for IVR menus included in simulation, which means system supports to service 400 customers at the same time in IVR.

In order to determine the number of replications that will be used in the study, we run the simulation ten times to get agent utilizations and calculate the average and standard

deviations of utilizations of both types of agents which are given in Table 5.2. Then the minimum number of replications is calculated similarly as in Ahmed (1999) by the formula below:

$$N = \left(\frac{s\, t_{\alpha/2,m-1}}{\overline{x}\, \varepsilon} \right)^2$$

where α is the significance level and taken as 0.05 so the critical value is 2.262, ε is the accuracy level and taken as 0.01, *s* is the standard deviation of agent utilization and $\overline{x}$ is the average of agent utilizations which are calculated according to the replication utilizations given in Table 5.2.

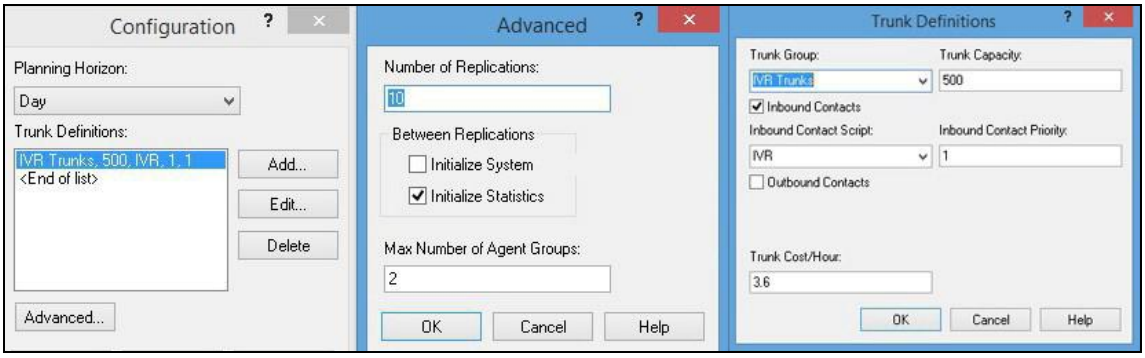
Table 5.2: Calculation for required replication count

$t_{0.025,9}$=	2.262	
ε=	0.01	
Replication Number	**Utilization for Agents with Basic Skill**	**Utilization for Agents with Basic+security skill**
Replication 1	0.5936	0.9691
Replication 2	0.5951	0.9692
Replication 3	0.5978	0.9694
Replication 4	0.5819	0.9694
Replication 5	0.5949	0.9719
Replication 6	0.5971	0.9715
Replication 7	0.5892	0.9705
Replication 8	0.5992	0.9714
Replication 9	0.6004	0.9684
Replication 10	0.5913	0.9690
Average ($\overline{x}$)	0.5940	0.9700
Standart Deviation (***s***)	0.0055	0.0012
Square Root of N	2.0912	0.2870
N	**4.3731**	**0.0823**

According to results in Table 5.2, it is seen that at least 4.3731 and 0.0823 replications are required respectively for *Utilization for Agents with Basic Skill* and *Utilization for Agents with Basic+security Skill*, to reach the desired accuracy in the simulation. So we decided to use 10 replications in our study.

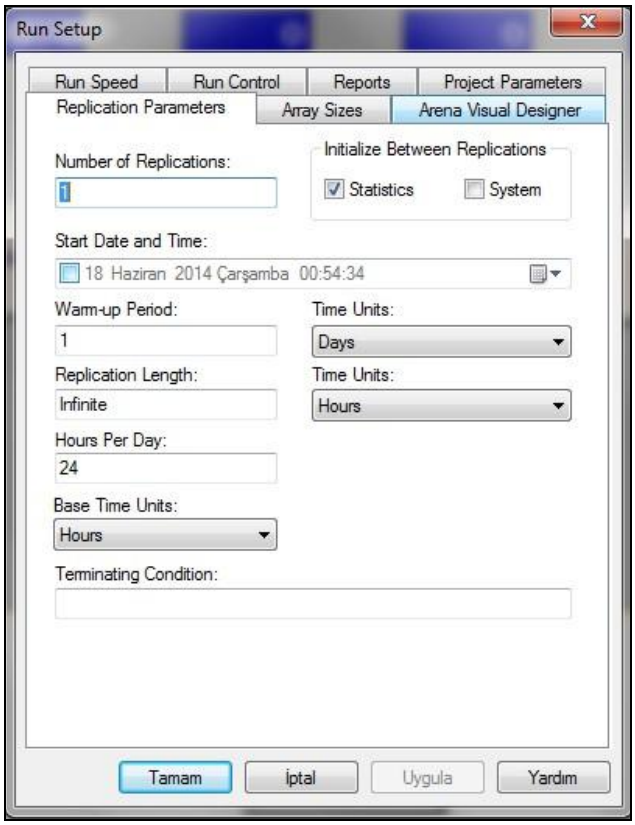
Number of replications is set to 10. Maximum number of agent groups is 2. Details of configuration boxes in the simulation are given in Figure 5.3.

Figure 5.3: Details of configuration boxes in the simulation



Number of Warm-up Period is set to 1 day to acquire starting as an ongoing operation while first replication starts. Warm-up Period is entered in the simulation as given in Figure 5.4.

Figure 5.4: Warm-up Period criteria entry



5.2.2 Contact: Customer

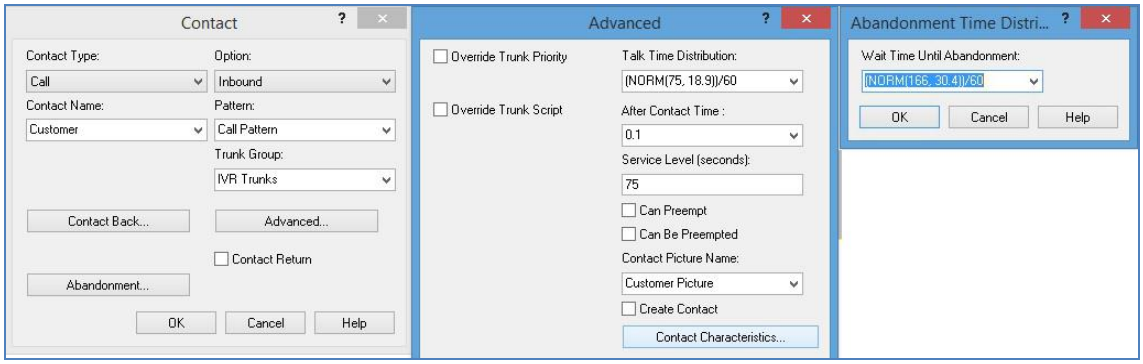
There is just one pattern for calls entitled Call Pattern.

Trunk Group is selected as IVR Trunks.

Approximate wait time until abandonment is set.

Details of customers in the simulation are given in Figure 5.5.

Figure 5.5: Details for customers in the simulation

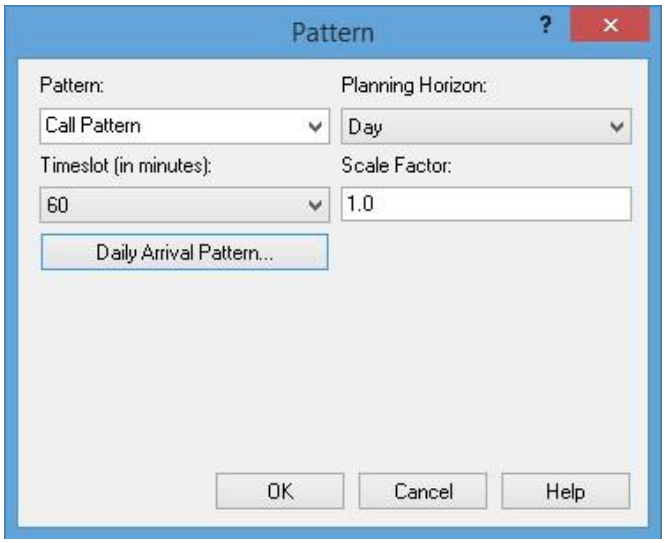


5.2.3 Pattern: Call Pattern

Incoming calls for one day are simulated.

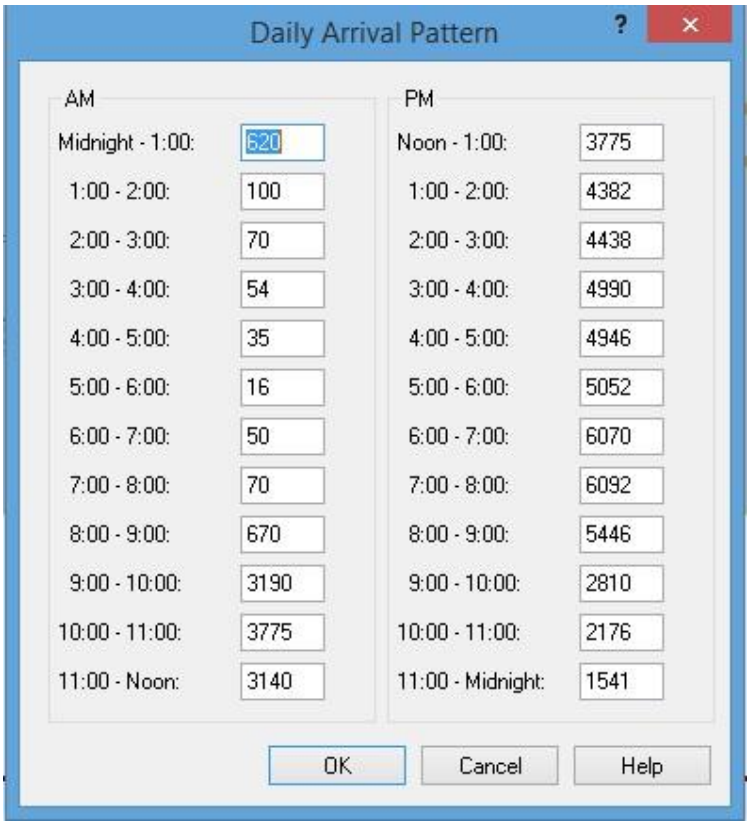
Time slot (in minutes) is set 60 as given in Figure 5.6.

Figure 5.6: Call pattern details



Customers' daily arrival pattern is taken from database records of a bank, for a random whole day as given in Figure 5.7.

Figure 5.7: Daily arrival pattern



Expected scenario to reach an IVR functionality in simulation is given below and shown in Figure 5.8 and Table 5.3.

a. Customer connects to IVR.
b. Customer enters his or her customer number in recognition process
c. Customer listens to IVR menu list and dials necessary menu numbers for the IVR function needed.
d. System checks if customer has a PIN for authorization, if so customer is requested to enter his PIN.
e. Customer reaches IVR process and satisfies his or her need and terminates the call.

In any unsuccessful process, customer is directed to customer representative agent.

Figure 5.8: Expected scenario to reach an IVR functionality

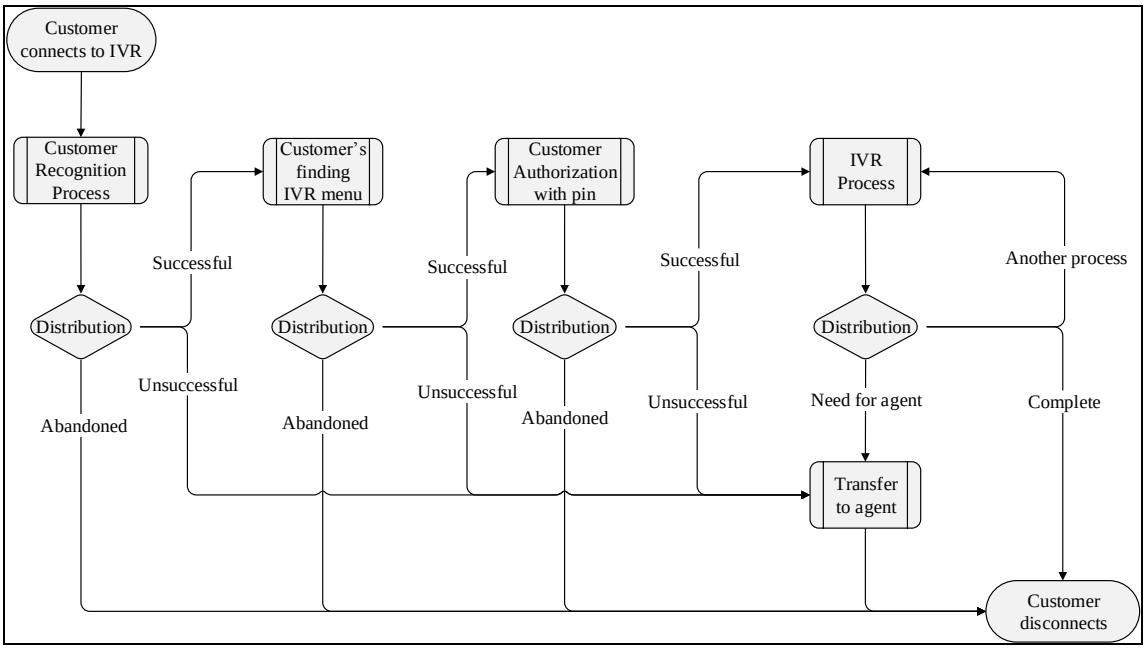


Table 5.3: IVR menu actions and inclusion in simulation

Menu Address	IVR Menu Name	Authorization	Type	Inclusion in Simulation
1.	Banking Transactions	Not required	Menu	
1.1.	Account Transactions	Not required	Menu	
1.1.1.	Account Balance Info	Required	IVR Functionality	Included
1.1.2.	Account Balance Receipt by Email	Required	IVR Functionality	Included
1.2.	Money Transfer	Required	Transfer to agent	Included
1.3.	Investment Info	Required	IVR Functionality	Included
1.4.	Bill Payment	Required	Transfer to agent	Included
2.	Credit Card Transactions	Not required	Menu	
2.1.	Credit Card Receipt Transactions	Not required	Menu	
2.1.1.	Credit Card Receipt Info and Payment	Required	IVR Functionality	Included
2.1.2.	Credit Card Receipt by Email	Required	IVR Functionality	Included
2.3.	Credit Card Limit Info	Required	IVR Functionality	Included
2.4.	Credit Card Campaign Info	Required	IVR Functionality	Included
3.	Password Transactions	Not required	Transfer to agent	Not included*
4.	Internet and Mobile Banking Support	Not required	Transfer to agent	Not included*
5.	Other banking services	Not required	Transfer to agent	Not included*

(*) These IVR menus don't require PIN and customers are directly transferred to agents. Because of these menus don't effect IVR performance, it is decided not to include these menus in simulation.

5.3 CUSTOMER RECOGNITION FLOW

Steps of customer recognition in simulation are given below and shown in Figure 5.9.

i. Customer calls IVR.

ii. Customer is transferred to Recognition Process.

iii. In Customer Recognition Process, customer is requested to enter his or her identification info. Entered numerical info is checked in database. Recognition process is successful with 0.9544 probability which is entered to simulation as given in Figure 5.10.

iv. a. If recognition is successful, *Customer Recognition Success Count* is assigned to customer. Success ratio of Customer Recognition Process will calculated by this assignment. Then *Customer's Finding IVR Menu* starts.

b. If recognition is unsuccessful, *Calls Diverted to Agent* is assigned to customer. Calls diverted to agent count will be calculated by this assignment. Then, call is transferred to agent.

Figure 5.9: Steps of customer recognition in simulation

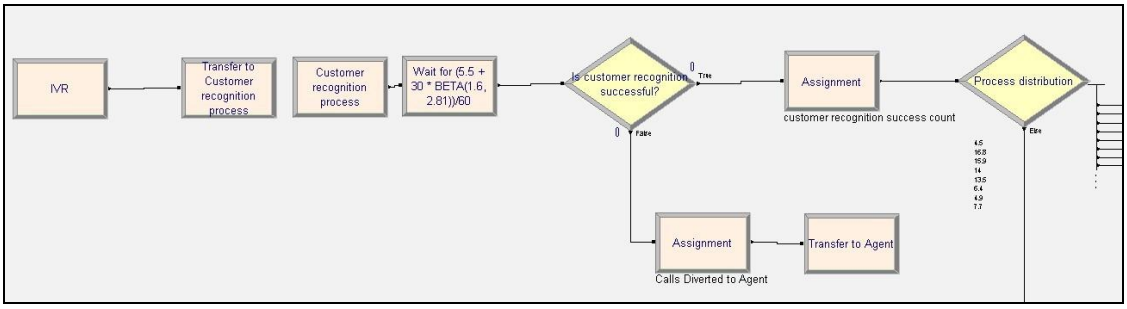


Figure 5.10: Decision box for success of recognition process

5.4 PROCESS DISTRIBUTION VALUES FOR EACH IVR MENU

Customers' process distribution ratios are daily menu entry ratios which are taken from database of a bank. Process distribution ratios are given in Table 5.4.

Table 5.4: Process distribution ratios

IVR MENU	RATIO
Enter to Account Balance Info Menu	6.4%
Enter to Account Balance Receipt by Email Menu	4.9%
Enter to Bill Payment Menu	7.7%
Enter to Credit Card Campaign Info Menu	13.5%
Enter to Credit Card Limit Info Menu	15.9%
Enter to Credit Card Receipt by Email Menu	14.0%
Enter to Credit Card Receipt Info and Payment Menu	16.8%
Enter to Investment Info Menu	4.5%
Enter to Money Transfer Menu	16.4%

5.5 CUSTOMER'S FINDING IVR MENU

Customers may have trouble to find IVR menu they are looking for due to complexity of IVR menus. In this section, flow of customer's finding IVR menus is analyzed in simulation. Steps of customer's finding IVR menu in simulation are given below and shown in Figure 5.11.

i. After successful customer recognition process, customers are distributed by IVR menu usage ratio,
ii. Customers are assigned with attribute of the IVR functionality he or she is looking for.
iii. Customers spend time for finding related IVR functionality. Each wait time of IVR functionalities are calculated by samples taken from database. Customer's Finding IVR Menu process is successful with 0.873 probability which is entered to simulation as given in Figure 5.12.
iv. a. If Customer's Finding IVR Menu process is successful,
    i. *Customer manually found IVR menu count* is assigned to customer. Success ratio of Customer's Finding IVR Menu will be calculated by this assignment.
    ii. Another distribution after finding IVR menu is run. Then customers are separated again regarding to the IVR functionality they are willing to reach.
    iii. Because of customer could find IVR functionality he or she is looking for, an assignment is made for related IVR functionality which is found by the customer. Success ratio of Customer's Finding IVR Menu for each

menu will be calculated by this assignment.

b. If Customer's Finding IVR Menu process is unsuccessful;

i. *Customer couldn't find IVR menu count* is assigned to customer. Customer count who couldn't find IVR menu will be calculated *by this assignment.*

ii. *Calls Diverted to Agent* is assigned to customer. Calls diverted to agent count will be calculated by this assignment.

iii. Call is transferred to agent.

Figure 5.11: Steps of customer finding IVR menu in simulation

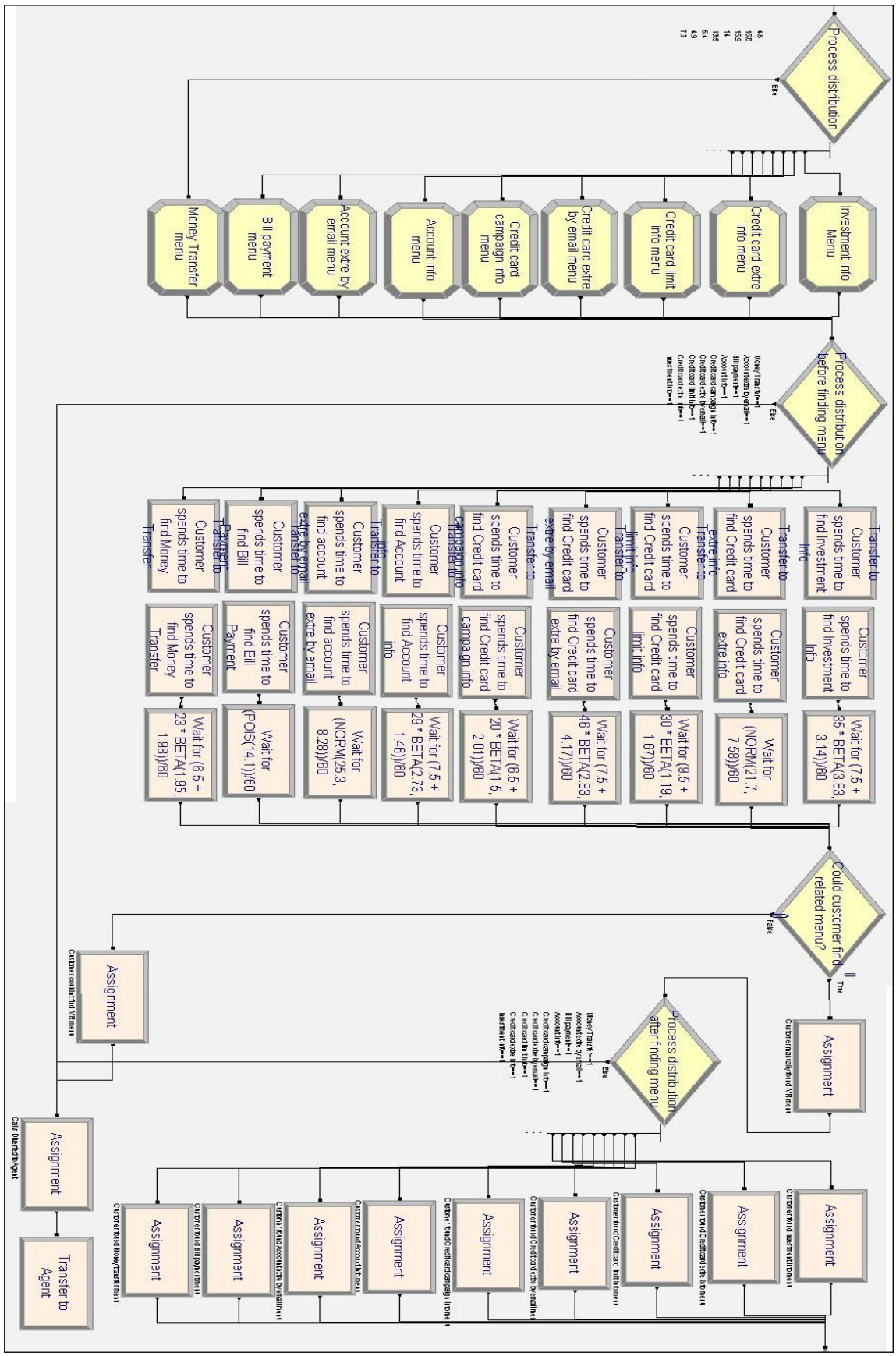
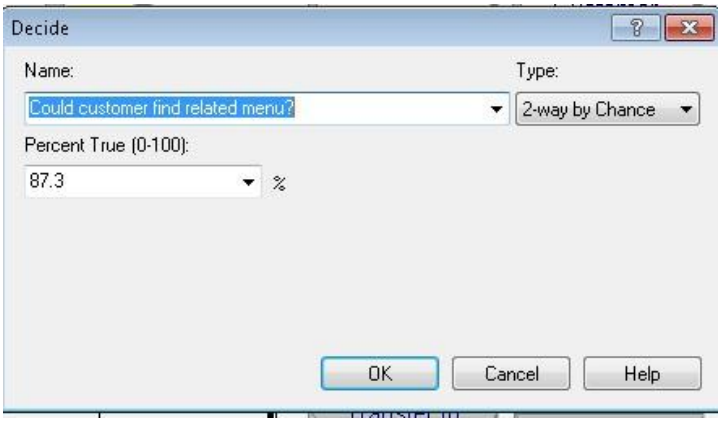


Figure 5.12: Decision box for success of customers' finding IVR menu



5.6 CUSTOMER AUTHORIZATION WITH PIN

After customer found IVR menu he or she is looking for, customer authorization is required due to security obligations. Steps of customer authorization with PIN in simulation are given below and shown in Figure 5.13.

i. After customer successfully finds IVR menu, system checks if customer has a valid PIN or not. Probability of customer's having a valid PIN is 0.6, which is entered to simulation as given in Figure 5.14.

ii. a. If customer has a valid PIN;

   i. *Customers who have PIN count* is assigned to customer. Customer count that has PIN will be calculated by this assignment.

   ii. Customer is requested to enter PIN. Probability of customer's entering PIN successfully is 0.75, which is entered to simulation as given in Figure 5.15.

   iii. a. If customer successfully enters PIN;

      i. PIN attribute is assigned to customer.

      ii. *Customers who entered PIN* successfully *count* is assigned to customer. Customer count who entered PIN successfully, will be calculated by this assignment.

   b. If customer doesn't enter PIN successfully; *Calls Diverted to Agent* is assigned to customer. Calls diverted to agent count will be calculated by this assignment. Then, call is transferred to agent.

b. If customer doesn't have a valid PIN; *Calls Diverted to Agent* is assigned to

customer. Calls diverted to agent count will be calculated by this assignment. Then, call is transferred to agent.

Figure 5.13: Steps of customer authorization with PIN in simulation

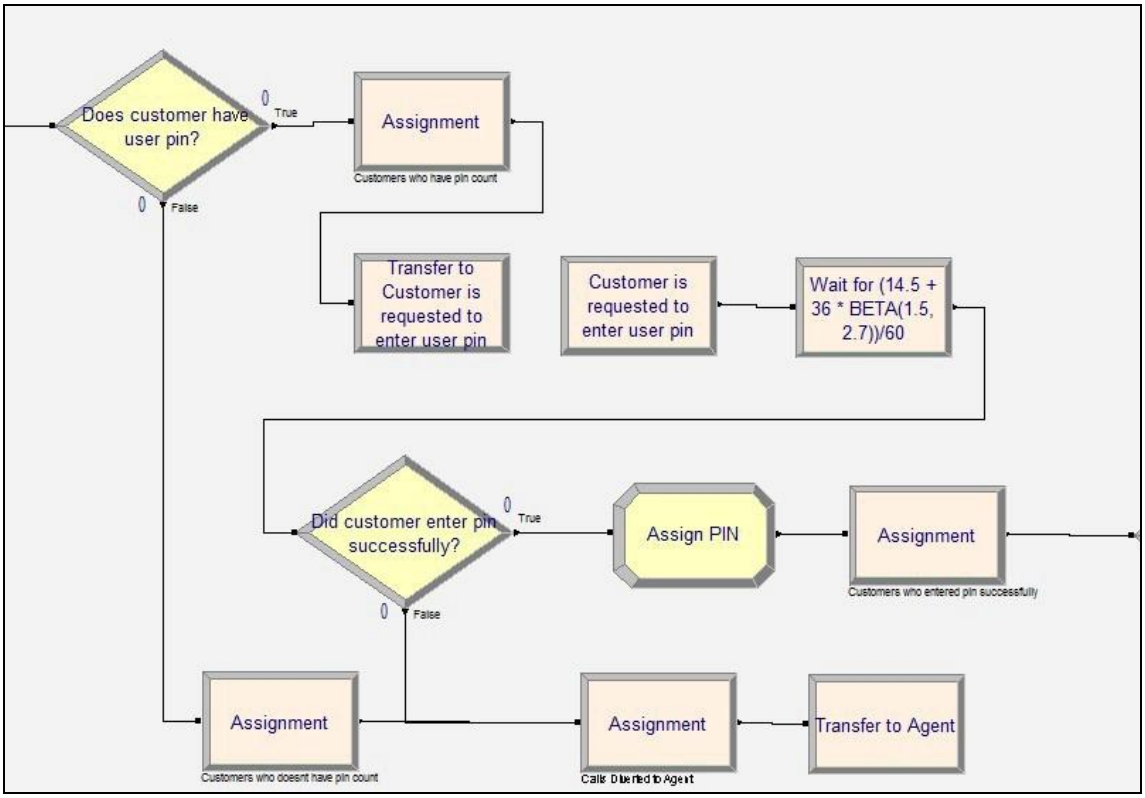


Figure 5.14: Decision box for customer's having a valid PIN

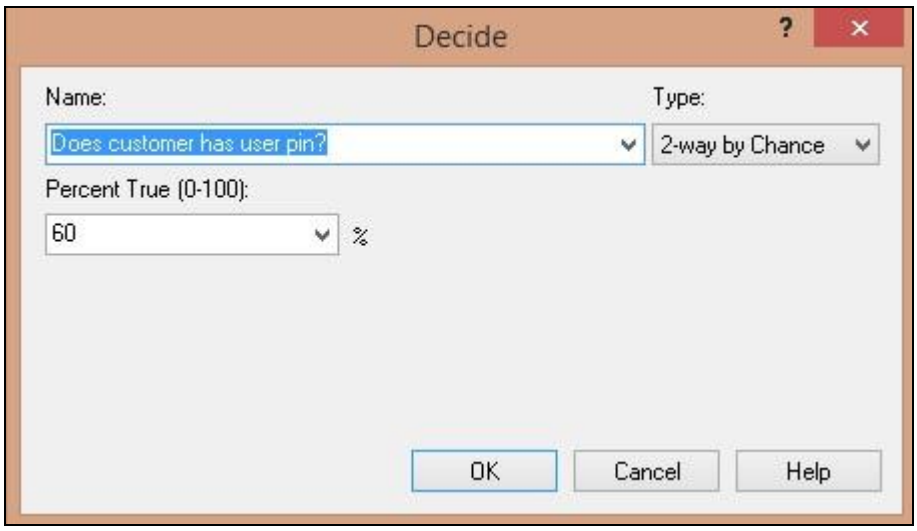
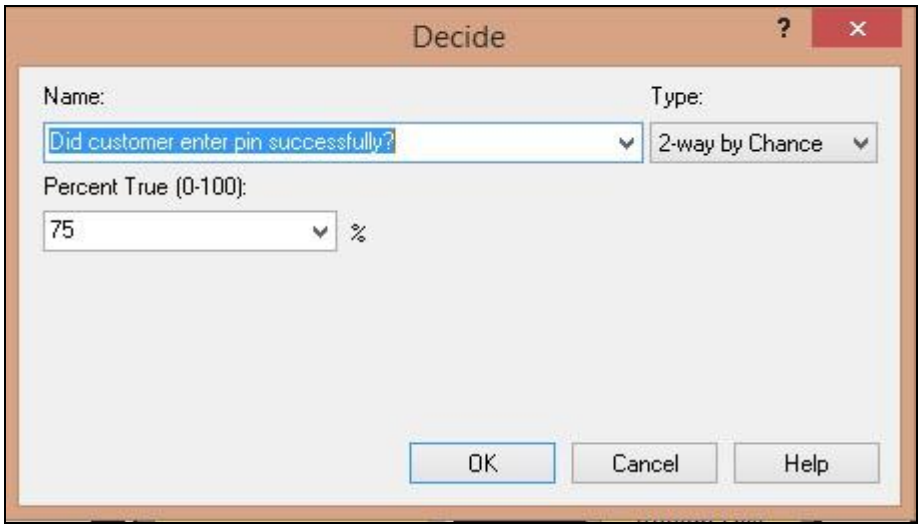


Figure 5.15: Decision box for probability of customer's entering PIN successfully



5.7 IVR PROCESSES

There are 12 end points in IVR.

7 end points are IVR functionalities which require PIN. These IVR menus are included in simulation as given in Table 5.5.

Table 5.5: 7 end points which are IVR functionality

IVR Functionalities which require PIN
Account Balance Info
Account Balance Receipt by Email
Investment Info
Credit Card Campaign Info
Credit Card Limit Info
Credit Card Receipt Info and Payment
Credit Card Receipt by Email

2 end points are IVR menus which are directed to agent which require PIN. These IVR menus are included in simulation as given in Table 5.6.

Table 5.6: 2 end points which are directed to agent

IVR Menus Directed to Agent which Require PIN
Bill Payment
Money Transfer

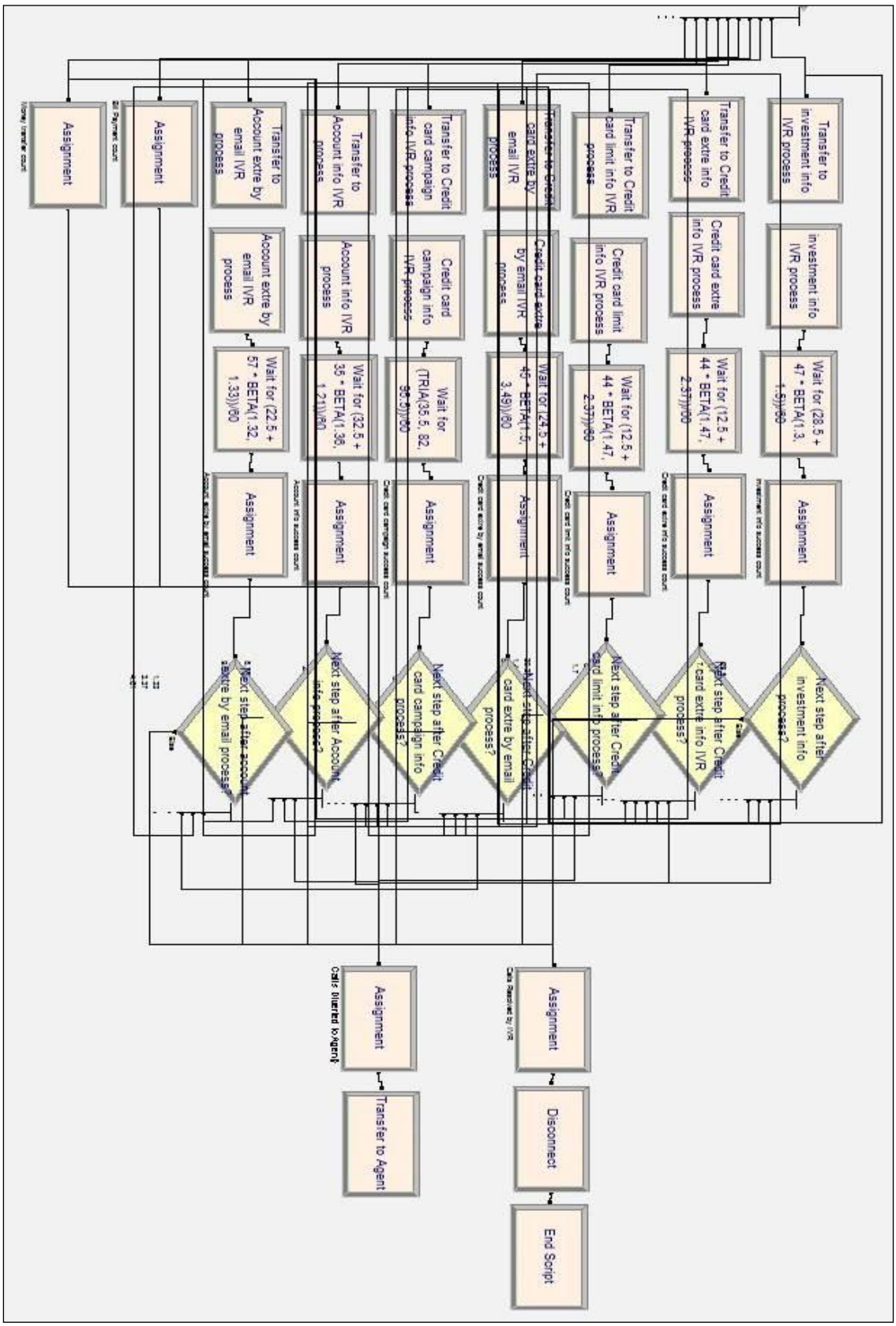
3 end points are IVR menus which are directed to agent which don't require PIN. These IVR menus are excluded in simulation to decrease complexity of the simulation and lack of improvement possibility as given in Table 5.7.

Table 5.7: 3 end points which are excluded in simulation

IVR Menus Directed to Agent which don't Require PIN
Internet and Mobile Banking Support
Other banking services
Password Transactions

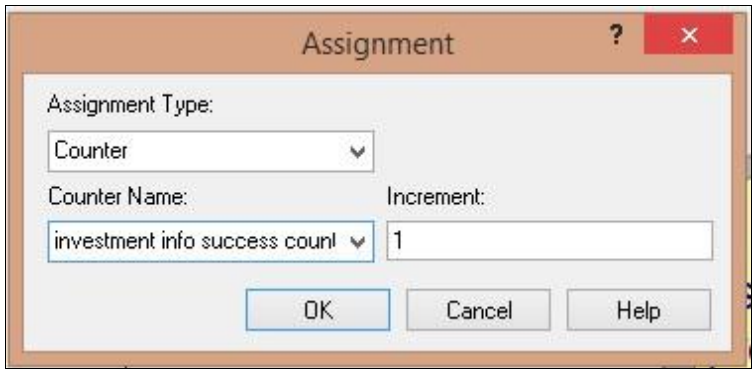
9 IVR menus are included in the simulation. Flow in simulation is given in Figure 5.16.

Figure 5.16: IVR menu flow in simulation



After each IVR process is run, counter of related functionality is assigned to customer. IVR functionality success counts will be calculated by these assignments. One of these assignments is given in Figure 5.17.

Figure 5.17: An example for counter of IVR functionality success in simulation



5.8 REQUESTS FOR ANOTHER IVR PROCESS OR TALKING TO AN AGENT AFTER AN IVR PROCESS

After customer completes an IVR process successfully, it is expected that he or she terminates the call. But some of the customers may need to do another operation or receive information via IVR. Also, they may still need an agent even they complete the process via IVR. Distributions of ratios are given in Table 5.8.

Table 5.8: Distribution of ratios for next step after an IVR functionality

IVR Functionality	Next Step	Distribution of Ratios for Next Step
Account Balance Info	Account Balance Info	2.13%
	Account Balance Receipt by Email	9.57%
	Termination	79.57%
	Transfer to Agent	8.73%
Account Balance Receipt by Email	Account Balance Info	3.37%
	Account Balance Receipt by Email	1.33%
	Termination	90.69%
	Transfer to Agent	4.61%
Credit Card Campaign Info	Credit Card Limit Info	8.43%
	Credit Card Receipt by Email	5.53%
	Credit Card Receipt Info and Payment	14%
	Termination	43.74%
	Transfer to Agent	28.3%
Credit Card Limit Info	Credit Card Limit Info	8.8%
	Money Transfer	1.4%
	Termination	59.43%
	Transfer to Agent	30.37%
Credit Card Receipt by Email	Credit Card Campaign Info	0.66%
	Credit Card Limit Info	0.9%
	Credit Card Receipt by Email	1.26%
	Termination	89.08%
	Transfer to Agent	8.1%
Credit Card Receipt Info and Payment	Credit Card Campaign Info	1.7%
	Credit Card Limit Info	1.88%
	Credit Card Receipt by Email	6.6%
	Credit Card Receipt Info and Payment	3.1%
	Termination	31.12%
	Transfer to Agent	55.6%
Investment Info	Account Balance Info	1.1%
	Investment Info	7.1%
	Termination	62.7%
	Transfer to Agent	29.1%

5.9 TRANSFER TO AGENT

Steps of *Transfer to Agent* flow in simulation is described below and entered to simulation as shown in Figure 5.18.

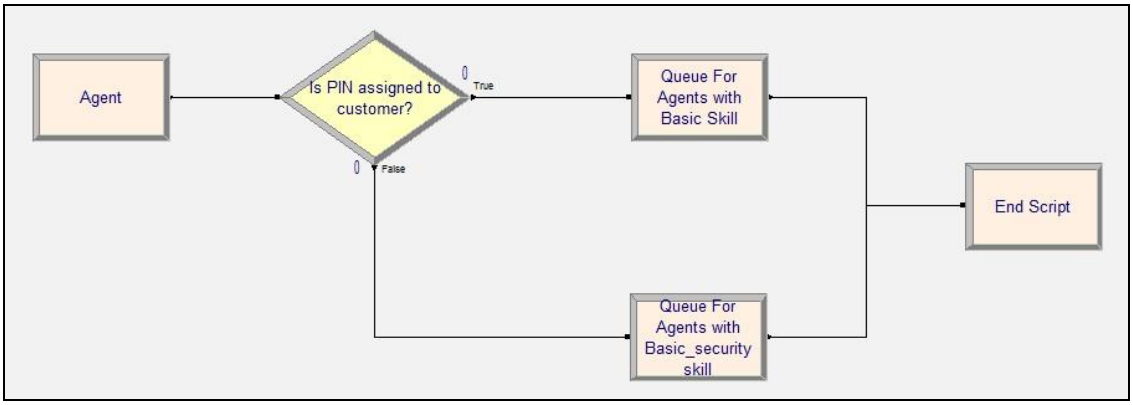
i. After Call is transferred to an agent, PIN assignment of the customer is controlled by the system.

ii. a. If PIN is assigned to customer, call is transferred to queue of agents with Basic skill.

b. If PIN is not assigned to customer, call is transferred to queue of agents with Basic+Security skill.

iii. Calls are distributed with First in first out method. When an agent is ready to take a call, customer who is waited most in the queue is transferred to that agent by the system.

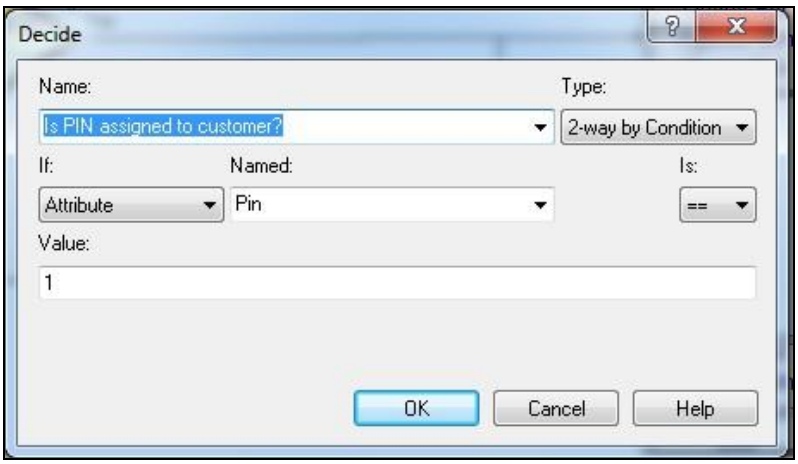
Figure 5.18: Transfer to agent flow in simulation



PIN assignment is controlled by a decision box. Configuration of decision box for PIN Assignment is entered to simulation as shown in Figure 5.19.

It is assumed that there is no After Call Work (ACW) required after a call ends before taking a new call.

Figure 5.19: Decision box for PIN assignment in simulation



5.9.1 Agent Configuration

Agents' shifts are planned as given in Table 5.9, depending on approximate daily call routine of customers.

Table 5.9: Agent shifts

Shift No	Shift Type	Beginning	Ending	Agents Scheduled	
				Basic Skill	Basic+Security Skill
1	Full Time	08:00	16:00	2	6
2	Full Time	09:00	17:00	20	60
3	Full Time	13:00	21:00	10	30
4	Full Time	17:00	01:00	10	30
5	Part Time	17:00	21:00	15	45
6	Full Time	01:00	09:00	2	4

In Rockwell Arena, agent counts for each period are expected to be entered for shifts. Due to this restriction, agent counts are entered to simulation for each time period that agent counts are fixed in that period. Schedule of agents with Basic Skill and Basic+Security Skill are entered to simulation as given respectively in Table 5.10 and Table 5.11.

Table 5.10: Schedule of agents with Basic Skill in simulation

	Agent State	Alter Capacity By	Agents Scheduled	Schedule Adherence Factor	Beginning AM or PM	Beginning Hour	Ending AM or PM	Ending Hour
1	On Duty	Number of Agents	10	1.0	Midnight	12	AM	1
2	On Duty	Number of Agents	2	1.0	AM	1	AM	8
3	On Duty	Number of Agents	4	1.0	AM	8	AM	9
4	On Duty	Number of Agents	22	1.0	AM	9	PM	1
5	On Duty	Number of Agents	32	1.0	PM	1	PM	4
6	On Duty	Number of Agents	30	1.0	PM	4	PM	5
7	On Duty	Number of Agents	35	1.0	PM	5	PM	9
8	On Duty	Number of Agents	10	1.0	PM	9	Midnight	12

Table 5.11: Schedule of agents with Basic+Security Skill in simulation

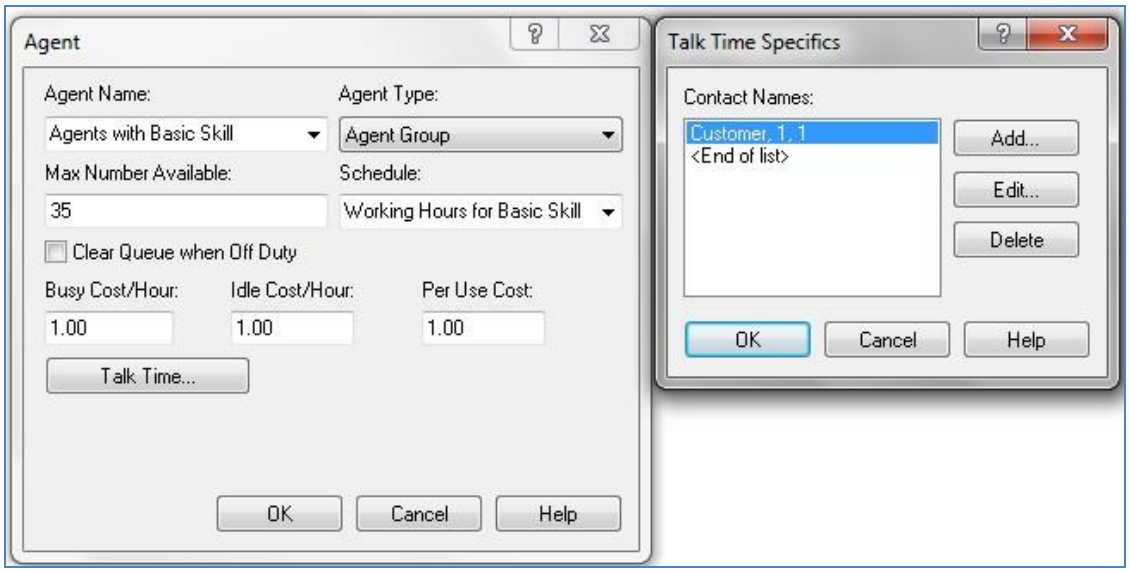
	Agent State	Alter Capacity By	Agents Scheduled	Schedule Adherence Factor	Beginning AM or PM	Beginning Hour	Ending AM or PM	Ending Hour
1	On Duty	Number of Agents	30	1.0	Midnight	12	AM	1
2	On Duty	Number of Agents	4	1.0	AM	1	AM	8
3	On Duty	Number of Agents	10	1.0	AM	8	AM	9
4	On Duty	Number of Agents	66	1.0	AM	9	PM	1
5	On Duty	Number of Agents	96	1.0	PM	1	PM	4
6	On Duty	Number of Agents	90	1.0	PM	4	PM	5
7	On Duty	Number of Agents	105	1.0	PM	5	PM	9
8	On Duty	Number of Agents	30	1.0	PM	9	Midnight	9

Daily talk time average values are compared for those 2 skills. Due to the database records, average call duration for an agent with Basic+Security Skill is 1.626 times of average call duration for an agent with Basic Skill. Talk time multiplier values are entered to simulation for Basic Skill and Basic+Security Skill respectively entered to simulation as shown in Figure 5.20 and Figure 5.21.

5.9.2 Basic Skilled Agents

Max number available value is the highest available agent count possible. Between 17:00 and 21:00, count of agents on schedule entered as 35, which is the highest agent with Basic Skill count in a time interval. Configuration entered to simulation is given in Figure 5.20.

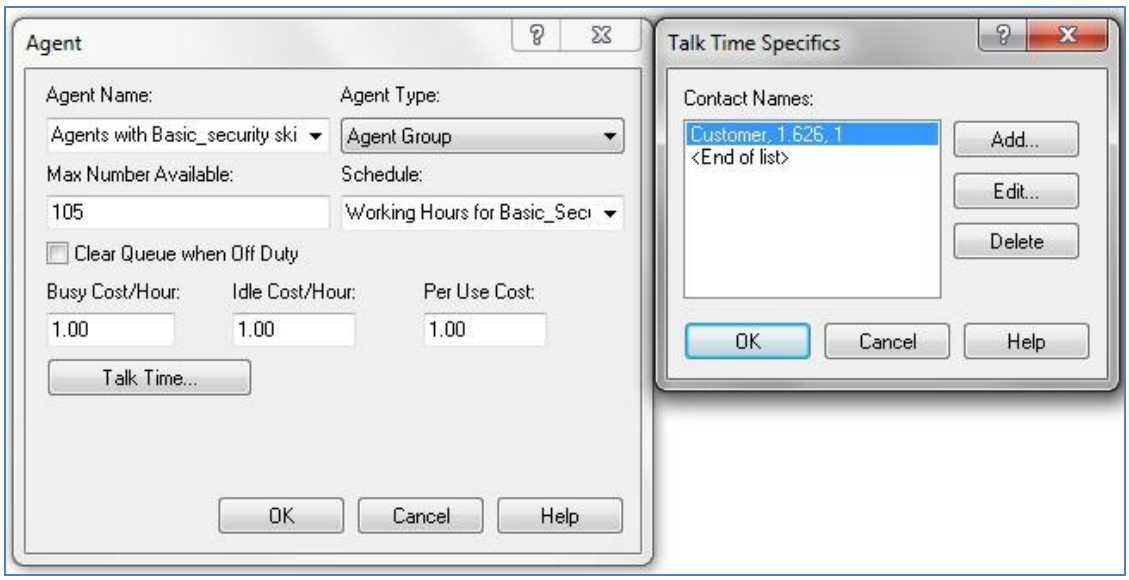
Figure 5.20: Basic skilled agent configuration in simulation



5.9.3 Basic+Security Skilled Agents

Between 17:00 and 21:00, count of agents on schedule entered as 105, which is the highest agent with Basic+Security skill count in a time interval. Configuration entered to simulation is given in Figure 5.21.

Figure 5.21: Basic+Security skilled agent configuration in simulation



6. SIMULATION MODEL FOR CALL CENTER WORKFLOW WITH PROPOSED APPLICATIONS

Four proposed simulation models are built to analyze effect of proposed applications to the performance. These simulation models are;

a. Model with Recognize Caller by ANI

b. Model with Call Steering

c. Model with Voice Verification

d. Model with Recognize Caller by ANI, Call Steering and Voice Verification

In first section of this chapter, values of times and probabilities for proposed applications are given. In sections 6.2, 6.3 and 6.4, Recognize Caller by ANI, Call Steering and Voice Verification (which are proposed applications) flows in simulations are given respectively. In section 6.5, values of times and probabilities for pessimistic scenario of proposed applications are given.

6.1 TIME AND PROBABILITY VALUES

Due to these applications are not ever used to service customers in the bank inspected, probability values and time durations couldn't be exported from any Database records. Average values are obtained from third party Vendors who previously supplied these applications to other banks.

Obtained probability ratio values are given in Table 6.1.

Table 6.1: Probability values for proposed applications

Functionality Name	Probability Ratio Name	Value
Recognize Caller by ANI	Average Success Probability for Matching ANI with Customer Contact	0.523
Recognize Caller by ANI	Average Process Success Probability of Recognize Caller by ANI	0.804
Call Steering	Average Process Success Probability of Call Steering	0.9211
Voice Verification	Average Success Probability for Matching User with Voice Verification Signture	0.359
Voice Verification	Average Success Probability for Users to Accept the Offer for Authorizing Themselves with Voice Verification Signture	0.8016
Voice Verification	Average Success Probability for Users to Accept Authorizing Themselves with Voice Verification Signture	0.8496

Obtained average duration values are given in Table 6.2.

Table 6.2: Duration values for proposed applications

Functionality Name	Time Name	Value (sec)
Recognize Caller by ANI	Average Duration for Recognize Caller by ANI Process	7
Call Steering	Average Duration of Call Steering Process	15
Voice Verification	Average Duration for Voice Verification Offer	8
Voice Verification	Average Duration for Voice Verification Process	10

6.2 RECOGNIZE CALLER BY ANI FLOW

Steps of *Recognize Caller by ANI Flow* in simulation are described below and entered to simulation as shown in Figure 6.1.

i. Before Customer Recognition Flow, customer's ANI is checked in database. Matching to a customer's contact number is successful with

0.523 probability. Decision box is entered to simulation as shown in Figure 6.2.

ii. a. If ANI matches with one of customer's phone numbers;

i. *Recognize Caller by ANI User Count* is assigned to customer. Success count of Recognize Caller by ANI user matching will calculated by this assignment.

ii. *Customer* is transferred to Recognize Caller by ANI Process. Success probability of the process is 0.804. Decision box is entered to simulation as shown in Figure 6.3.

iii. a. If Recognize Caller by ANI Process is successful;

i. *Recognize Caller by ANI Success Count* is assigned to customer. Success count of Recognize Caller by ANI process will calculated by this assignment.

ii. Call is transferred to *Customer's Finding Menu Process* or *Call Steering Process* (if available).

b. If ANI doesn't match with one of customer's phone numbers;

i. *Recognize Caller by ANI not User Count* is assigned to customer. Count of customers who's ANI wasn't found in database will be calculated by this assignment.

ii. Call is transferred to *Customer Recognition Process.*

Figure 6.1: Recognize Caller by ANI flow in simulation

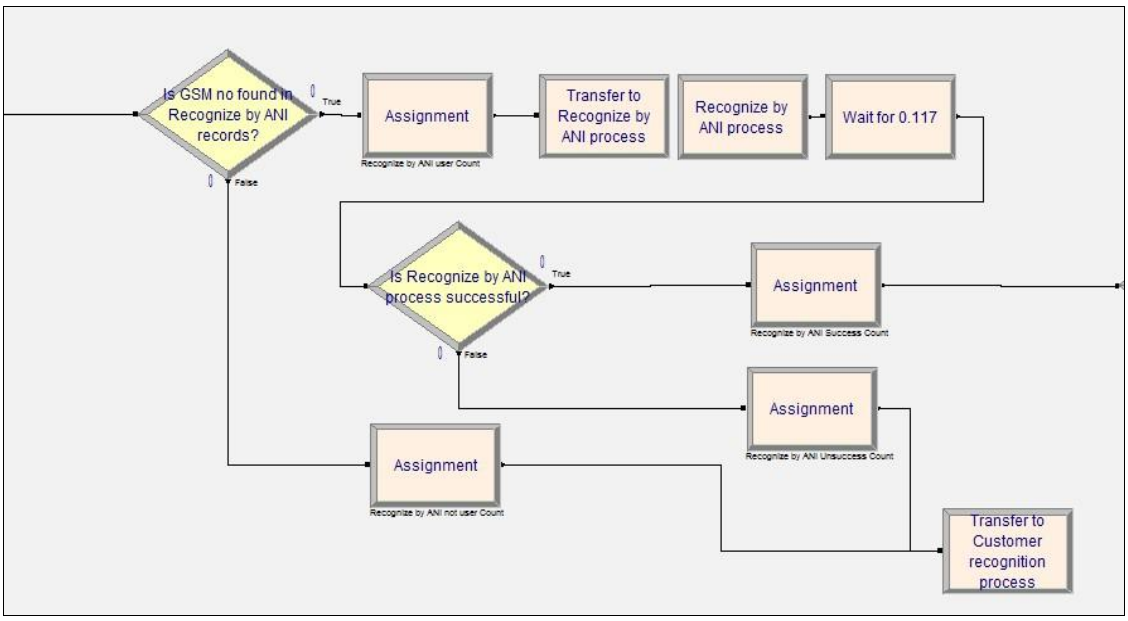


Figure 6.2: Decision box for finding GSM number by Recognize Caller by ANI flow

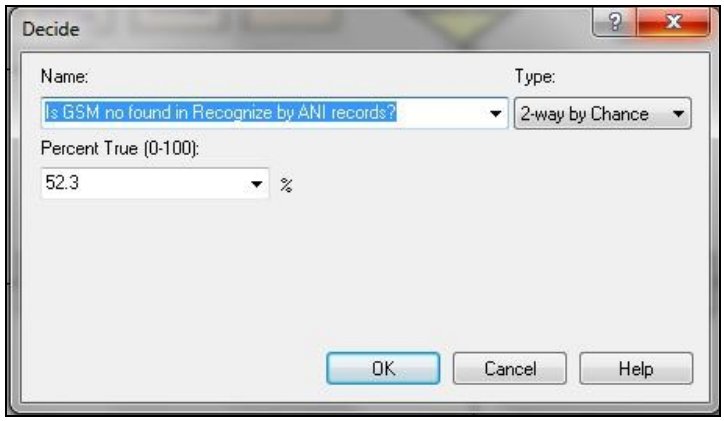
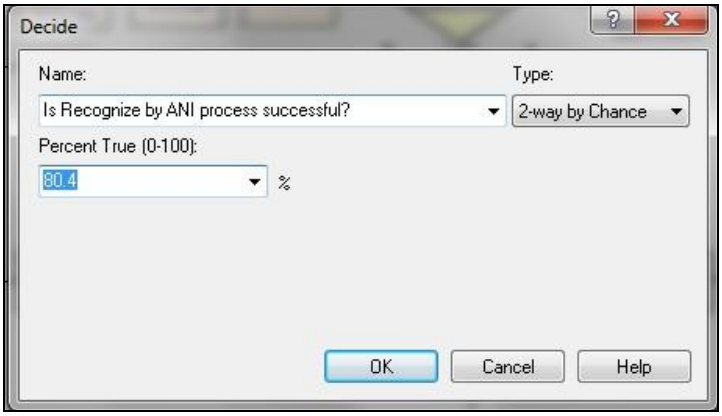


Figure 6.3: Decision box for Recognize Caller by ANI flow in simulation



6.3 CALL STEERING FLOW

Steps of *Call Steering Flow* in simulation are described below and shown in Figure 6.4.

i. Recognized customer is transferred to *Call Steering Process*. Probability of Call Steering process success is 0.9211 probability. Decision box is entered to simulation as shown in Figure 6.5.

ii. a. If Call Steering process is successful;

   i. *Call Steering Success Count* is assigned to customer. Success count of Call Steering process will calculated by this assignment.

   ii. Call is transferred to *Customer Authorization Flow* or *Voice Verification* (if available).

   b. If Call Steering process is unsuccessful;

   i. *Call Steering Unsuccess Count* is assigned to customer. Unsuccess count of Call Steering process will be calculated by this assignment.

   ii. Call is transferred to *Customer's Finding Menu Flow*.

Figure 6.4: Call Steering flow in simulation

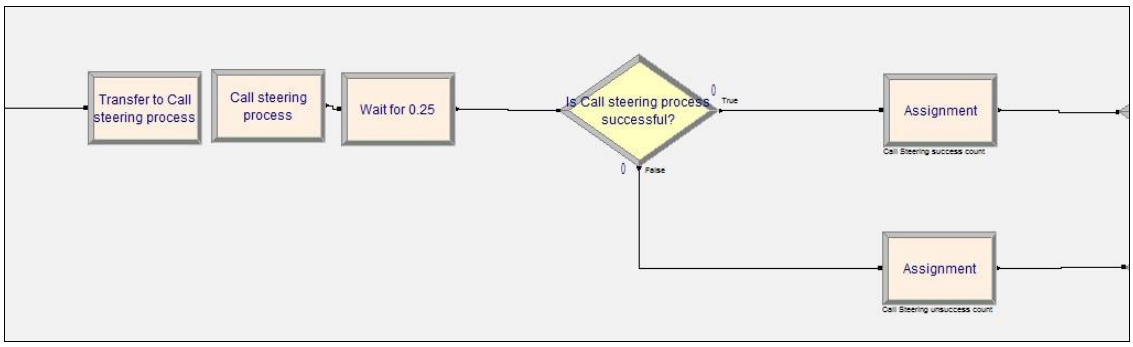
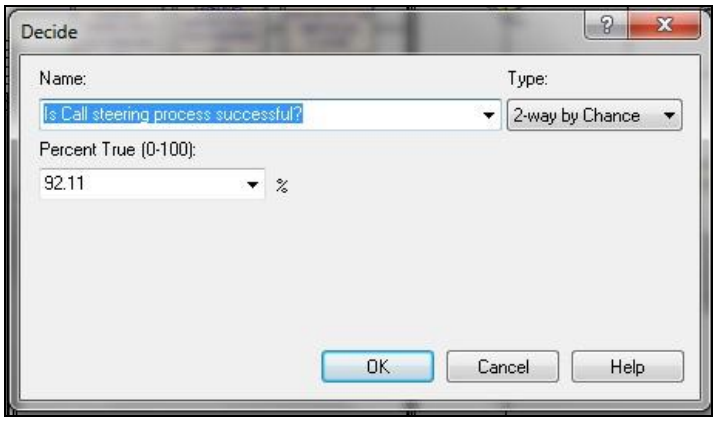


Figure 6.5: Decision box for success probability of Call Steering flow



6.4 VOICE VERIFICATION FLOW

Steps of *Voice Verification Flow* in simulation are described below and entered to simulation as shown in Figure 6.6 and Figure 6.7.

i. Before Authorization Process, it is checked if customer has a Voice Verification Signature. Success probability is 0.359. Decision box is entered to simulation as shown in Figure 6.8.

ii. a. If customer has a Voice Verification Signature;

   i. *Voice Verification User Count* is assigned to customer. Success count of Voice Verification user matching will calculated by this assignment.

ii. Customer is transferred to Voice Verification Offer Process. Success probability of the offer is 0.8016. Decision box is entered to simulation as shown in Figure 6.9.

iii. a. If customer accepts the offer to authorize himself or herself with Voice Verification;

i. Customer is transferred to Voice Verification process. Success probability of the offer is 0.8496. Decision box is entered to simulation as shown in Figure 6.10.

ii. a. If voice verification is successful;

i. *VV Signature* attachment is assigned to customer.

ii. *Voice Verification Success Count* is assigned to customer. Success count of Voice Verification will calculated by this assignment.

iii. Customer is transferred to IVR functionality regarding he or she is willing to reach.

b. If voice verification isn't successful;

i. *Voice Verification Unsuccess Count* is assigned to customer. Count of customers who failed to authorize themselves by Voice Verification will be calculated by this assignment.

ii. Call is transferred to *Customer Authorization with PIN Process*.

b. If customer denies the offer to authorize himself or herself with Voice Verification;

i. *Customers who deny to sign VV Count* is assigned to customer. Count of customers who denied authorizing themselves by Voice Verification will be calculated by this assignment.

ii. *Call* is transferred to *Customer Authorization with PIN Flow*.

b. If customer doesn't have a Voice Verification Signature;

i. *Voice Verification not User Count* is assigned to customer. Count of customers who don't have a Voice Verification Signature will be calculated by this assignment.

ii. *Call* is transferred to *Customer Authorization with PIN Flow*.

iii. If call is transferred to agent, PIN assignment is checked. If PIN is not assigned to customer then Voice Verification signature assignment is checked. Decision box is entered to simulation as shown in Figure 6.11.

a. If PIN or Voice Verification is assigned to customer, call is transferred to agents with Basic Skill.

b. If PIN or Voice Verification is not assigned to customer, call is transferred to agents with Basic+Security Skill.

Figure 6.6: Voice Verification flow in simulation in IVR

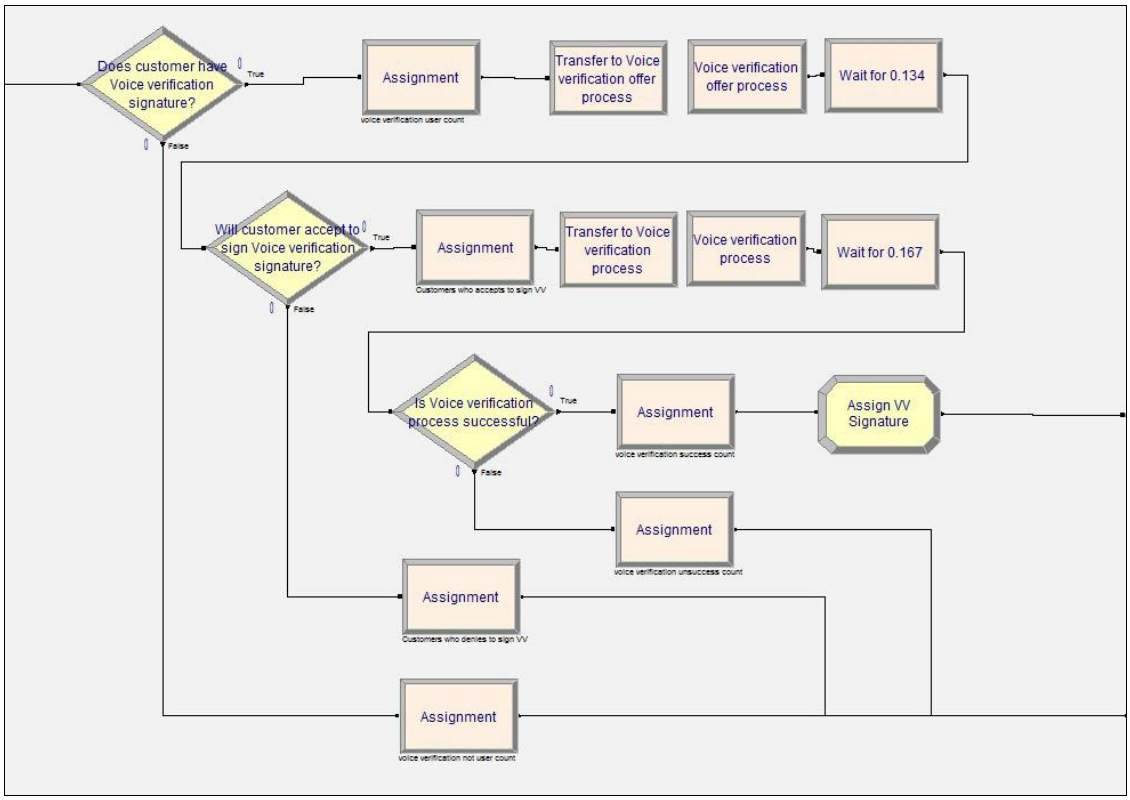


Figure 6.7: Voice Verification flow in simulation after call is diverted to agent

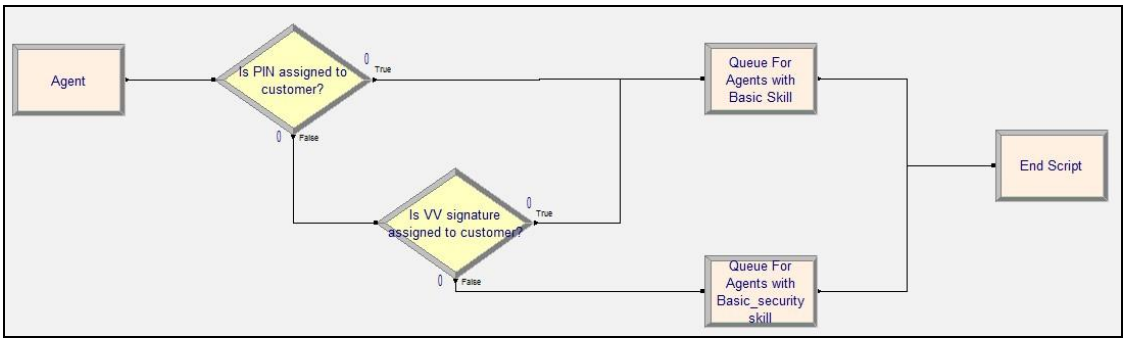


Figure 6.8: Decision box for having Voice Verification Signature

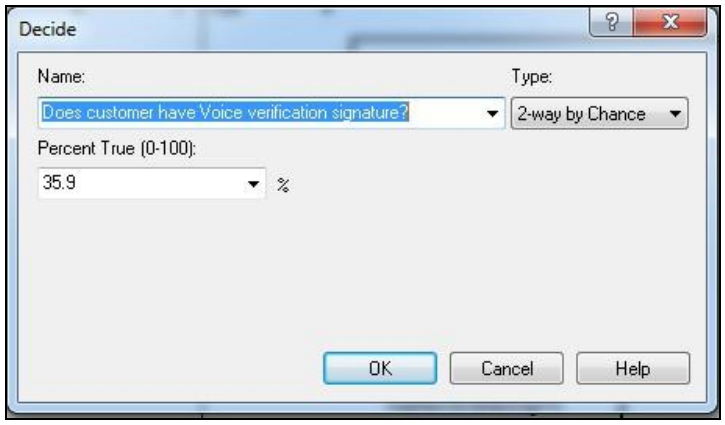


Figure 6.9: Decision box for accepting to sign Voice Verification Signature

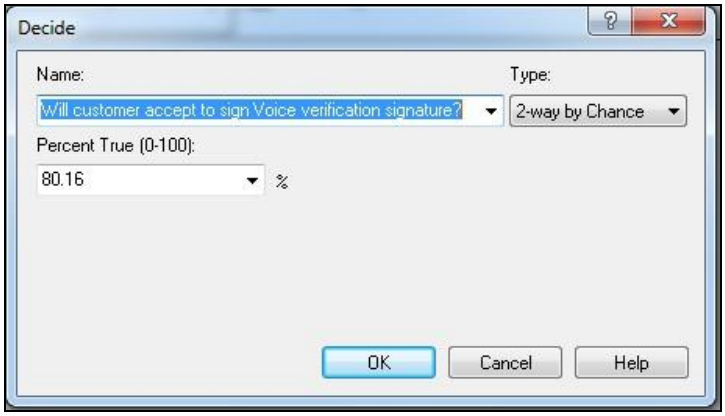


Figure 6.10: Decision box for success ratio of Voice Verification process

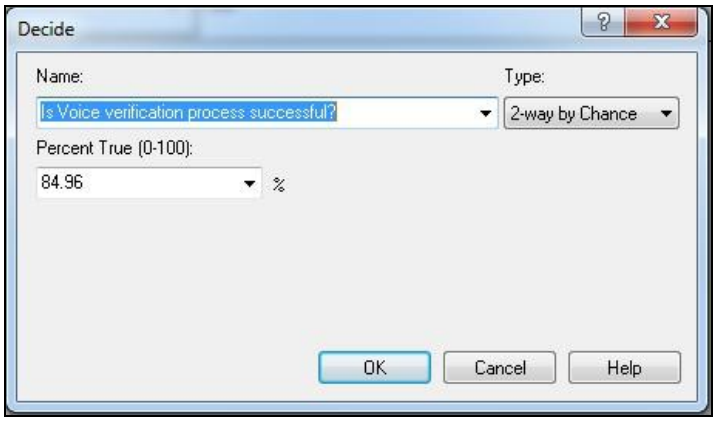


Figure 6.11: Decision box for Voice Verification Signature assignment

6.5 TIME AND PROBABILITY VALUES FOR PESSIMISTIC SCENARIO

Due to time and probability values are taken from third party Vendors, running the simulations for proposed applications with a ten percentage pessimistic time and probability values will be a healthy decision. Then results of simulations with pessimistic values also should be compared with simulation with current flow. Average values with a ten percentage pessimistic perspective are calculated over the values supplied by third party Vendors.

Average probability ratio values with a ten percentage pessimistic perspective are given in Table 6.3.

Table 6.3: Pessimistic probability values for proposed applications

Functionality Name	Probability Ratio Name	Value
Recognize Caller by ANI	Average Success Probability for Matching ANI with Customer Contact	0.4707
Recognize Caller by ANI	Average Process Success Probability of Recognize Caller by ANI	0.7236
Call Steering	Average Process Success Probability of Call Steering	0.8290
Voice Verification	Average Success Probability for Matching User with Voice Verification Signture	0.3231
Voice Verification	Average Success Probability for Users to Accept the Offer for Authorizing Themselves with Voice Verification Signture	0.7214
Voice Verification	Average Success Probability for Users to Accept Authorizing Themselves with Voice Verification Signture	0.7646

Average duration values with a ten percentage pessimistic perspective are given in Table 6.4.

Table 6.4: Pessimistic duration values for proposed applications

Functionality Name	Time Name	Value (sec)
Recognize Caller by ANI	Average Duration for Recognize Caller by ANI Process	7.7
Call Steering	Average Duration of Call Steering Process	16.5
Voice Verification	Average Duration for Voice Verification Offer	8.8
Voice Verification	Average Duration for Voice Verification Process	11

7. RESULTS AND DISCUSSION

Five simulation models were constructed and run to be able to make comparisons with current call center model to proposed call center model alternatives. Result values were exported from Arena Simulation Software. All results are average values of 10 replications. Results are categorized for;

a. Model of current call center,
b. Model with Recognize Caller by ANI,
c. Model with Call Steering,
d. Model with Voice Verification,
e. Model with Recognize Caller by ANI, Call Steering and Voice Verification

Performance metrics inspected in sections of this chapter are; average agent counts, agent utilization, customer counts in terms of ending point of calls, average durations of a call, average IVR port counts, customer counts in terms of finding IVR menus, customer counts in terms of successful IVR processes, customer recognition success counts and customer authorization success counts. Definitions of these performance metrics can be found in Table 3.4.

Results of each simulation model for the performance metrics given above are presented in Sections 7.1-7.5 and they are compared in Section 7.6 for each performance criterion. Sensitivity analysis of each model is also analyzed by creating a pessimistic scenario which is run with the time and probability values given in Section 6.5. Results of comparisons of models with the pessimistic scenario are presented in Section 7.7 for each performance criterion.

7.1 RESULTS FOR CURRENT CALL CENTER MODEL

Average agent counts for available and busy status are given in Table 7.1.

Table 7.1: Average agent counts for available and busy status for current call center model

Average Agent Count	Agent Group	
	Agents with Basic Skill	Agents with Basic+Security Skill
Available Status	6.98	1.50
Busy Status	10.19	49.38

Percentage values for agent utilization are given in Table 7.2.

Table 7.2: Percentage values for agent utilization for current call center model

Agent Group	Agent Utilization
Agents with Basic Skill	59.35%
Agents with Basic+Security Skill	97.05%

Customer counts in terms of ending point of calls are given in Table 7.3.

Table 7.3: Customer counts in terms of ending point of calls for current call center model

Termination of Customer	Customer Count	Percentage
Abandoned	7,024.9	11%
Disconnected in IVR	12,259.3	19%
Handled by Agent	44,208.7	70%
Total	**63,492.9**	**100%**

Average durations of a call are given in Table 7.4.

Table 7.4: Average durations of a call for current call center model

Average Durations	Time (minute)	Percentage
Handle Time of Agent	1.94	53%
Speed of Answer	0.97	27%
Time Spent in IVR	0.73	20%
Total Time in Contact Center	**3.64**	**100%**

Average IVR port counts for available and busy status are given in the Table 7.5.

Table 7.5: Average IVR port counts for available and busy status for current call center model

Utilization of IVR and Agent Ports	Average	Percentage
Ports Available	260.92	65%
Ports Busy	139.08	35%
Ports Blocked	-	0%
Total	**400**	**100%**

Customer counts in terms of finding IVR menus are given in Table 7.6.

Table 7.6: Customer counts in terms of finding IVR menus for current call center model

Finding IVR Menu Counts	Counts	Percentage
Customer found Account Balance Receipt by Email menu	2,595.3	4.28%
Customer found Account Balance Info menu	3,404.1	5.62%
Customer found Bill Payment menu	4,065.5	6.71%
Customer found Credit Card Campaign Info menu	7,172.6	11.83%
Customer found Credit Card Receipt by Email menu	7,396.7	12.20%
Customer found Credit Card Receipt Info menu	8,924.1	14.72%
Customer found Credit Card Limit Info menu	8,388.5	13.84%
Customer found Investment Info menu	2,369.6	3.91%
Customer found Money Transfer menu	8,572.5	14.14%
Customer couldn't find IVR menu	7,727.0	12.75%
Total	**60,615.9**	**100%**

Customer counts in terms of successful IVR processes and transfers to agents for *Bill Payment* and *Money Transfer* transactions are given in Table 7.7.

Table 7.7: Customer counts in terms of successful IVR processes for current call center model

Successful Process Counts	Counts	Percentage
Account Balance Receipt by Email	1,340.1	5.12%
Account Balance Info	1,611.3	6.15%
Bill Payment	1,838.2	7.02%
Credit Card Campaign Info	3,322.8	12.69%
Credit Card Receipt by Email	3,850.6	14.71%
Credit Card Receipt Info	4,607.1	17.60%
Credit Card Limit Info	4,563.6	17.43%
Investment Info	1,135.4	4.34%
Money Transfer	3,913.1	14.95%

Total	**26,182.2**	**100%**

Customer Recognition success count is 60515.8.

Customer Authorization success count is 23740.1.

7.2 RESULTS FOR MODEL WITH RECOGNIZE CALLER BY ANI

Average agent counts for available and busy status are given in Table 7.8.

Table 7.8: Average agent counts for available and busy status for model with Recognize Caller by ANI

Average Agent Count	Agent Group	
	Agents with Basic Skill	**Agents with Basic+Security Skill**
Available Status	6.68	1.55
Busy Status	10.49	49.33

Percentage values for agent utilization are given in Table 7.9.

Table 7.9: Percentage values for agent utilization for model with Recognize Caller by ANI

Agent Group	Agent Utilization
Agents with Basic Skill	61.08%
Agents with Basic+Security Skill	96.95%

Customer counts in terms of ending point of calls are given in Table 7.10.

Table 7.10: Customer counts in terms of ending points of calls for model with Recognize Caller by ANI

Termination of Customer	Customer Count	Percentage
Abandoned	6,446.0	10%
Disconnected in IVR	12,534.3	20%
Handled by Agent	44,495.8	70%
Total	**63,476.1**	**100%**

Average durations of a call are given in Table 7.11.

Table 7.11: Average durations of a call for model with Recognize Caller by ANI

Average Durations	Time (minute)	Percentage
Handle Time of Agent	1.94	54%
Speed of Answer	0.95	26%
Time Spent in IVR	0.69	19%
Total Time in Contact Center	**3.58**	**100%**

Average IVR port counts for available and busy status are given in Table 7.12.

Table 7.12: Average IVR port counts for available and busy status for model with Recognize Caller by ANI

Utilization of IVR and Agent Ports	Average	Percentage
Ports Available	263.30	66%
Ports Busy	136.70	34%
Ports Blocked	-	0%
Total	**400**	**100%**

Customer counts in terms of finding IVR menus are given in the Table 7.13.

Table 7.13: Customer counts in terms of finding IVR menus for model with Recognize Caller by ANI

Finding IVR Menu Counts	Counts	Percentage
Customer found Account Balance Receipt by Email menu	2,621.1	4.24%
Customer found Account Balance Info menu	3,481.5	5.63%
Customer found Bill Payment menu	4,165.5	6.74%
Customer found Credit Card Campaign Info menu	7,304.1	11.82%
Customer found Credit Card Receipt by Email menu	7,541.8	12.20%
Customer found Credit Card Receipt Info menu	9,087.5	14.71%
Customer found Credit Card Limit Info menu	8,557.3	13.85%
Customer found Investment Info menu	2,428.5	3.93%
Customer found Money Transfer menu	8,762.0	14.18%
Customer couldn't find IVR menu	7,844.9	12.70%
Total	**61,794.2**	**100%**

Customer counts in terms of successful IVR processes and transfers to agents for *Bill Payment* and *Money Transfer* transactions are given in Table 7.14.

Table 7.14: Customer counts in terms of successful IVR processes for model with Recognize Caller by ANI

Successful Process Counts	Counts	Percentage
Account Balance Receipt by Email	1,346.1	5.01%
Account Balance Info	1,659.2	6.18%
Bill Payment	1,865.4	6.94%
Credit Card Campaign Info	3,432.1	12.78%
Credit Card Receipt by Email	3,946.5	14.69%
Credit Card Receipt Info	4,717.2	17.56%
Credit Card Limit Info	4,693.5	17.47%
Investment Info	1,178.0	4.39%
Money Transfer	4,024.1	14.98%
Total	**26,862.1**	**100%**

Customer counts in terms of successful Customer Recognition processes are given in Table 7.15.

Table 7.15: Customer counts in terms of successful Customer Recognition processes for model with Recognize Caller by ANI

Successful Customer Recognition Counts	Customer Count	Percentage
Recognize by ANI	26,672	43%
Manual Customer Recognition	35,123.2	57%
Total	**61,794.9**	**100%**

Customer Authorization success count is 24316.0.

7.3 RESULTS FOR MODEL WITH CALL STEERING

Average agent counts for available and busy status are given in Table 7.16.

Table 7.16: Average agent counts for available and busy status for model with Call Steering

Average Agent Count	Agent Group	
	Agents with Basic Skill	Agents with Basic+Security Skill
Available Status	5.59	2.22
Busy Status	11.59	48.66

Percentage values for agent utilization are given in Table 7.17.

Table 7.17: Percentage values for agent utilization for model with Call Steering

Agent Group	Agent Utilization
Agents with Basic Skill	67.47%
Agents with Basic+Security Skill	95.63%

Customer counts in terms of ending point of calls are given in Table 7.18.

Table 7.18: Customer counts in terms of ending points of calls for model with Call Steering

Termination of Customer	Customer Count	Percentage
Abandoned	4,315.0	7%
Disconnected in IVR	13,926.8	22%
Handled by Agent	45,210.4	71%
Total	**63,452.2**	**100%**

Average durations of a call are given in Table 7.19.

Table 7.19: Average durations of a call for model with Call Steering

Average Durations	Time (minute)	Percentage
Handle Time of Agent	1.92	58%
Speed of Answer	0.69	21%
Time Spent in IVR	0.71	21%
Total Time in Contact Center	**3.33**	**100%**

Average IVR port counts for available and busy status are given in Table 7.20.

Table 7.20: Average IVR port counts for available and busy status for model with Call Steering

Utilization of IVR and Agent Ports	Average	Percentage
Ports Available	271.32	68%
Ports Busy	128.68	32%
Ports Blocked	-	0%
Total	**400**	**100%**

Customer counts in terms of finding IVR menus are given in Table 7.21.

Table 7.21: Customer counts in terms of finding IVR menus for model with Call Steering

Finding IVR Menu Counts	Counts	Percentage
Customer found Account Balance Receipt by Email menu	2,948.3	4.87%
Customer found Account Balance Info menu	3,856.7	6.37%
Customer found Bill Payment menu	4,585.8	7.57%
Customer found Credit Card Campaign Info menu	8,066.9	13.32%
Customer found Credit Card Receipt by Email menu	8,340.3	13.77%
Customer found Credit Card Receipt Info menu	10,137.4	16.74%
Customer found Credit Card Limit Info menu	9,552.4	15.77%
Customer found Investment Info menu	2,694.3	4.45%
Customer found Money Transfer menu	9,771.4	16.13%
Customer couldn't find IVR menu	614.6	1.01%
Total	**60,568.1**	**100%**

Customer counts in terms of successful IVR processes and transfers to agents for *Bill Payment* and *Money Transfer* transactions are given in Table 7.22.

Table 7.22: Customer counts in terms of successful IVR processes for model with Call Steering

Successful Process Counts	Counts	Percentage
Account Balance Receipt by Email	1,531.3	5.14%
Account Balance Info	1,827.7	6.14%
Bill Payment	2,059.4	6.92%
Credit Card Campaign Info	3,735.6	12.55%
Credit Card Receipt by Email	4,387.2	14.74%
Credit Card Receipt Info	5,247.2	17.62%
Credit Card Limit Info	5,220.7	17.54%
Investment Info	1,306.3	4.39%
Money Transfer	4,456.3	14.97%
Total	**29,771.7**	**100%**

Customer Recognition success count is 60567.8.

Customer Authorization success count is 26981.0.

7.4 RESULTS FOR MODEL WITH VOICE VERIFICATION

Average agent counts for available and busy status are given in Table 7.23.

Table 7.23: Average agent counts for available and busy status for model with Voice Verification

Average Agent Count	Agent Group	
	Agents with Basic Skill	Agents with Basic+Security Skill
Available Status	4.07	4.72
Busy Status	13.10	46.16

Percentage values for agent utilization are given in Table 7.24.

Table 7.24: Percentage values for agent utilization for model with Voice Verification

Agent Group	Agent Utilization
Agents with Basic Skill	76.28%
Agents with Basic+Security Skill	90.73%

Customer counts in terms of ending point of calls are given in Table 7.25.

Table 7.25: Customer counts in terms of ending points of calls for model with Voice Verification

Termination of Customer	Customer Count	Percentage
Abandoned	2,346.7	4%
Disconnected in IVR	15,917.9	25%
Handled by Agent	45,161.8	71%
Total	**63,426.4**	**100%**

Average durations of a call are given in Table 7.26.

Table 7.26: Average durations of a call for model with Voice Verification

Average Durations	Time (minute)	Percentage
Handle Time of Agent	1.89	63%
Speed of Answer	0.33	11%
Time Spent in IVR	0.78	26%
Total Time in Contact Center	**3.00**	**100%**

Average IVR port counts for available and busy status are given in Table 7.27.

Table 7.27: Average IVR port counts for available and busy status for model with Voice Verification

Utilization of IVR and Agent Ports	Average	Percentage
Ports Available	281.33	70%
Ports Busy	118.67	30%
Ports Blocked	-	0%
Total	**400**	**100%**

Customer counts in terms of finding IVR menus are given in Table 7.28.

Table 7.28: Customer counts in terms of finding IVR menus for model with Voice Verification

Finding IVR Menu Counts	Counts	Percentage
Customer found Account Balance Receipt by Email menu	2,605.4	4.30%
Customer found Account Balance Info menu	3,389.5	5.60%
Customer found Bill Payment menu	4,060.5	6.71%
Customer found Credit Card Campaign Info menu	7,137.2	11.79%
Customer found Credit Card Receipt by Email menu	7,431.9	12.28%
Customer found Credit Card Receipt Info menu	8,896.9	14.70%
Customer found Credit Card Limit Info menu	8,366.7	13.82%
Customer found Investment Info menu	2,371.6	3.92%
Customer found Money Transfer menu	8,559.9	14.14%
Customer couldn't find IVR menu	7,711.5	12.74%
Total	**60,531.1**	**100%**

Customer counts in terms of successful IVR processes and transfers to agents for *Bill Payment* and *Money Transfer* transactions are given in Table 7.29.

Table 7.29: Customer counts in terms of successful IVR processes for model with Voice Verification

Successful Process Counts	Counts	Percentage
Account Balance Receipt by Email	1,740.0	5.11%
Account Balance Info	2,093.5	6.15%
Bill Payment	2,374.6	6.98%
Credit Card Campaign Info	4,296.2	12.62%
Credit Card Receipt by Email	5,047.6	14.83%
Credit Card Receipt Info	6,005.1	17.64%
Credit Card Limit Info	5,921.0	17.39%
Investment Info	1,488.6	4.37%
Money Transfer	5,076.4	14.91%

Total	**34,043.0**	**100%**

Customer Recognition success count is 60531.6.

Customer counts in terms of successful Customer Authorization processes are given in Table 7.30.

Table 7.30: Customer counts in terms of successful Customer Authorization processes for model with Voice Verification

Successful Customer Authotization Counts	Customer Count	Percentage
Voice Verification	12,907	42%
Manual Customer Authorization	17,920.3	58%
Total	**30,827.7**	**100%**

7.5 RESULTS FOR MODEL WITH ALL THREE APPLICATIONS

Average agent counts for available and busy status are given in Table 7.31.

Table 7.31: Average agent counts for available and busy status for model with all three proposed applications

Average Agent Count	Agent Group	
	Agents with Basic Skill	Agents with Basic+Security Skill
Available Status	2.23	10.70
Busy Status	14.94	40.16

Percentage values for agent utilization are given in Table 7.32.

Table 7.32: Percentage values for agent utilization for model with all three proposed applications

Agent Group	Agent Utilization
Agents with Basic Skill	87.00%
Agents with Basic+Security Skill	78.96%

Customer counts in terms of ending point of calls are given in Table 7.33.

Table 7.33: Customer counts in terms of ending points of calls for model with all three proposed applications

Termination of Customer	Customer Count	Percentage
Abandoned	1,929.4	3%
Disconnected in IVR	18,469.7	29%
Handled by Agent	43,045.5	68%
Total	**63,444.6**	**100%**

Average durations of a call are given in Table 7.34.

Table 7.34: Average durations of a call for model with all three proposed applications

Average Durations	Time (minute)	Percentage
Handle Time of Agent	1.84	67%
Speed of Answer	0.15	6%
Time Spent in IVR	0.74	27%
Total Time in Contact Center	**2.74**	**100%**

Average IVR port counts for available and busy status are given in Table 7.35.

Table 7.35: Average IVR port counts for available and busy status for model with all three proposed applications

Utilization of IVR and Agent Ports	Average	Percentage
Ports Available	293.02	73%
Ports Busy	106.98	27%
Ports Blocked	-	0%
Total	**400**	**100%**

Customer counts in terms of finding IVR menus are given in Table 7.36.

Table 7.36: Customer counts in terms of finding IVR menus for model with all three proposed applications

Finding IVR Menu Counts	Counts	Percentage
Customer found Account Balance Receipt by Email menu	2,995.2	4.85%
Customer found Account Balance Info menu	3,916.2	6.34%
Customer found Bill Payment menu	4,715.6	7.63%
Customer found Credit Card Campaign Info menu	8,214.4	13.30%
Customer found Credit Card Receipt by Email menu	8,497.9	13.76%
Customer found Credit Card Receipt Info menu	10,285.8	16.65%
Customer found Credit Card Limit Info menu	9,791.5	15.85%
Customer found Investment Info menu	2,754.8	4.46%
Customer found Money Transfer menu	9,982.1	16.16%
Customer couldn't find IVR menu	626.4	1.01%
Total	**61,779.9**	**100%**

Customer counts in terms of successful IVR processes and transfers to agents for *Bill Payment* and *Money Transfer* transactions are given in Table 7.37.

Table 7.37: Customer counts in terms of successful IVR processes for model with all three proposed applications

Successful Process Counts	Counts	Percentage
Account Balance Receipt by Email	2,022.1	5.11%
Account Balance Info	2,441.8	6.17%
Bill Payment	2,744.7	6.94%
Credit Card Campaign Info	4,968.5	12.56%
Credit Card Receipt by Email	5,791.2	14.64%
Credit Card Receipt Info	6,934.2	17.53%
Credit Card Limit Info	6,991.0	17.67%
Investment Info	1,739.0	4.40%
Money Transfer	5,927.9	14.98%
Total	**39,560.4**	**100%**

Customer counts in terms of successful Customer Recognition processes are given in Table 7.38.

Table 7.38: Customer counts in terms of successful Customer Recognition processes for model with all three proposed applications

Successful Customer Recognition Counts	Customer Count	Percentage
Recognize by ANI	26,631	43%
Manual Customer Recognition	35,148.8	57%
Total	**61,779.5**	**100%**

Customer counts in terms of successful Customer Authorization processes are given in Table 7.39.

Table 7.39: Customer counts in terms of successful Customer Authorization processes for model with all three proposed applications

Successful Customer Authotization Counts	Customer Count	Percentage
Voice Verification	15,003	42%
Manual Customer Authorization	20,808.6	58%
Total	**35,811.5**	**100%**

7.6 COMPARISON OF RESULTS

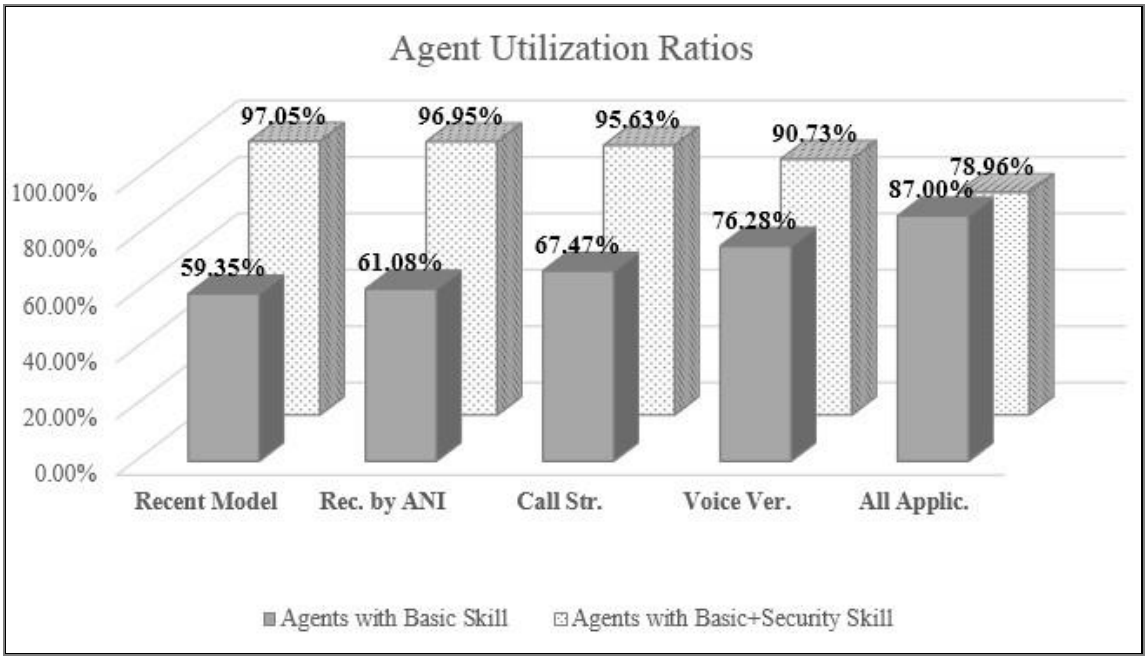
In this section, results given in previous sections of the chapter are shown in graph and compared to each other.

7.6.1 Agent Utilization Ratios

In all of simulation models in this thesis, incoming call distribution and agent counts with Basic Skill and Basic+Security Skill are fixed. It is also previously mentioned that call duration of Agents with Basic Skill is less than call duration of Agents with Basic+Security Skill.

Agent Utilization criteria is the *average busy agent count* divided by *average total agent count*. Increasing utilization (need) of Agents with Basic Skill and decreasing utilization (need) of Agents with Basic+Security Skill will obliquely decrease average call duration of the whole call center. Results for agent utilization ratios are compared in Figure 7.1.

Figure 7.1: Comparison of agent utilization ratios



As it is seen in Figure 7.1, best Agent Utilization results are achieved when all of the three applications are implemented. Using all three applications will make a 46.58 percent of improvement in utilization of Agents with Basic Skill compared to current model.

As Voice Signature highly increases ratio of authorization in IVR, second best option for decreasing need of Agents with Basic+Security Skill and increasing need of Agents with Basic Skill is implementing Voice Verification application. Implementing Voice Verification will make a 28.51 percent improvement in utilization of Agents with Basic Skill compared to current model.

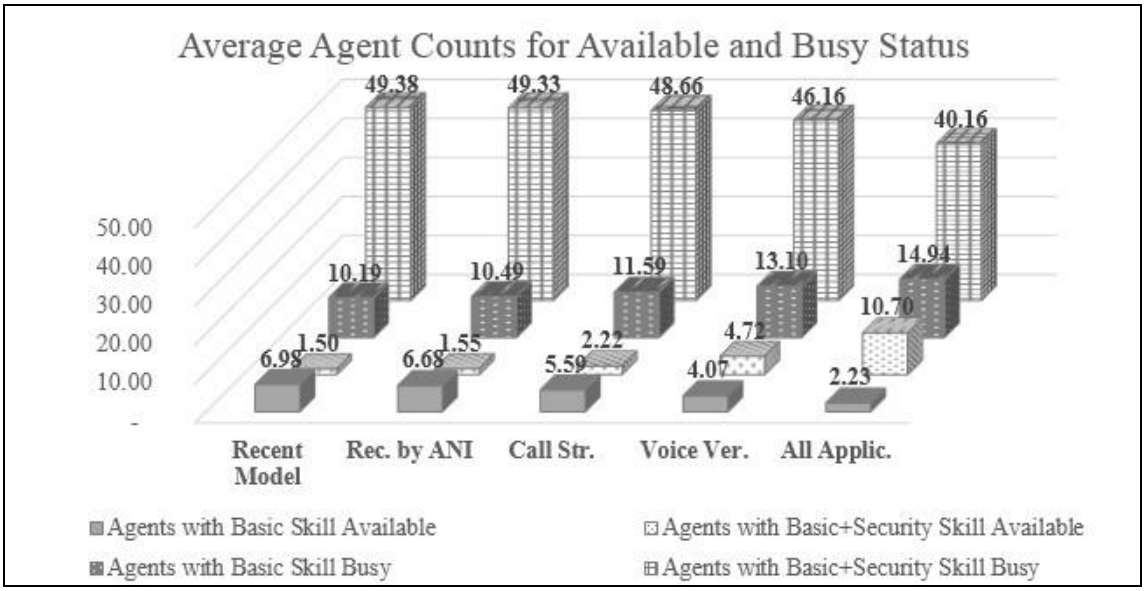
7.6.2 Average Agent Counts for Available and Busy Status

Average agent counts are calculated as the average number of agents throughout the timeslot. In simulation model of current call center, average available agent counts are low for Basic+Security skilled agents and high for Basic skilled agents, as well as average busy agent counts are high for Basic+Security skilled agents and low for Basic skilled agents.

It is previously mentioned that average talk time of agents with Basic+Security Skill is

1.626 times of average talk time of agents Basic Skill. As incoming call distribution and scheduled agent counts are fixed in all simulation models, decreasing availability of agents with Basic skill and increasing availability of agents with Basic+Security skill will result of decreasing total talk time of the whole call center. Results for average agent counts for available and busy status are compared in Figure 7.2.

Figure 7.2: Comparison of average agent counts



As it is seen in Figure 7.2, best results of agent statuses are achieved when all of the three applications are implemented.

As Voice Signature highly increases ratio of authorization in IVR, second best option for decreasing need of Agents with Basic+Security Skill and increasing need of Agents with Basic Skill is implementing Voice Verification application.

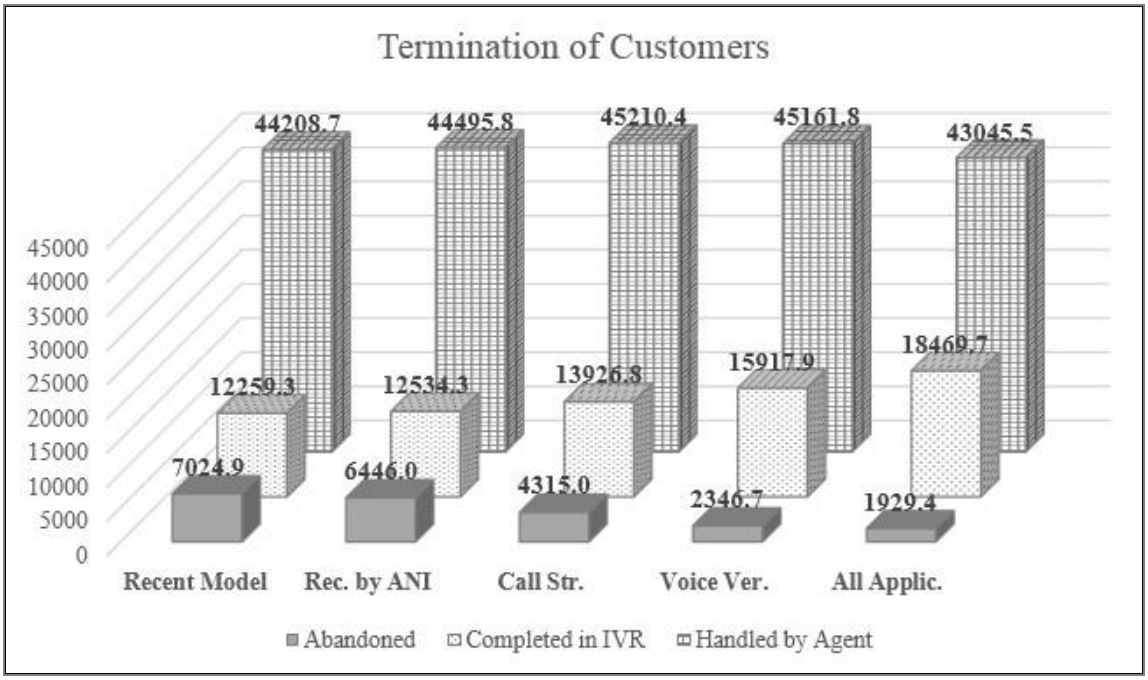
7.6.3 Termination of Customers

Abandonment of the customers means not satisfying their needs and is metric of the failure in call center.

Call center managers focus to increase calls completed in IVR instead of an agent to decrease call center costs for not abandoned calls.

Results for call termination are compared in Figure 7.3.

Figure 7.3: Comparison of call terminations



It is seen in Figure 7.3, using all of the three applications decreases count of abandonment and agent need as well as it increases count of calls completed in IVR. Abandonment and calls handled by agents will respectively decrease 72.53 percent and 2.16 percent and calls completed in IVR will increase 50.66 percent compared to current model of call center.

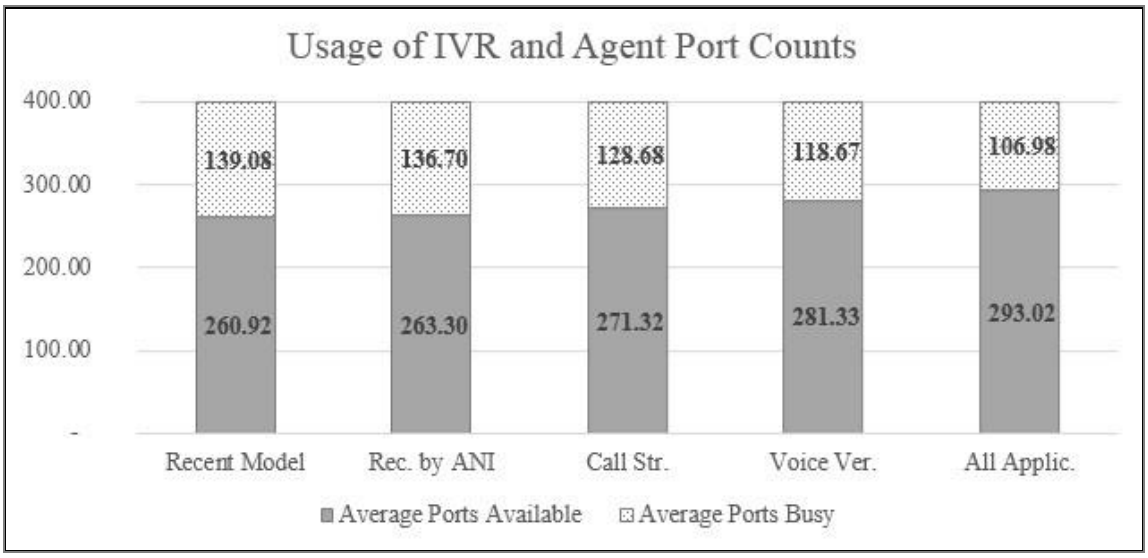
Second best option is implementing Voice Verification application. Abandonment will decrease 66.59 percent and calls completed in IVR will increase 29.84 percent compared to current model of call center. There will be a raise of 2.16 percent in calls handled by agents based on high decrease of abandonment.

7.6.4 Usage of IVR and Agent Ports

As incoming call distribution is fixed in all simulations, change in average of IVR and agent ports will let us predict change in total time in contact center. Under stationary conditions, as available IVR and agent port counts increase, it is possible to mention of a decrease in total time in contact center.

Usage of IVR and agent ports for all simulation models are given in Figure 7.4.

Figure 7.4: Comparison of usage of IVR and agent ports



Using all of the three applications increases count of available IVR and agent ports 12.30 percent compared to current call center model.

Second best option is implementing Voice Verification application. Count of available IVR and agent ports will increase 7.82 percent compared to current call center model.

7.6.5 Average Call Durations

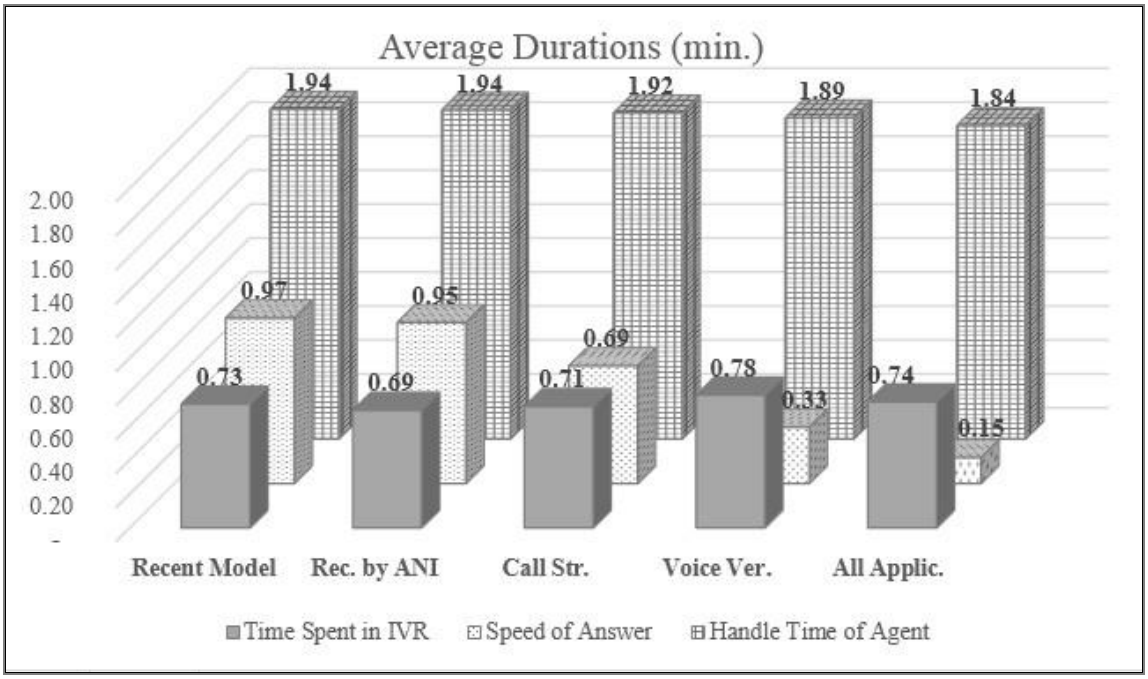
Total Time in Contact Center is the sum of Time Spent in IVR, Time Spent in Queue (which is also mentioned as Speed of Answer) and Handle Time of Agent.

Decreasing Speed of Answer and Handle Time of Agent criteria are very important to increase customer satisfaction.

As it is seen in Figure 7.5, speed of answer and handle time of agent respectively decreases 84.45 percent and 5.00 percent, if all three applications are implemented to current call center model.

Second best option is implementing Voice Verification application. Speed of answer and handle time of agent respectively decreases 65.94 percent and 2.63 percent, compared to current call center model.

Figure 7.5: Comparison of average durations

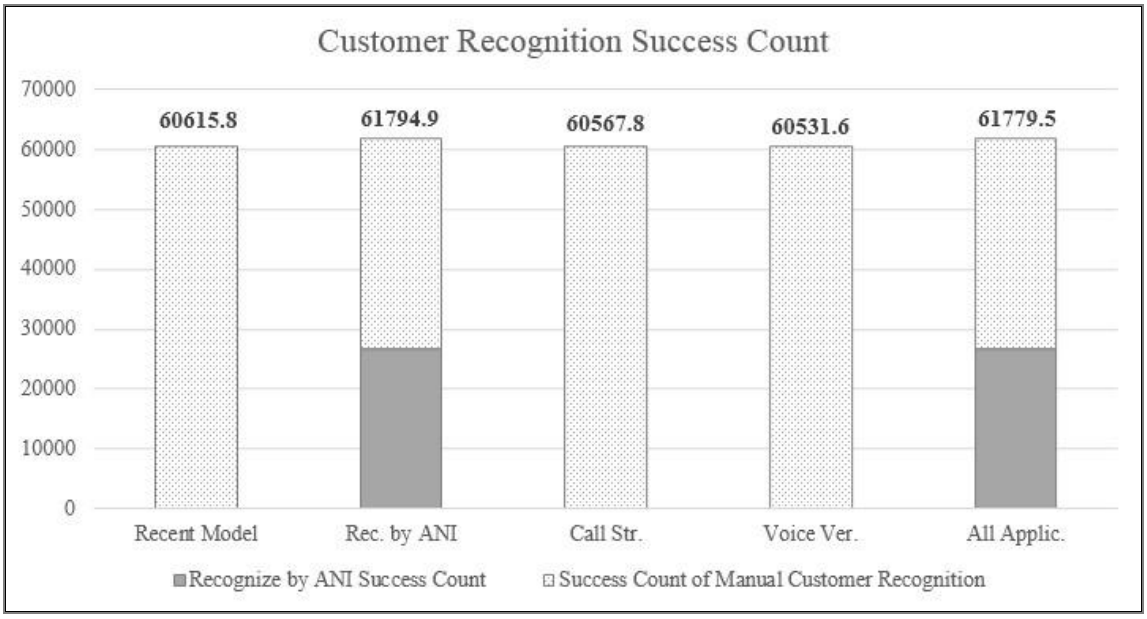


7.6.6 Customer Recognition Success

As mentioned before, some customers have trouble in customer recognition process. Not being able to let system to recognize customer, may limit IVR functionality usage and comes out as a problem which should be minimized.

For each simulation model, counts of customer recognition success are given in Figure 7.6.

Figure 7.6: Comparison of customer recognition success counts



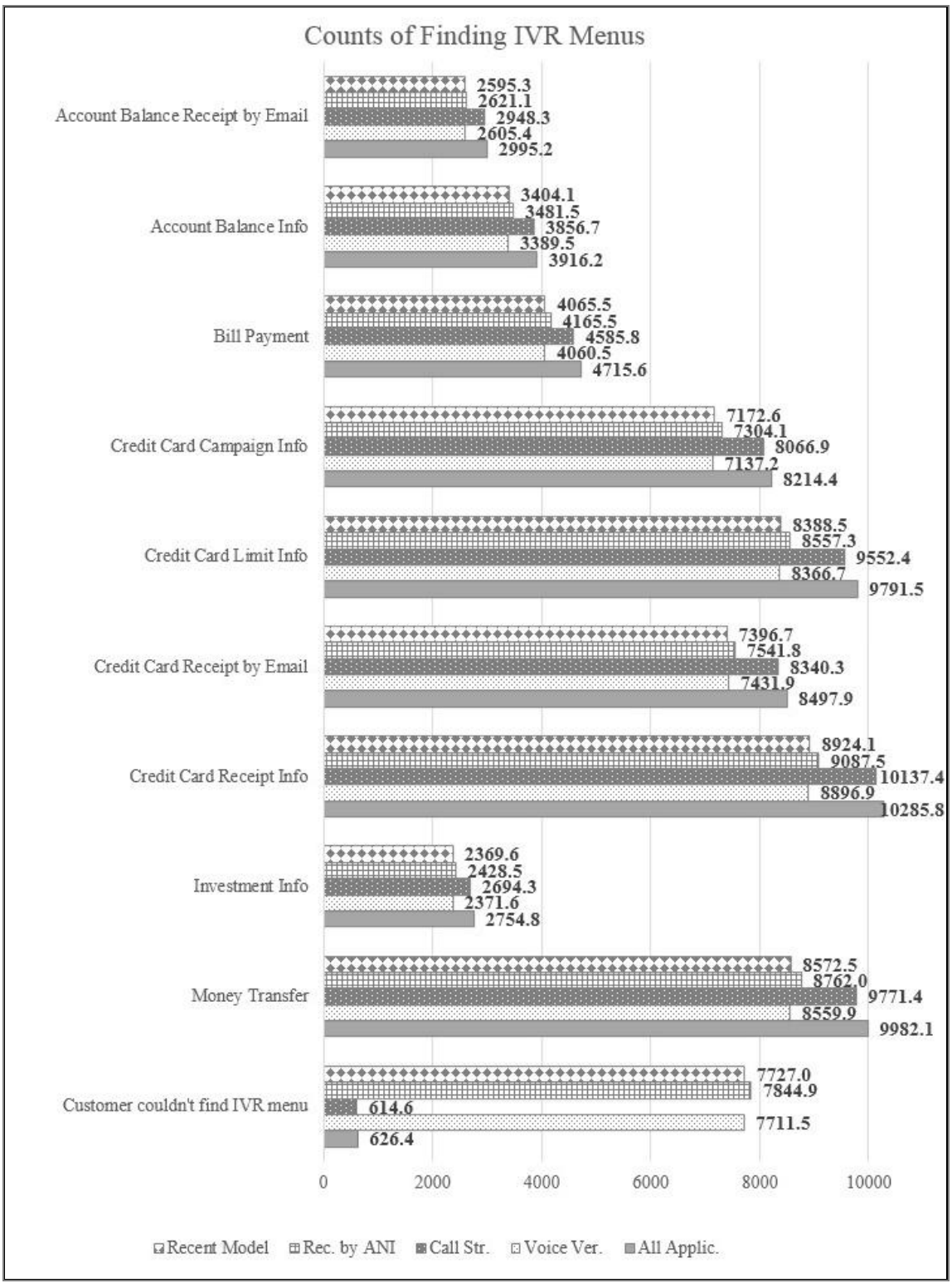
It came along that using Recognize Caller by ANI Application increased successful customer recognition ratio by only 1.95 percent and decreased total time spent in call center per call by 1.83 percent, compared to current call center model. Change in the ratio may look low but this application will help ~1.179 potential customer complaints solved before they occur and prevent Customer Relations work which was going to grow if complaint was going to occur. Recognize Caller by ANI application takes only 7 seconds in average. This application affects customer perception in a positive direction because of customer doesn't need to enter his or her customer ID and move on to next step quicker.

7.6.7 Finding IVR Menus

As mentioned before, some customers have trouble in reaching IVR functionalities they need. Not being able to find related IVR menu by dialing limits IVR functionality usage and comes out as a problem which should be minimized.

For each simulation model, counts of finding IVR menus are given in Figure 7.7.

Figure 7.7: Comparison of counts of finding IVR menus



It came along that using Call Steering Application increased reaching to IVR menu ratio by ~12-14 percent, depending on IVR menu to be reached, compared to current call

center model. When total of finding IVR menu counts are compared, reaching to IVR menus increased from 52889 to 59954. Percentage of the difference is 13.36. Counts of customers who couldn't find related IVR menu also decreased 92.05 percent. As results are seen in Figure 7.5, average of total time spent in call center per call decreased 8.70 percent by implementing Call Steering Application due to simulation results.

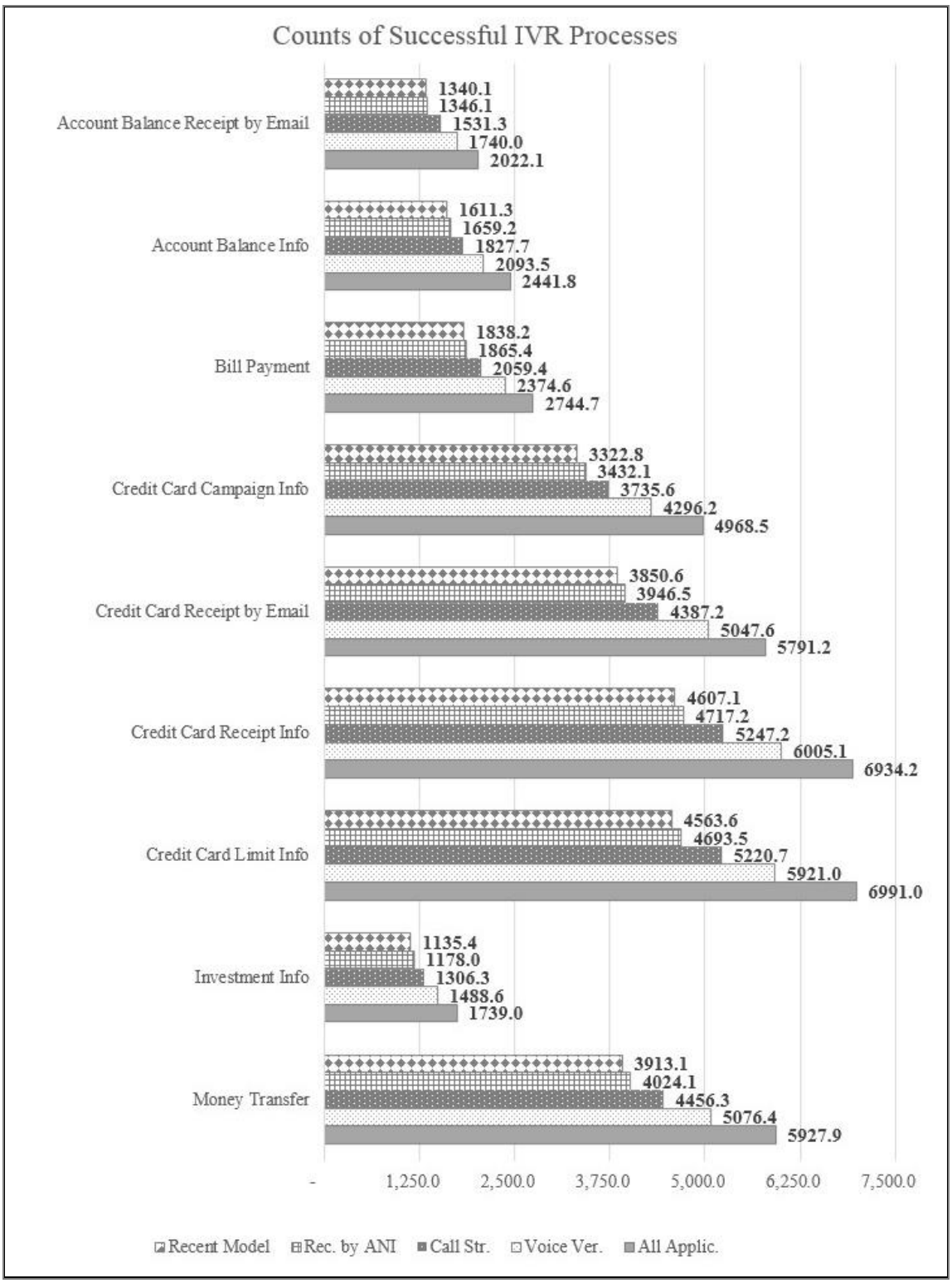
As it is expected, using all of three applications has a better effect. Reaching to IVR menu ratio increased by 15-17 percent, depending on IVR menu to be reached, compared to current call center model. When total of finding IVR menu counts are compared, reaching to IVR menus increased from 52889 to 61154. Percentage of the difference is 15.63. Counts of customers who couldn't find related IVR menu also decreased 91.89 percent.

7.6.8 Successful IVR Processes

Finding IVR menu is not enough to run an IVR functionality. Customers also need to authorize themselves to be able to run an IVR functionality.

In Figure 7.8, counts of customers who found IVR menus and authorized themselves successfully are given for each simulation model.

Figure 7.8: Comparison of counts of successful IVR processes



By using all of the three applications, successful IVR process ratio increased 49-53 percent, depending on IVR functionality to be run, compared to current model. When

total of successful IVR process counts are compared, successful IVR process counts increased from 26182 to 39560 in simulation, with implementation of all three application. Percentage of the difference is 51.10.

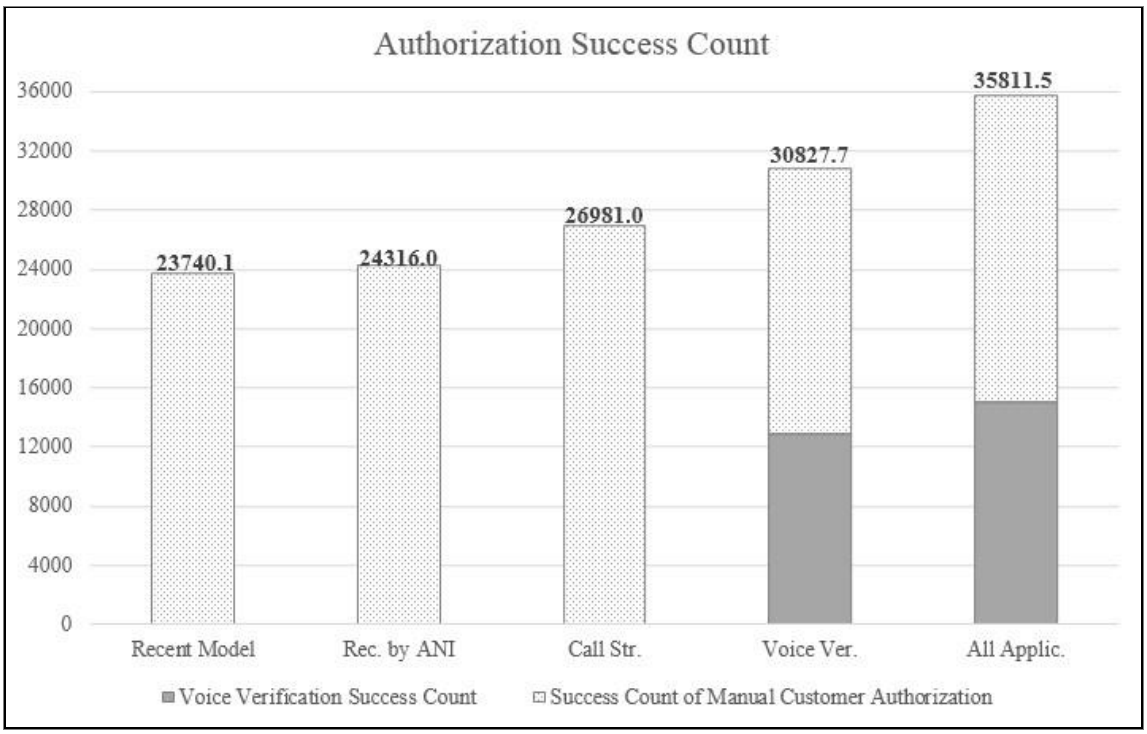
Second best option is implementing Voice Verification application. Successful IVR process ratio increased 29-31 percent, depending on IVR functionality to be run, compared to current model. When total of successful IVR process counts are compared, successful IVR process counts increased from 26182 to 34043 in simulation, with implementation of Voice Verification application. Percentage of the difference is 30.02.

7.6.9 Verification Success

As mentioned before, some customers have trouble in customer authorization process. Not being able to let system to authorize customer, may limit IVR functionality usage and comes out as a problem which should be minimized.

For each simulation model, counts of successful customer authorization are given in Figure 7.9.

Figure 7.9: Comparison of authorization success counts



It came along that using Voice Verification Application increased successful customer authorization ratio by 29.85 percent, compared to current call center model. As results are seen in Figure 7.5, average of total time spent in call center per call decreased 17.56 percent by implementing Voice Verification Application due to simulation results.

As it is expected, using all of three applications has a better effect. Successful customer authorization ratio increased by 51.10 percent, compared to current call center model.

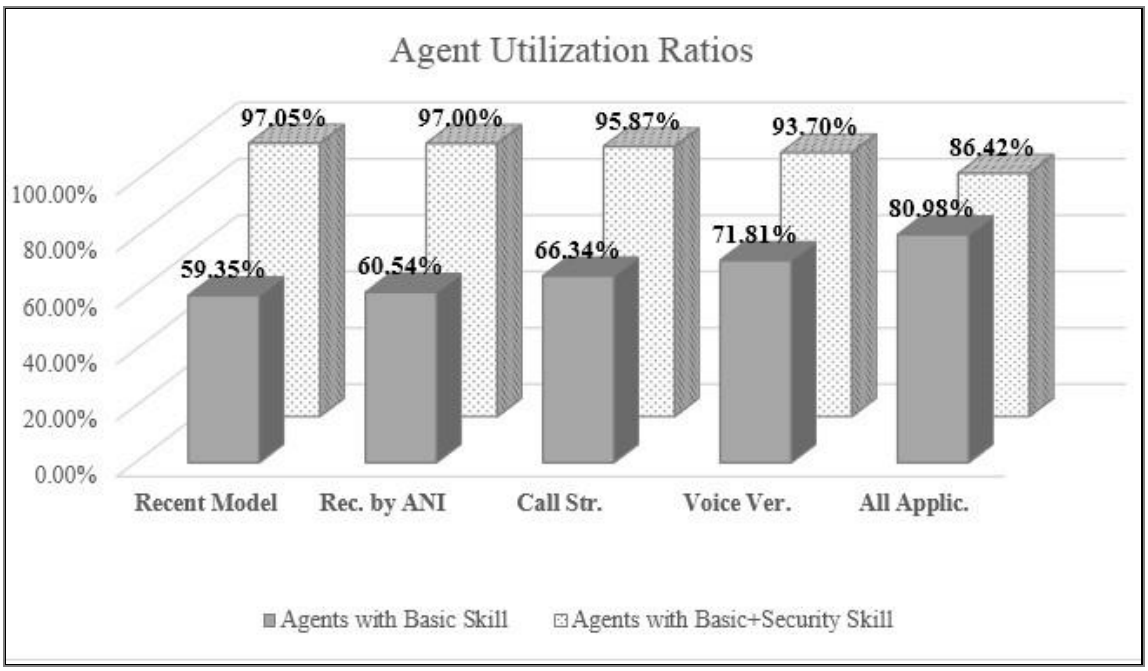
7.7 COMPARISON OF RESULTS FOR PESSIMISTIC SCENARIO

In this section, results of current call center model simulation and proposed application simulations with pessimistic perspective are shown in graph and compared to each other.

7.7.1 Agent Utilization Ratios

Results for agent utilization ratios of current call center model simulation and proposed application simulations with pessimistic perspective are compared in Figure 7.10.

Figure 7.10: Comparison of agent utilization ratios

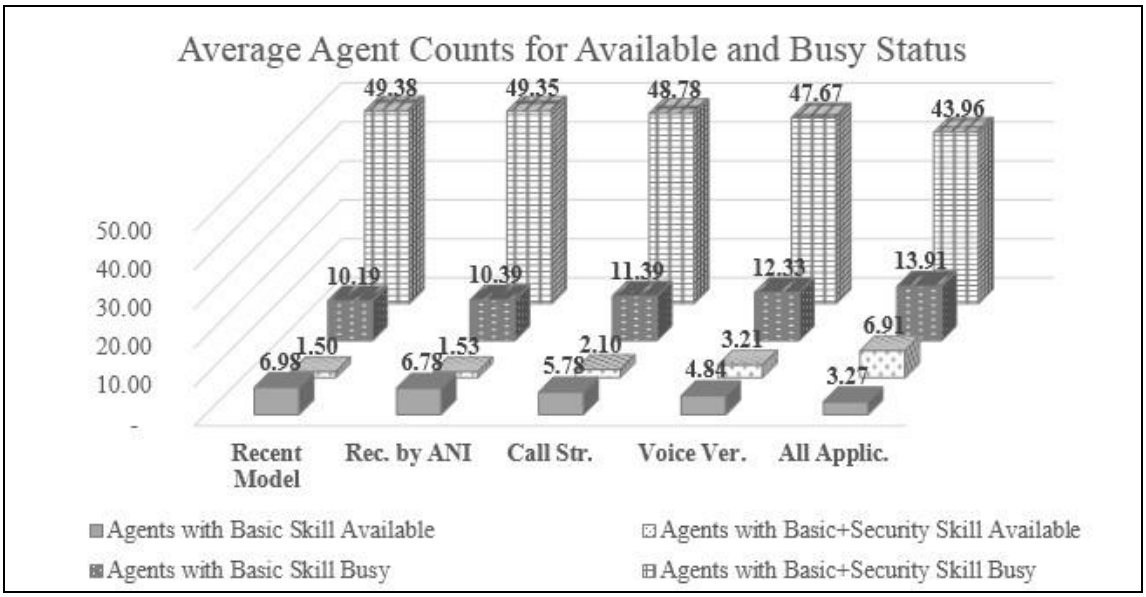


As it is seen in Figure 7.10, even values are changed with a pessimistic perspective, better Agent Utilization results are achieved with implementation of proposed applications. Using all three applications will make a 36.43 percent of improvement in utilization of Agents with Basic Skill compared to current model.

7.7.2 Average Agent Counts for Available and Busy Status

Results for average agent counts for available and busy status of current call center model simulation and proposed application simulations with pessimistic perspective are compared in Figure 7.11.

Figure 7.11: Comparison of average agent counts

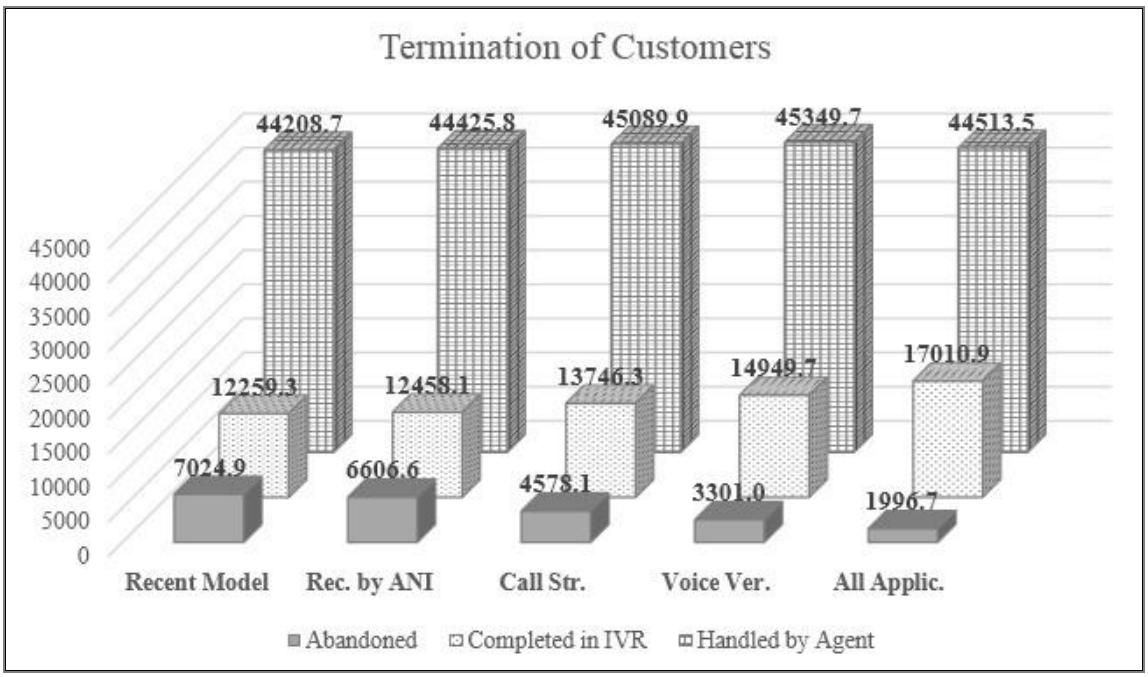


As it is seen in Figure 7.11, even values are changed with a pessimistic perspective, better agent statuses are achieved with implementation of proposed applications.

7.7.3 Termination of Customers

Results for call termination of current call center model simulation and proposed application simulations with pessimistic perspective are compared in Figure 7.12.

Figure 7.12: Comparison of call terminations

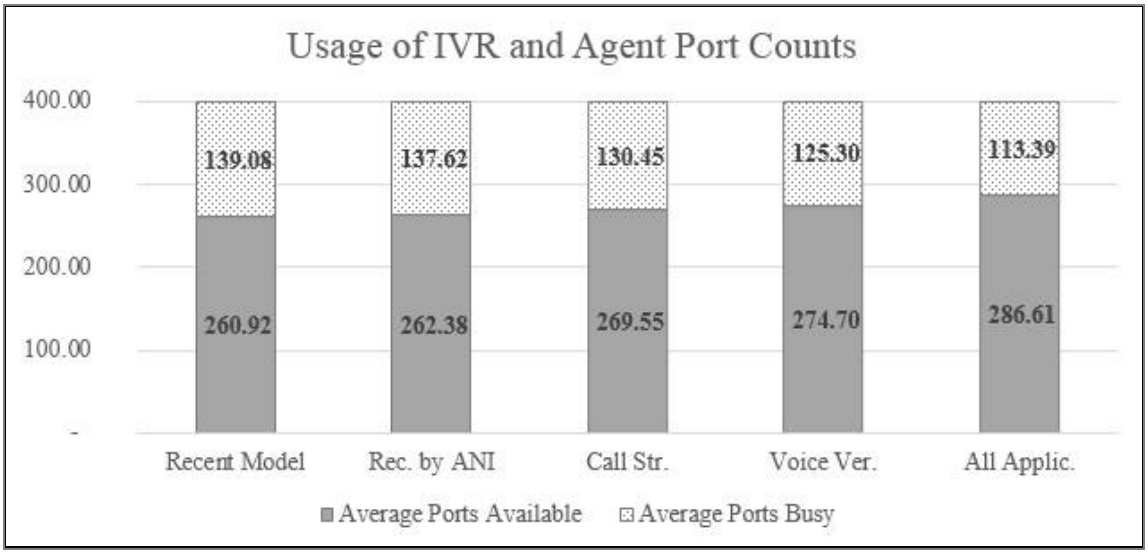


As it is seen in Figure 7.12, even values are changed with a pessimistic perspective, implementing proposed applications decreases abandonment and agent need and increases count of calls completed in IVR. Abandonment and calls handled by agents will respectively decrease 71.58 percent and 0.69 percent and calls completed in IVR will increase 38.76 percent compared to current model of call center.

7.7.4 Usage of IVR and Agent Ports

Usage of IVR and agent ports of current call center model simulation and proposed application simulations with pessimistic perspective are given in Figure 7.13.

Figure 7.13: Comparison of usage of IVR and agent ports

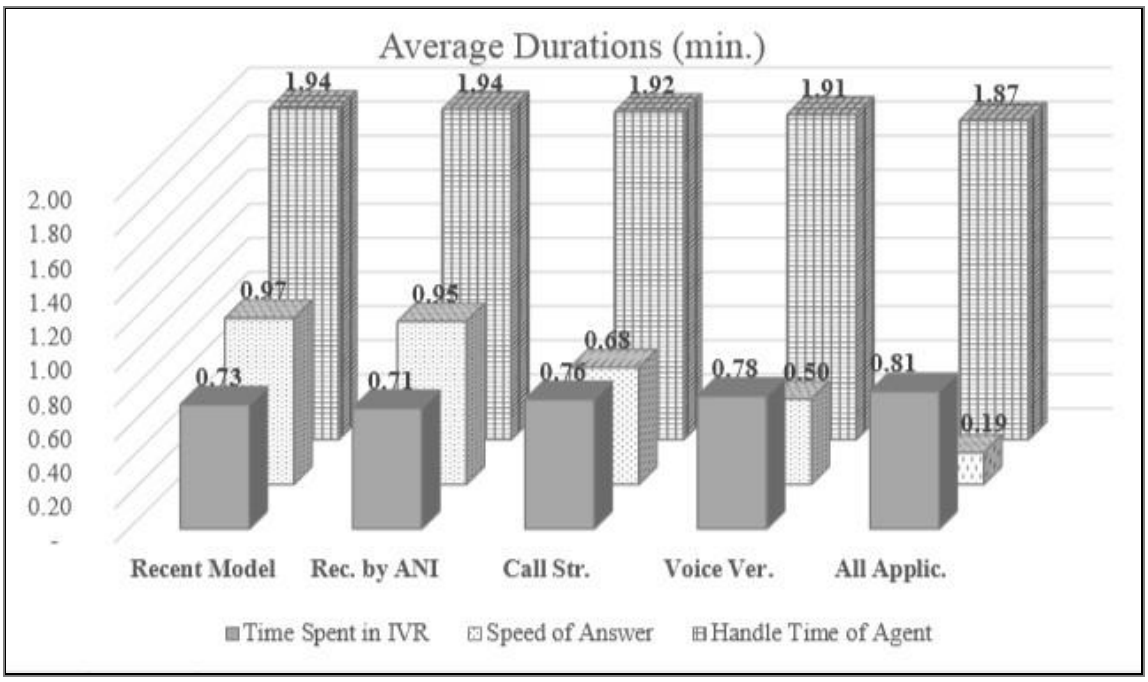


Even values are changed with a pessimistic perspective, implementing proposed applications increases count of available IVR and agent ports. Implementing all proposed applications will increase count of available IVR and agent ports by 9.85 percent compared to current call center model.

7.7.5 Average Call Durations

As it is seen in Figure 7.14, even values are changed with a pessimistic perspective, implementing proposed applications will make improvements for speed of answer, handle time of agent and time spent in IVR criterion. Speed of answer and handle time of agent respectively decreases 80.98 percent and 3.53 percent, if all three applications are implemented to current call center model.

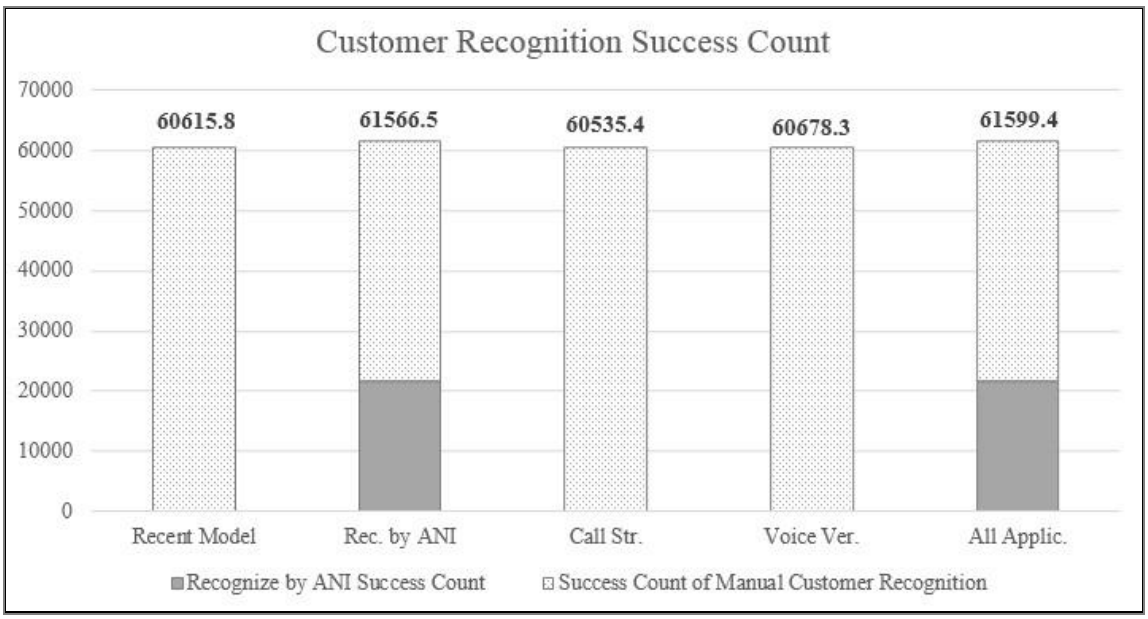
Figure 7.14: Comparison of average durations



7.7.6 Customer Recognition Success

For current call center model and simulations with pessimistic perspective, counts of customer recognition success are given in Figure 7.15.

Figure 7.15: Comparison of customer recognition success counts

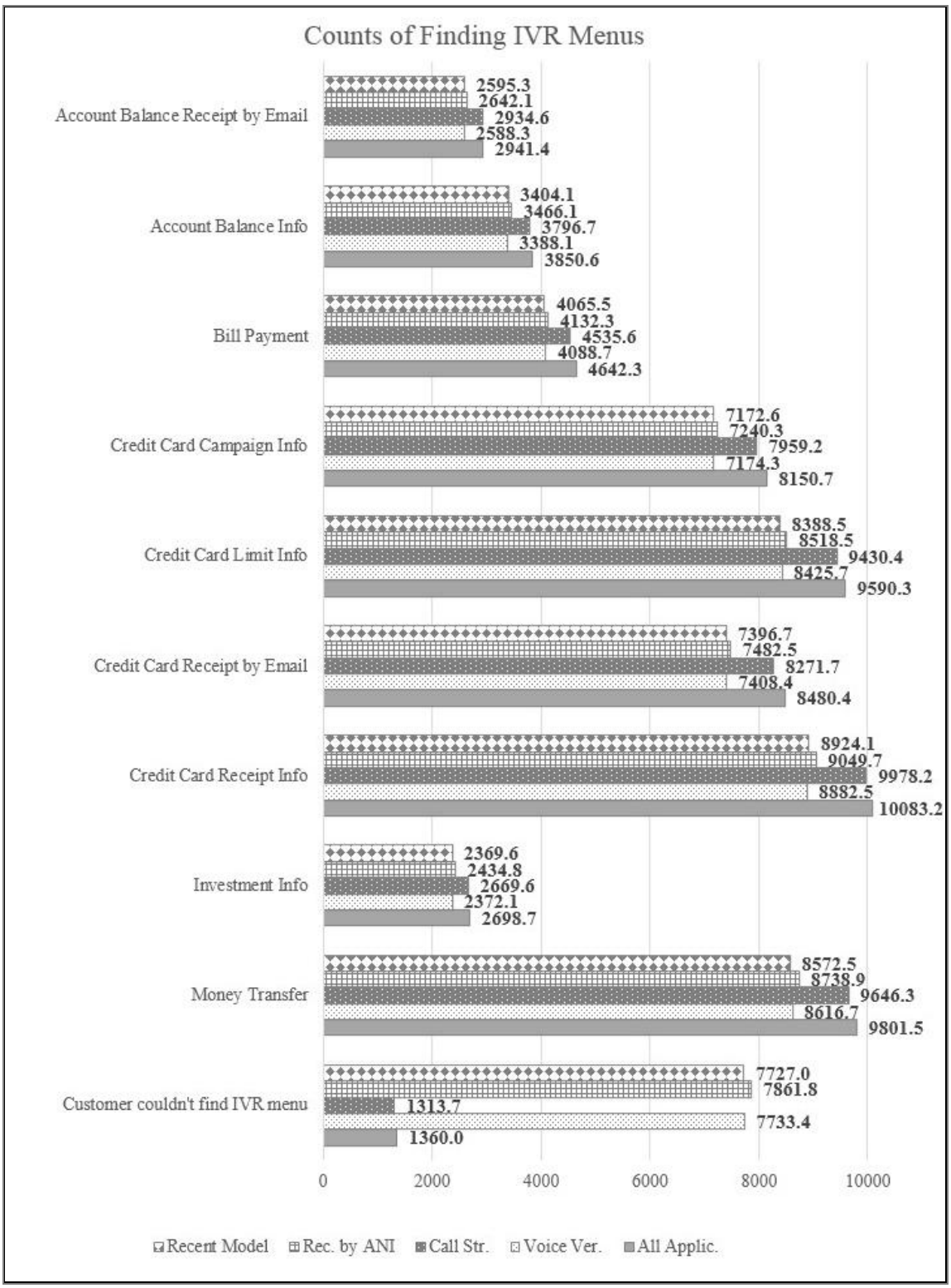


It came along that in pessimistic Recognize Caller by ANI Application simulation model, successful customer recognition ratio is increased by 1.57, compared to current call center model simulation.

7.7.7 Finding IVR Menus

For current call center model and simulations with pessimistic perspective, counts of finding IVR menus are given in Figure 7.16.

Figure 7.16: Comparison of counts of finding IVR menus



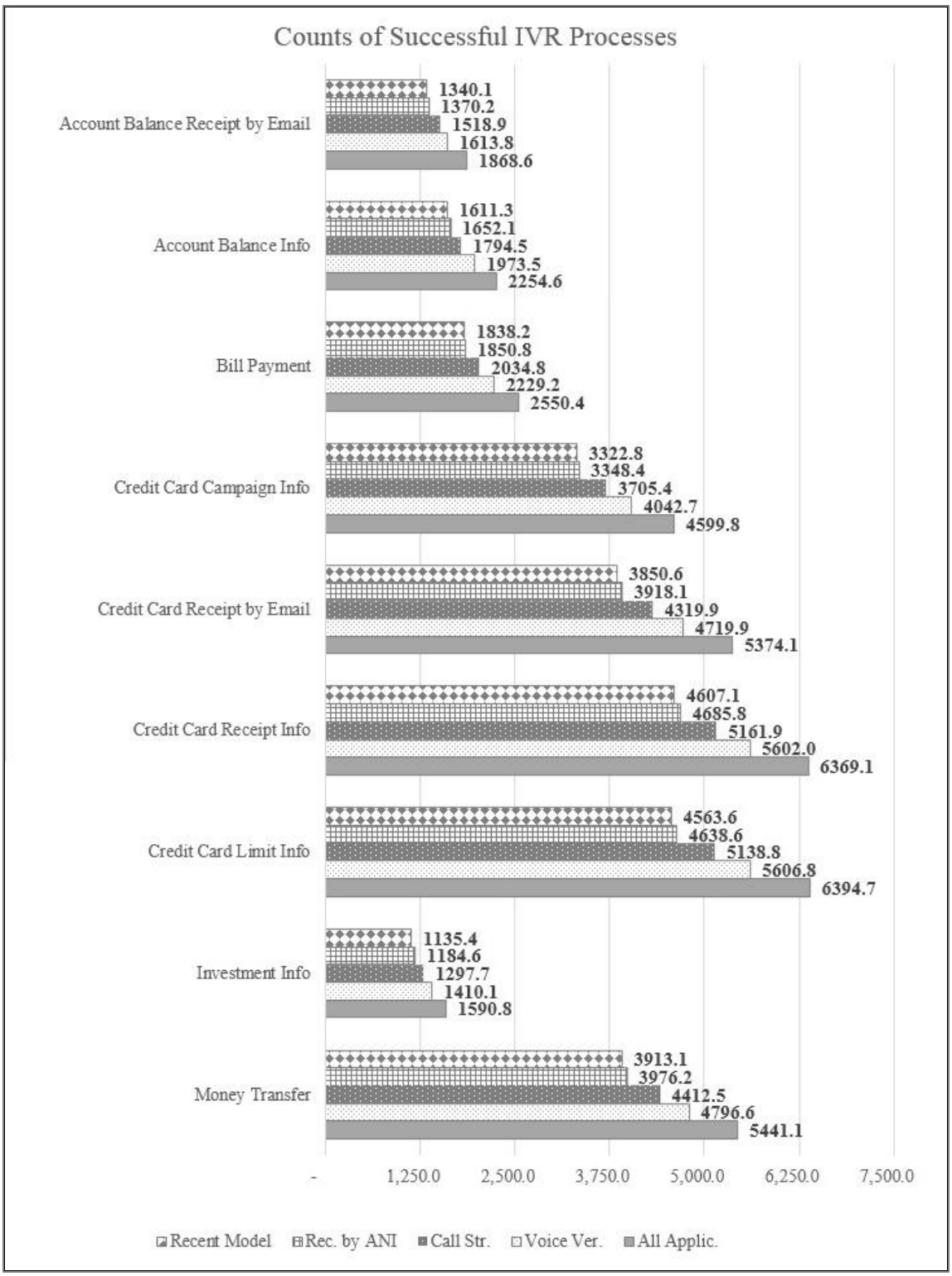
It came along that, even values are changed with a pessimistic perspective, implementing proposed applications will increase reaching to IVR menu ratios. Using Call Steering Application increased reaching to IVR menu ratio by ~11-13 percent,

depending on IVR menu to be reached, compared to current call center model. Counts of customers who couldn’t find related IVR menu also decreased 83.00 percent.

7.7.8 Successful IVR Processes

In Figure 7.17, counts of customers who found IVR menus and authorized themselves successfully are given for current call center model and simulations with pessimistic perspective.

Figure 7.17: Comparison of counts of successful IVR processes



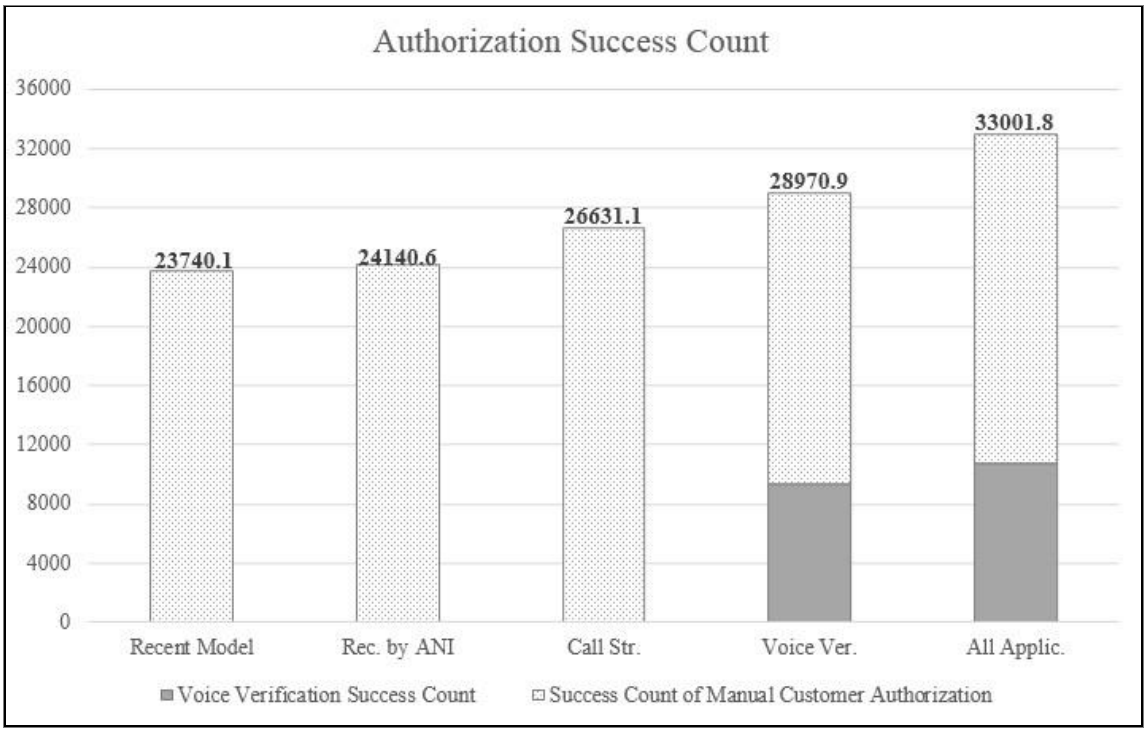
Even values are changed with a pessimistic perspective, implementing proposed applications increased successful IVR process counts. By using all of the three applications, successful IVR process ratio increased 39-40 percent, depending on IVR

functionality to be run, compared to current model. When total of successful IVR process counts are compared, successful IVR process counts increased from 26182 to 36443 in simulation, with implementation of all three application. Percentage of the difference is 39.19.

7.7.9 Verification Success

For each simulation model, counts of successful customer authorization for current call center model and simulations with pessimistic perspective are given in Figure 7.18.

Figure 7.18: Comparison of authorization success counts



It came along that, even values are changed with a pessimistic perspective, using Voice Verification Application increased successful customer authorization ratio by 22.03 percent, compared to current call center model.

7.8 DISCUSSION

As it is seen in simulation results, proposed applications provide a noticeable improvement in overall call center performance. Impressive changes in call counts of

termination points and average call durations are given in following paragraphs.

Due to simulation results, with implementation of three applications, abandonment decreases 72.53 percent and calls completed in IVR increases 50.66 percent compared to current model of call center. Even in pessimistic scenario, with implementation of three applications, abandonment decreases 71.58 percent and calls completed in IVR increases 38.76 percent compared to current model of call center.

With implementation of three applications, speed of answer and handle time of agent respectively decreases 84.45 percent and 5.00 percent compared to current call center model. Even in pessimistic scenario, with implementation of three applications, speed of answer and handle time of agent respectively decreases 80.98 percent and 3.53 percent.

8. CONCLUSION

As mentioned, banking sector is one of the major areas in the service industry and in last decades, competition between banking companies increasingly raised. Because of these companies service to their customers via Call Centers to increase customer satisfaction, Call Center services such as IVR and customer representative services are continuously being improved.

Previous research on call centers has focused on different areas. This thesis aimed to;

a. Satisfy the need for research in the area of new IVR applications to improve IVR and total call center performance.
b. Provide a comparison between standard IVR model and IVR with new applications such as Recognize Caller by ANI, Call Steering and Voice Verification with a focus on processes done in IVR.

With increment of customer needs, new applications and technologic conditions also have to be improved. In this thesis, Recognize Caller by ANI, Call Steering and Voice Verification applications and their effect to call center performance are analyzed. A current call center model is simulated and simulation results were compared to improved models with these applications. The models are also compared under a pessimistic scenario created for each model.

The results of this research study supported hypothesis that IVR applications such as Recognize Caller by ANI, Call Steering and Voice Verification noticeably increase the performance.

Recognize Caller by ANI application slightly increase the performance but recognizing customer without dialing any number may make a good impression on customers.

Call Steering noticeably decrease customers' being lost in IVR menus. Call Steering also noticeably decreases abandonment and increases IVR usage.

Voice Verification noticeably increase successful authorization in IVR. Voice

Verification also noticeably decreases abandonment and increases IVR usage.

For future work, it is possible to analyze; different applications if call center performance is effected by them or not, other usage areas for applications analyzed in this thesis, costs and financial feasibility study of proposed applications and inclusion of *after call work* criteria and/or *retrial* criteria in simulation.

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