Maximize the resource utilization in Outbound call center operations by using simulation modeling

by

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Executive Summary

A call center consists of different departments, various physical, intellectual and human resources and the data is managed by an ERP system. Cell C makes use of the C-Advance ERP system in their call centers, and this ERP system needs to be integrated with the rest of the ERP system used in other departments. There are internal and external departments within the whole call center system. Internal departments include Sales, Quality Control and the warehouse. External departments are the courier service RAM and the audit company Vericon.

The Pre-to-Post process has various steps. From the initial call, quality control, credit check, RICA registration, order picking, order correctly shipped, RAM delivery service, activation and termination of the order entity.

Currently the system is not mapped and the process flow is not visible. Too many resources are allocated to certain departments and the throughput rate is smaller than the set target. There also exists a shortage in stock of the more popular handsets on contract.

The aim of this project is to map the process and identify problem areas. Then to remove bottlenecks, streamline the operations and eliminate the stock shortage by making use of tools such as *Arena® Simulation Software, Microsoft Office Visio 2007, Probability Models, Operations Management and Fixed-order Quantity Models.*

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Chapter 1

1. Introduction and Background

1.1 The Cell C Call Center

Since the early 1990's mobile phone technology has made major inroads in the South African economic and social environment.

Cell C is South Africa's third cellular operator founded after Vodacom and MTN. The company is currently owned by 3C Telecommunications. The Cell C network covers nearly thirty percent of South Africa's geographical area and caters for between 80% and 90% of the general population. The majority of their sales are initiated and processed by a single call center unit situated in Midrand, Johannesburg. Cell C has both inbound and outbound call centers. Inbound call centers receives incoming calls generated by the outside caller and an outbound system generates the calls from within the center to the customer or public (Gans, Koole, & Mandelbaum, 2003). According to (Gans, Koole, & Mandelbaum, 2003), there is almost no research that has been done on pure outbound call centers.

The Pre-to-Post call center at Cell C is an outbound call center which phones from a random set of cell phone numbers off the internal data base in order to make an attractive contract offer to current pre-paid customers. The Pre-to-Post process can be viewed as a Tele-marketing system to convert pre-paid users to a contract phone. In the severely competitive cell phone market, heightened by the ministers ruling that charges should be decreased by all players, the contract option provides a measure of predictability in income to cell phone companies. Cell C would like to further the company's sustainability by expanding their contract customer base. With the low income but high quantity target customer strategy, Cell C has the potential to increase their competitive advantage against the other two leading Cellular Service Providers by streamlining the Initiation to Delivery process.

During both inbound and outbound operations, each call is attached with a unique identification number. In outbound systems, the unique identification number (ID) is set as an indicator for the call status. If a caller accepts a particular offer, the unique ID is saved and follows the customer's request through to the end process. If a customer wants to convert from Pre-Paid to a contract, the unique ID is the specific job number allocated to the specific conversion process. On the other hand, if the customer declines the offer, the unique ID is scrapped. This is explained later on.

Cell C also engages with several selected service provider. RAM is an external and key service provider for Cell C in handling all deliveries of new contract phones. RAM Hand-to-Hand, is a high risk courier company that opened in 1997 in South Africa. The benefit of using RAM is that they have delivery hubs stationed right across South Africa which increases the ease and speed of delivery. Another benefit is the level of security RAM offers Cell C in the safe delivery of their cargo.

1.2 Aim of the Project

The aim of the project will be to visually map and determine the process in order to streamline the call centre processes and balance the current resources. One of the main goals is to investigate the system and reduce the duration of one entity through the system form the currently 7 workdays, to 4 and a half workdays, the target set by Cell C. This will be done by firstly simulating the process within 95% accuracy of the current status and then analyze and inspect the system to improve. The areas of investigation will be to determine the bottlenecks in the system by identifying the stations and resources which are idle as a result of an unbalanced system. Furthermore, the solution will attempt to integrate the sales, Quality control and RAM departments to a single process to increase the ease of operations and information flow. After investigation, the increase of resource capacity in certain departments by finding an innovative way to manage resources.

1.3 Project scope

The project will focus on the optimal allocation and utilization of resources in the Cell C call center in Midrand, as well as the elimination of the shortage in the E-72 handset stock. This particular call center contributes to the majority of sales and conversion from Pre-paid to contract. The project will only cover the basic processes in the Pre-to-Post system and the use of statistic such as handling time, arrival rates and capacity. Excluded from the project:

- Quality of performance and skill of agents
- The system of numbers being called
- Physical distribution of the phones (Although it would be modeled as a time constraint)

Chapter 2

2. Literature Review

2.1 Introduction

A typical call center consist of two main resources, equipment and people (agents). The equipment is mainly telecommunication equipment and computers. Traditional telephones are replaced by headsets. The typical layout of a call or contact center is a large room consisting of hundreds of cubicles.

Call centers, according to (Gans, Koole, & Mandelbaum, 2003), have become the primary means of communication between many companies and their customers. Call centers are being created to internally manage and outsource call centers. According to United States (U.S.) statistics, the number of agents working in call centers in the U.S.A. in the year 2000 was 1.55 million and consisted of more than 1.3% of the private sector and increased in growth with 8% annually. As a result, the management of call centers became much more difficult and complicated with external interferences including trends in networking, skill based routing and the various media applied. Most call centers do not implement the principles of best practice.

The personnel making or receiving the calls are known as agents. The requirements to become an agent are not set very high, although some may be trained to handle different types of calls. Since the call center operation is the company's interface with the public, the quality and the service level provided are highly important. For some calls, Skilled-Based (Wallace & Whitt, 2005) routing is applied where a specific call is transferred to the appropriate agent who is competent to handle the specific query. Unlike other sources of company to client communication like e-mail, web pages and instant messaging, call centers are personal and the agent's attitude will be perceived as the overall attitude of the company.

Contact centers provide numerous services such as call –marketing, after sales customer services, help desk and emergency services. Call-marketing is the only outbound call center service among the four mentioned above. An outbound call center, better known as a Tele-marketing center, generates calls from the center to the predefined public. The Pre-to-Post call center of Cell C is a good example of an outbound call center. In the Pre-to-Post call center, the prepaid customer is called and presented with an offer to convert to a contract. On the other hand, in an inbound system, calls are generated by the general public or customers and the call center receives incoming calls. The Advertisement call center of Cell C is an example of an inbound call center.

2.1.1 Call center terminology

(Gans, Koole, & Mandelbaum, 2003) Defines certain common terms used in the call center environment. The mostly used are:

- Average Handle Time (AHT), also called the average service time.
- Talk Time, average talking time during a customer call.
- Hold Time, on average how long a customer is put on hold by the agent.
- Wrap Time, average amount of time it takes an agent to finalize the service.

Wrap Time is an important factor in outbound centers if the customer request is submitted.

2.1.2 Call center operating tools

Inbound call centers makes use of Interactive Voice Response (IVR) units (Wallace & Whitt, 2005). At present, IVR's are not used by the outbound system. Another highly sophisticated device is an Automatic Call Distributor (ACD) which is programmed to distribute calls against certain criteria (Wallace & Whitt, 2005). These tools are used to optimize call operations by the effective call routing according to customer specification. It also allows agents to access customer information in order to fully utilize call duration and eliminate time consuming operations.

Computer-telephone Integration (CTI), also known as "middleware", is used to integrate telephone operations with the company's local information system (Wallace & Whitt, 2005). Customer relationship management (CRM), which uses customer information to make certain operating decisions and in turn increase effectiveness of operations, is implemented through the CTI tool (Wallace & Whitt, 2005).

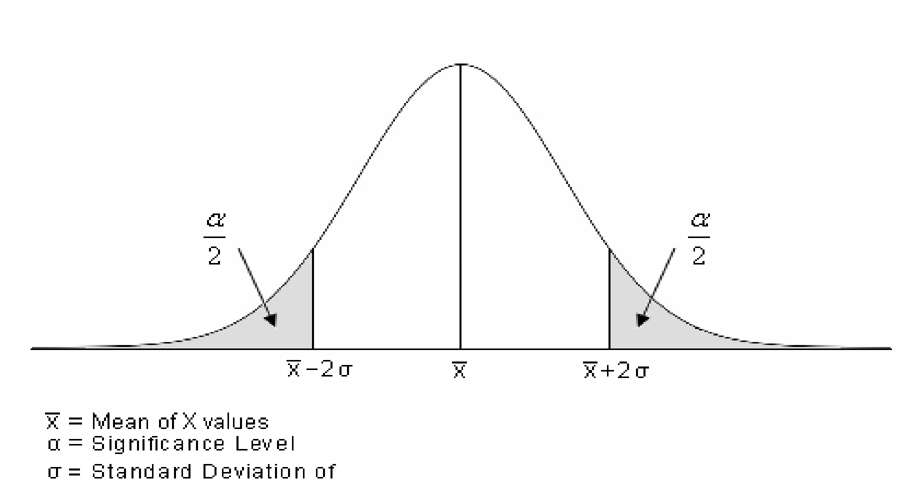
2.2 Data management

Call center data management is important as a call center easily carries many Giga Bites worth of data on their server. It becomes necessary to eliminate excess data from the system.

Different types of call center data according to (Gans, Koole, & Mandelbaum, 2003)

- *Operational data*: Physically reflects the process and how data is handled
- *Operational customer data*: List of all calls handled by a network of contact centers
- *Operational agent data*: History provided of each agent that has logged in
- *Marketing data*: The corporate information system is responsible for data
- *Human resource data*: Recorded history of the agents
- *Psychological data*: Gathered surveys of all participating parties

The processing times of each operation mostly follows a Normal distribution. A Normal distribution consists of a set of random variables with a mean (μ) and standard deviation (σ). (Larry E. Richards, 1983)



2.3 Inventory

Inventory is defined as the stock of any item or resource that is used within an organization. Controls are used to monitor the levels of inventory and to determine what levels of inventory needs to be maintained, when stock needs to be replenished and the size of the orders. (Chase, 2006)

2.3.1 Inventory Costs

Holding/ carrying costs: Includes the cost of storage facilities, handling, insurance, pilferage, breakage, obsolescence, depreciation, taxes as well as the opportunity cost of capital. If the holding cost is relatively high, it is clear that it would favor low inventory levels.

Setup costs: Includes the cost of obtaining materials, arranging specific equipment setups, filling out the required papers as well as the moving of the previous stock of material.

Ordering cost: Includes the clerical and managerial costs to prepare the purchase order.

Shortage cost: If there should be insufficient stock, the order will either be canceled or wait until the stock is replenished.

2.3.2 Fixed-order Quantity Models

These models determine the point at which an order should be placed and how large the order should be. This means that and order of size Q is placed when the on hand inventory reaches the point R. The **Inventory Position** is defined as on hand add the on order less the backordered quantities.

Certain assumptions are made using a Fixed-order Quantity models:

- The demand is constant as well as uniform throughout the period
- The Lead time is constant
- The price per unit is constant
- The holding cost is based on the average inventory
- Setup and ordering costs are constant
- All demand will be met

The total cost (TC) of an order is calculated using the following equation:

Where…

TC = Total annual cost

D = Annual demand

C = Cost per unit

Q = Quantity of order

S = Setup cost

R = Reorder Point

L = Lead time

H= Annual Holding cost

By using the derivative of the equation of the TC, we get the optimal order quantity, also known as the Economic Order Quantity (EOQ):

If safety stock is not taken into account, the reorder point R is

Where *d* is the average daily demand and *L* is the lead time is days. If the demand is to a certain extent uncertain, safety stock is taken into account by using:

Where *z* is the number of standard deviations for the service probability and is the standard deviation of usage during lead time. (Chase, 2006)

2.4 Quality of service

Different measures exist in call center operations stated by (Gans, Koole, & Mandelbaum, 2003). Effectiveness is a measure for customer satisfaction. It indicates whether the necessary work has been performed without rework. The criterion being whether or not, the customer's request has been submitted successfully. A second quality measure is the agent's personal interaction with the customer i.e. being polite, using the customer's name, etc. A third indicator is the agent's knowledge and the protocol followed.

2.5 Measuring service quality

In most inbound call centers, the arrival of calls are denoted by a Poisson distribution (Gans, Koole, & Mandelbaum, 2003). The affirmed contract conversion is assumed to be an entity.

If the arrival rate of entities in the system is a constant, then the estimated time that customers wait can be calculated using the Erlang formula (Jongbloed & Koole, Accesed in 2010). This is explained later on. This is, however, unlikely. It is therefore proposed that this arrival rate must be modeled as a random variable (Jongbloed & Koole, Accesed in 2010).

The total labor cost is quantifiable and can be applied as a performance measure when proportioned to income created. The optimum number of both flexi and permanent personnel is to be determined with a prediction interval in the Erlang formula. The lower bound will indicate the number of fixed personnel. The difference between the upper and lower bounds will then indicate the number of flexi agents required (Wallace & Whitt, 2005).

In call marketing (outbound) the call volume is to a certain extent known, and there is no waiting time, since the customer is being called. Therefore agents control the number of calls in a given period of time. There is no incoming traffic. The variables in call marketing are the number of agents per shift and the average duration of a call. Both variables are affected by the day of the week, public holidays and the time of month.

There are two scenarios where a customer is called. The first is a customer who is by no means interested in the proposed offer and the call ends quickly. The other is when a customer is interested and the process is taken to the next step. The call handling time is exponentially distributed (Jongbloed & Koole, Accesed in 2010).

2.6 Capacity Management

In inbound call center operations, a tradeoff between resource utilization and accessibility needs to be made (Gans, Koole, & Mandelbaum, 2003). This is due to the fact that higher utilization rates lead to longer delays in the queue given the resource allocation. Companies make use of some workforce management tools to support this tradeoff. In most cases, there exists a direct link between system-performance and operating cost, therefore, the desired action would be to optimize the output to cost ratio by minimizing the operating cost. It is stated that the "operations cost grows linearly to the average number in queue due to the use of toll-free services or out-of-pocket services. Call centers do make use of extra hardware capacity, but they often neglect the fact that planning models do not account for other types of bottlenecks in the system." (Gans, Koole, & Mandelbaum, 2003)

Number of calls arriving

The graphs below shows the general flow of arriving calls in an inbound call center...

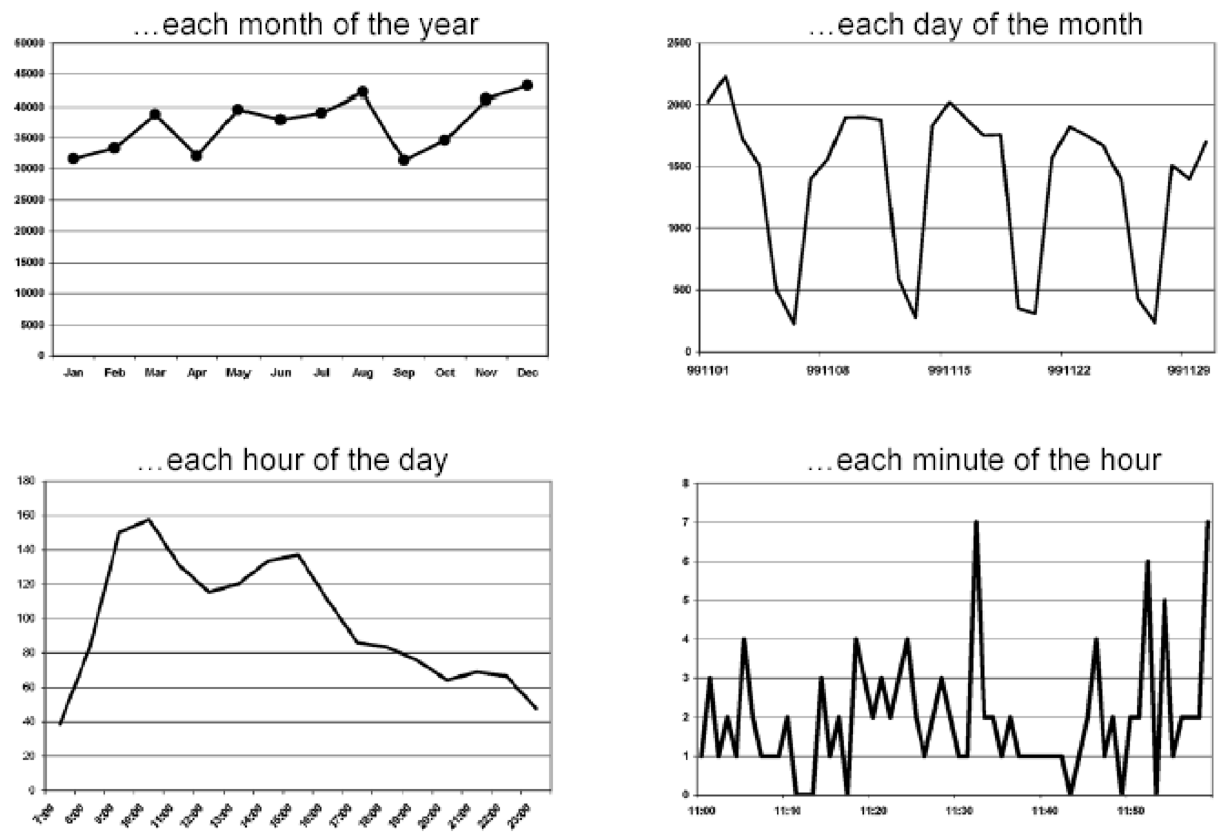


Figure 1 – A graphical presentation of arrival rates by (Gans, Koole, & Mandelbaum, 2003) adapted form (Buffa, Cosgrove, & Luce, 1976)

Arrival rates vary according to different time intervals. A day to day interval usually depicts stochastic variability while longer periods tend to show predictable variability. The approach adopted to solve a resource capacity problem makes use of queuing models, scheduling models and hiring models (Gans, Koole, & Mandelbaum, 2003).

2.7 Analysis of call center operations

2.7.1 Functioning of inbound systems

As previously mentioned, in an inbound center the calls are coming in at an arrival rate that follows a Poisson distribution. The average service level is denoted by an exponential distribution. The service level is measured in terms of queue duration, in other words, how long a customer has to wait before attended to.

If

λ: Arrival rate

μ: Average service rate of the call center

S: Number of agents available per shift.

Then (Winston, 2004) states that the utilization factor is…

$$\rho = \frac{\lambda}{S\mu}$$

The probability of *n* number calls entering the system is $\boldsymbol{\pi_n}$ (Winston, 2004)

$$\pi_n = \left(\sum_{i=0}^{S-1} \frac{(S\rho)^i}{i!} + \frac{(S\rho)^S}{(1-\rho)S!} \right)^{-1}$$

Thus the probability of a customer waiting to be served can be calculated by subtracting the probability of the number of calls entering the system from (Winston, 2004)

$$P(Customer\ Wait) = 1 - \left(\sum_{i=1}^{n} \pi(n) \right)$$

In the same way the probability of the number of agents being idle can be calculated using π_n. If there are four agents available (*S=4)…*

$$P(Agent\ idle) = 4\pi_0 + 3\pi_1 + 2\pi_2 + 1\pi_3$$

And subsequently the probability of an agent not being idle which is *1-P(Agent idle).*

These values are used to calculate the average time any agent will be idle or not idle in a given period of time. The average idle time of an agent per week or working day can be determined and thus the over or under utilization of resources is given.

Further, the average time that a customer spends in the system *(w)*, is calculated by (Winston, 2004)

$$w = \frac{L}{\lambda}$$

And the average waiting time of a customer being in a queue *(w_q)* (Winston, 2004),

$$W_q = \frac{P(j \geq S)}{S\mu - \lambda}$$

With…

$$P(j \geq S) = \frac{(S\rho)^S \pi_0}{S!\,(1-\rho)}$$

L: Average number of customers in the system

Lq: Average number of customers in the queue

$L = L_q + L_S$

With L_S according to (Winston, 2004) being…

$$L_S = \frac{\lambda}{S\mu}$$

And L_q…

$$L_q = \frac{P(j \geq S)\rho}{(1-\rho)}$$

2.7.2 Erlang Formula

.The use of the Erlang formula is centered on a fixed period of time. The average service time is given by the inverse of μ and the average arrival rate is given by λ. The call center is modeled as a M/M/c/∞ system which has an independent arrival rate with intervals between arrivals equal. In order to use the Erlang formula, the service times need to be exponential with a stationary position. W is the average waiting time and the load of the system. **a** is calculated by multiplying the average arrival rate with the average service time, thus a=λ/μ. When the load is greater than the service capacity, then $a \geq c$, and the number of calls increases to infinity. Jongbloed & Koole (Gross & Harris, 1985) states that

Where

With the probability of delay, the offered load (a) equals λ/μ and the utilization rate (ρ) equal to λ/(cμ).

Using the Erlang formula for simple call center calculations, the probability that there will be a delay in the system is determined. The goal is to use the findings to manage resources such that the load on the system is minimized by either reducing the service rate (μ), or increase the capacity (c) without increasing the waiting time in the queue.

2.8 Simulation as a tool

2.8.1 Introduction

Simulation has to a great extent replaced analytical techniques in solving different problems. (REF) Simulation software programs and models compensate for the inability to implement mathematical skills for the solving of analytical models. According to (Gans, Koole, & Mandelbaum, 2003), it is best to integrate analytical models with simulation. Analytical models, even limited in scope, will improve the use of simulation in problem solving. The journal also states that since capacity and human resources costs account for 60-70% of the total operating expense, simulation should point out the opportunity that exists to effectively manage capacity and human resources.

Simulation is used to estimate certain service level requirements. It uses a number of fixed variables to run the simulation. When using simulation as a problem solving tool, it is important that variable inputs are derived from a large sample size, using the correct statistical methods (Atlason, Epelman, & Henderson, 2004).

2.8.2 Goals of simulation

According (Atlason, Epelman, & Henderson, 2004), the main goal of simulation as problem solving tool in call centers is to minimize the operating cost of the center under a set of constraints on the quality of service (QoS). The main deliverable of the simulation is to decide on the number of agents of a certain skill group to schedule in the call center as a function of time ($F(t)$). If the agents of a particular call center fall into a single skill group, the simulation is a straight forward formulation of the number of agents and their service times against the arrival rate of calls.

2.8.3 Arena as simulation tool

Arena is a modeling system, develop by System Modeling Corporation® in 1993. Arena is used to create a virtual map of almost any queuing system (Andradottir, Healy, Withers, & Nelson, 1997). In Arena the layout of a system of objects can be designed/determined/portrayed and includes machines, operators and material handling devices. The language System Modeling Corporation used to build the Arena simulation tool is called SIMAN. Increased system flexibility and control is the core benefit of using the SIMAN language (Andradottir, Healy, Withers, & Nelson, 1997). In total, Arena consists of 60 modules to provide core features for inspection, queuing, resources and external file interface. Another important function of Arena is its support of Active X, which allows the user to embed Excel spreadsheets and other Microsoft office applications. With this function a database of quantified information can be directly inserted.

2.8.4 Simulating a call center using Arena

To build a simulation model, the first step is to draw up a detailed flowchart to indicate process status and data flow. The model follows an 'IF/THEN/ELSE' logic (Andradottir, Healy, Withers, & Nelson, 1997).

In Arena there is a Pentium-based simulation tool called Arena Call Center which models call centers and generates reports as a measure of the effectiveness of call centers using built in software (Miller & Bapat, Accesed in 2010). The benefit of using Arena Call Center is that it minimizes the time it takes to construct the model, although the general Arena program is just as effective but it is more time consuming to construct.

In Return on investment (ROI) analysis the operational cost factors are mapped against the key performance indicators selected. The performance indicators (Miller & Bapat, Accesed in 2010) selected is

- Service level as reflected by (defined as),
- Average delay in queue,
- Average speed of answer,
- % utilization,
- Secondary Abandoned Rate,
- Overflow Rate.

The important costs to consider are

- Trunk cost,
- Agent cost

against the number of calls serviced.

To assign agents the time is divided into eight-hour shifts. With staff scheduling, one first specifies the schedules with the decision variables consisting of the number of agents. In some cases, the use of a shrinkage factor is needed to adjust the number of agents scheduled for a specific time period. This shrinkage factor is in the form of a triangular distribution which can be derived from historical data. Adapted from (Miller & Bapat, Accesed in 2010)

$$Trunk\ Cost = Service\ level + Average\ delay + Average\ speed$$

$$Agent\ cost = \%\ Utilization$$

$$Number\ of\ calls\ serviced = Secondary\ abandoned\ rate + Overflow\ rate$$

The Operational cost is then…

$$Operational\ Cost = \frac{Trunk\ Cost + agent\ cost}{Calls\ serviced}$$

The objective function is to minimize the cost of agents. The fraction of calls answered, is considered the service level of the center.

2.9 Conclusion

Sufficient research has been done on call center and call center operations in particularly inbound systems. By using certain mathematical and probability modals and integrating it with a simulation program such as Arena, a clear can be found in order first visually interpret and secondly improve call center operation and efficiency.

Chapter 3

3.1 Method and Formulation

3.1. Tools and Techniques

In order to visually map the process, *Microsoft Visio 2007* has been identified to draw up a flowchart of all the processes within the system. This flowchart will be used as a template to build the *Arena*® simulations model when all relevant data is gathered.

After conducting research, the Arena model is the most effective tool to simulate the call center process, do an analysis of the results and then offer a proposed solution.

According to (Miller & Bapat, Accesed in 2010), these are the advantages of using simulation to solve problems

- A controlled environment is provided for the evaluation of performance
- Changes are easily made in the model and one can quickly evaluate changes and results
- Due to the cost effectiveness, the whole call center environment can be modeled.
- It has the ability of simulation both light and heavy volume days
- In conducting a sensitivity analysis, the model easily controls other influencing factors.

A Fixed-order quantity model will be used to calculate the economic order quantity and intervals of orders.

3.2 Data analysis

3.2.1The Process

Cell C uses four different Enterprise Resource Planning (ERP) systems.

- Oracle – Database
- Clarify – Customer relationship management system
- PIGO – RAM Courier
- C – Advance - The link

The whole process from initiation to termination has been divided into different phases depicting the different departments and people involved in the system of processes. This focuses the area of work to capture all information in detail.

RICA Registration

The Regulation of Interception of Communications and Provision of Communication-Related Act (RICA), was introduced in 2009 and is a new law by the South African government. The aim of implementing RICA in South Africa is to help law enforcement agencies use cell phones to narrow down on criminals and criminal activities. RICA registration is compulsory for all Prepaid and Contract holders in South Africa, both current and new. The registration is a timely process in need of a large number of personal information. Information include…

- Residential Address
- Passport or ID number
- Full names and surname
- SIM card details
- Cell phone number

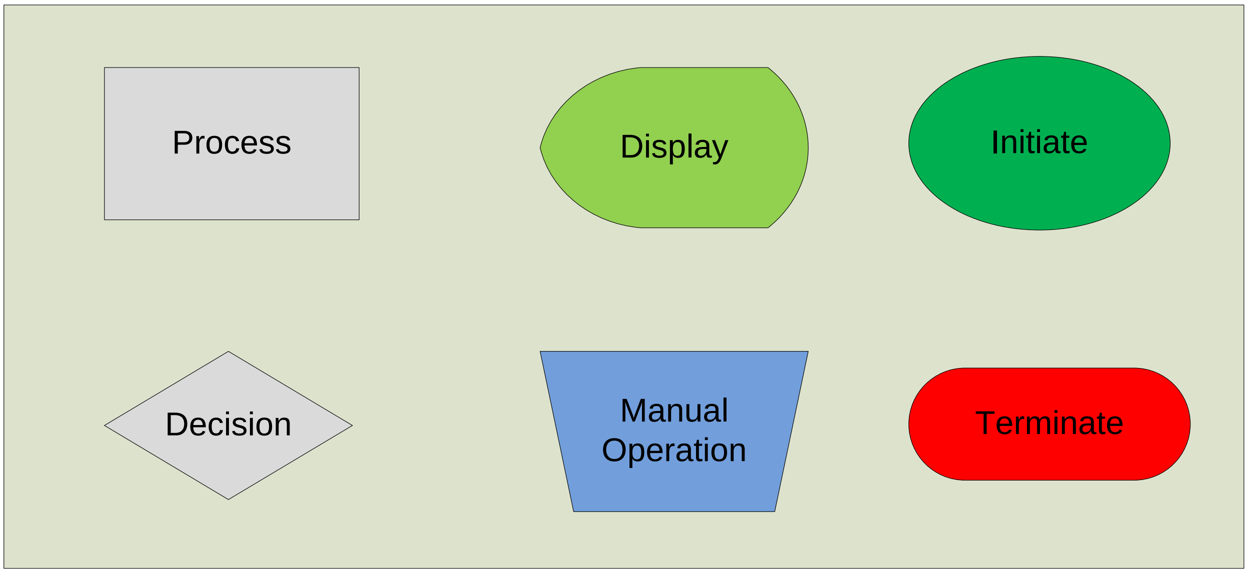
Failure to register for RICA will result in the deactivation of SIM cards in December 2010.

RICA and Cell C's call center

In the case of the Cell C call center process, if a customer would like to convert to a contract, he/she has to register with RICA before the SIM is activated. As RICA is a new and compulsory process added to the existing operation, new variables enter the system…

- Time it takes to gather correct information from the customer
- Time it takes to do the registration
- Appropriate agents familiar with registration (train or add new)
- Where in the flow of operations to insert registration process.

The key for interpreting the flow chart:



3.2.2 Flowchart

The flowchart is generic following a Pre to Post format from Initiation to Termination. The flowchart is broken down into the different departments. A phase number is allocated to each department and process within that department.

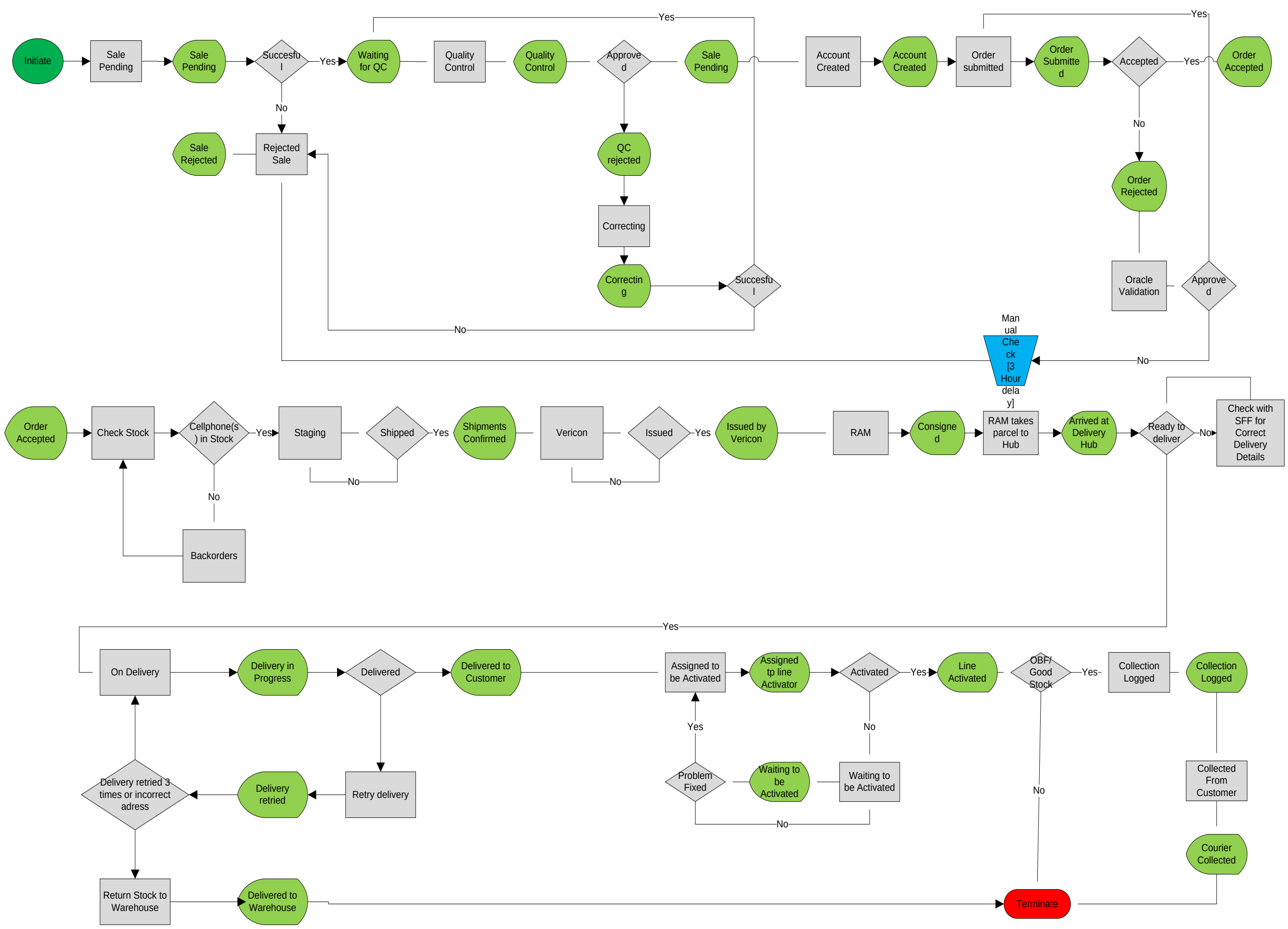


Figure 2 - Process flow from initiation to termination

3.2.2.1 Phase 1

The call is initiated automatically by a computer system. Once the process is in the ‘Sales Pending’ status, a unique reference number is given to trace the product in the system. The unique reference number is the form of *SPI000####*. All these numbers are automatically saved to the IPS database.

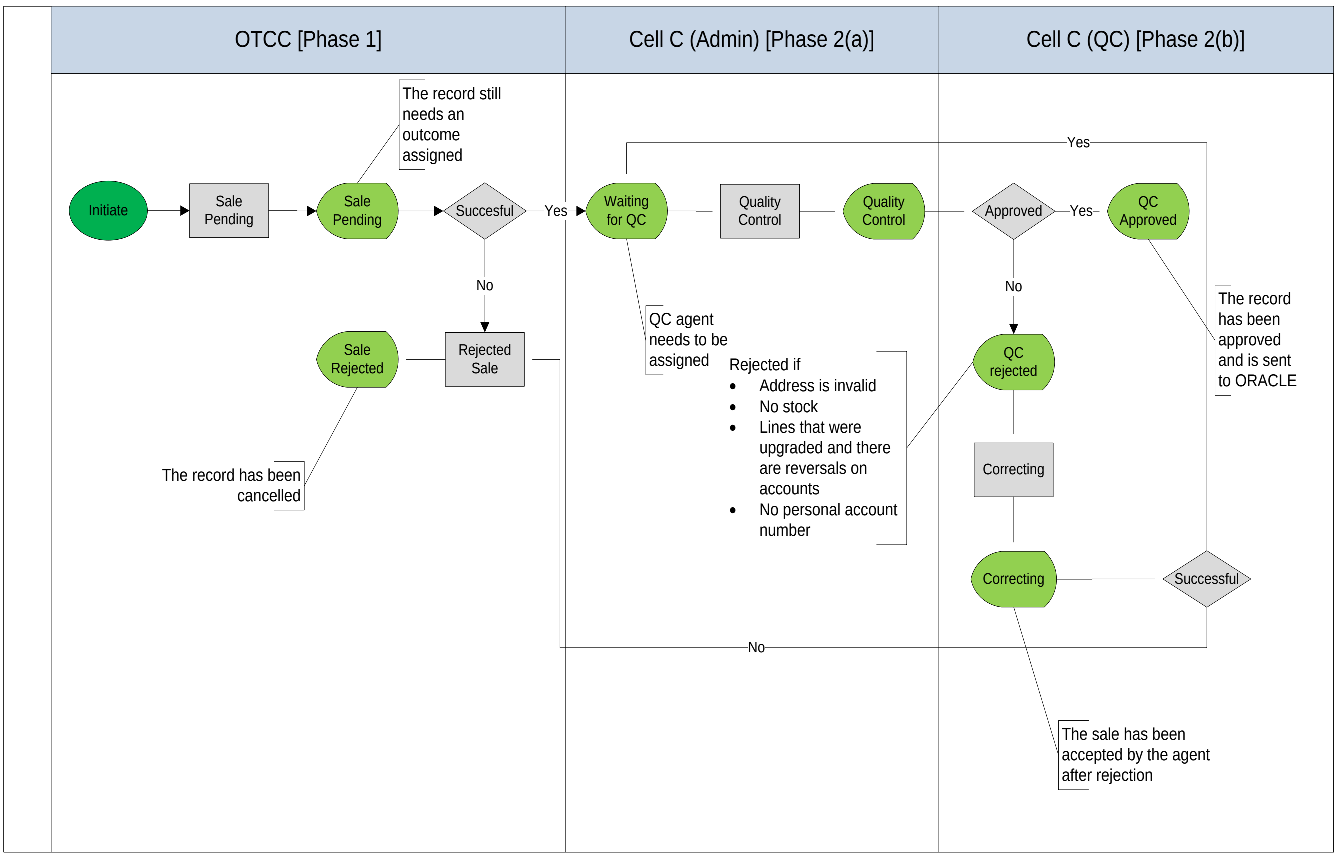


Figure 3 - Phases 1 to 3

3.2.2.2 Phase 2

Phase two represents the Quality Control and Administration departments. This phase is apart from the sales department and reserves all administration rights. They have the power to change information and are also responsible for the XDS Credit check. The ERP system used in this department is C- Advance.

The record is assigned to a QC agent and will either be rejected or approved. There are two main checks performed by the QC agent, the New Line check, and the Upgrades Check.

New Line check:

- It is compulsory that salary is sufficient with business rules.
- Delivery address must be complete
- Must have no other lines in the last three months or duplicates
- Account number captured is the same as account number in Clarify
- No returned payments in the last three months
- Account must not be in arrears
- Deal sold must be valid
- Client's data on C-advance must correspond with data in Clarify
- Handset sold must be in stock

Upgrades Check:

- Line must be renewed
- Line must have four months or less remaining
- Account number matches the line's account number in Clarify
- No returned payments in the last three months
- Account must not be in arrears
- Delivery address must be complete.
- Details must be valid
- Client's details on C-Advance correspond with client data in Clarify.
- Duplicates
- Handset sold must be in stock

RICA registration happens in phase two.

3.2.2.3 Phase 3

Phase 3 is the Oracle Auto Check and Oracle validation. The order is submitted and Oracle either accepts or rejects the order. If the order is rejected, it needs to be manually rechecked and validated by Oracle. If it fails to be approved again, it would move to the 'Sale Rejected' state. After approval, the order is in the 'Order Accepted' state and will proceed to the warehouse.

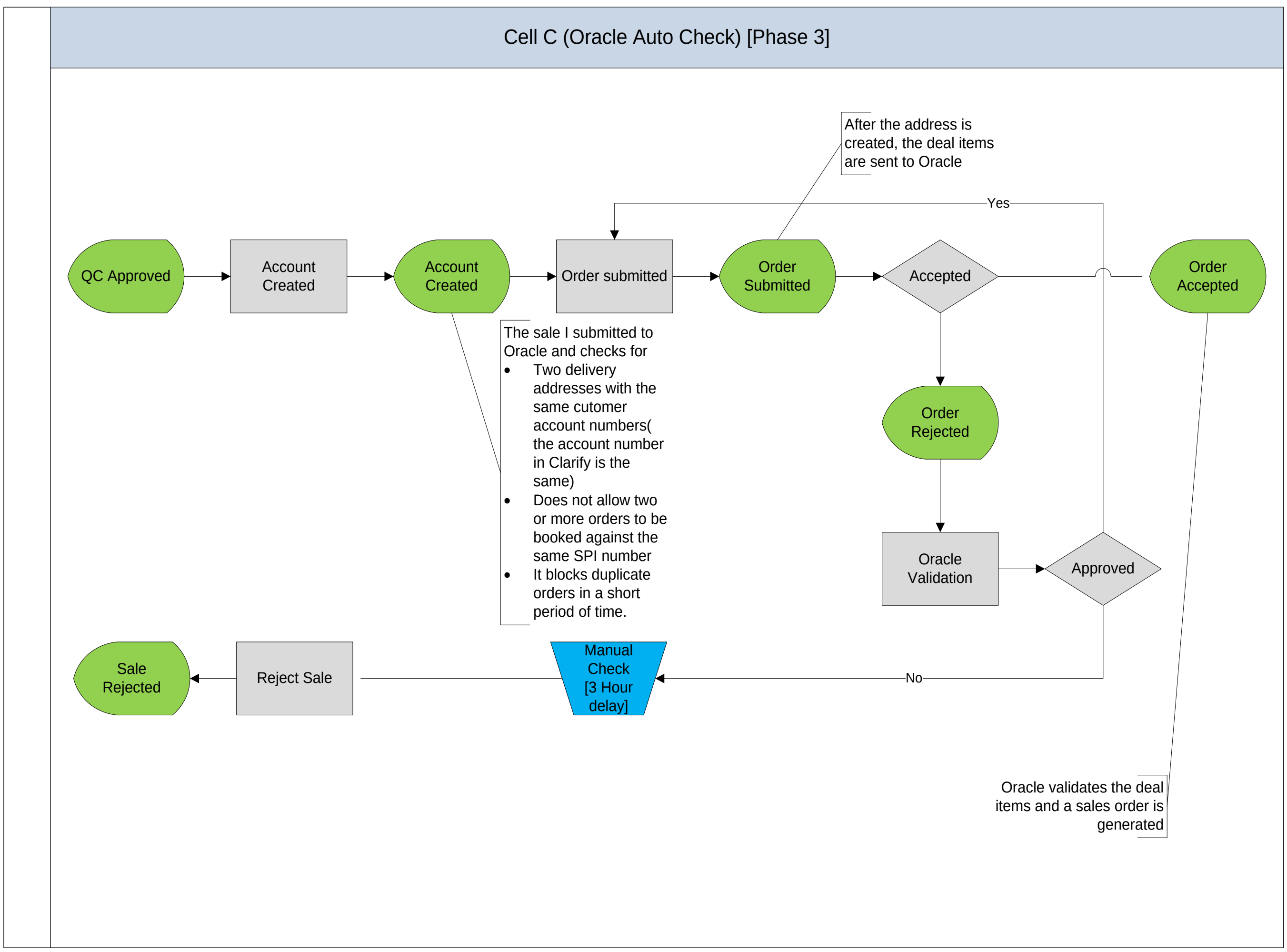


Figure 4 - Phase 3

3.2.2.4 Phase 4

Phase four consists of the warehouse operations of checking and preparing required stock. The warehouse makes use of daily reports to maintain desired stock levels and compensate for demand. Statistics shows that about 3% of the time the desired product is not in stock. It is a Single Order Picking system.

The stock is checked and verified by an external auditing company, Vericon. Vericon conducts a very thorough investigation and it therefore is a timely process. The order is check and rechecked to ensure a 100% correct and legitimate order.

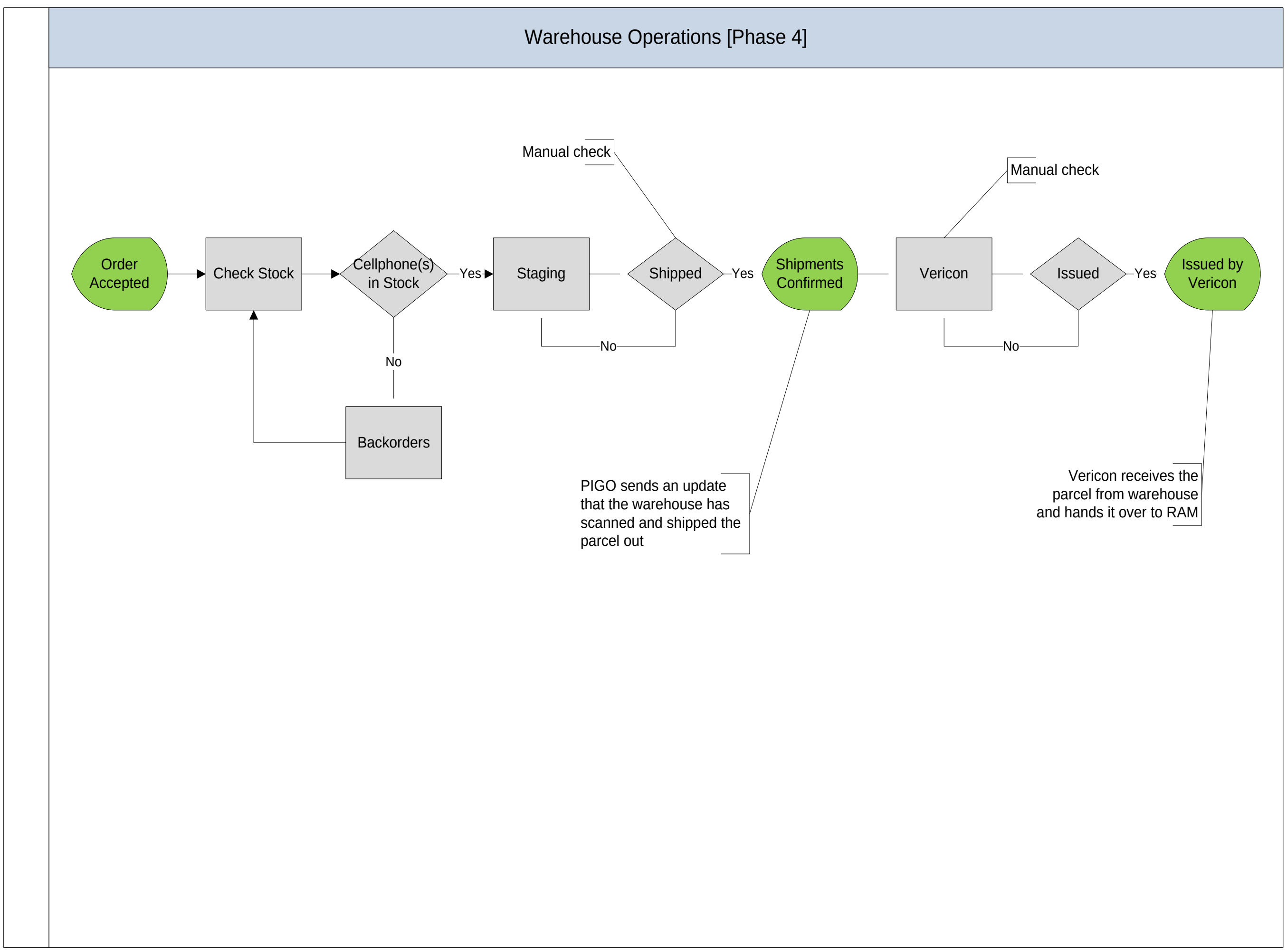


Figure 5 - Phase 4

3.2.2.5 Phase 5

Once the parcel has been verified and issued by Vericon and enters the 'Consigned' state, the data parcel transferred to the RAM system. The parcel is taken to delivery hub allocated nearest to the desired destination. If the parcel is ready for delivery, it goes out with the RAM courier. If not, the order is checked by Sales Fulfillment (SFF) which is a part of Quality Control for correct delivery details and resubmitted.

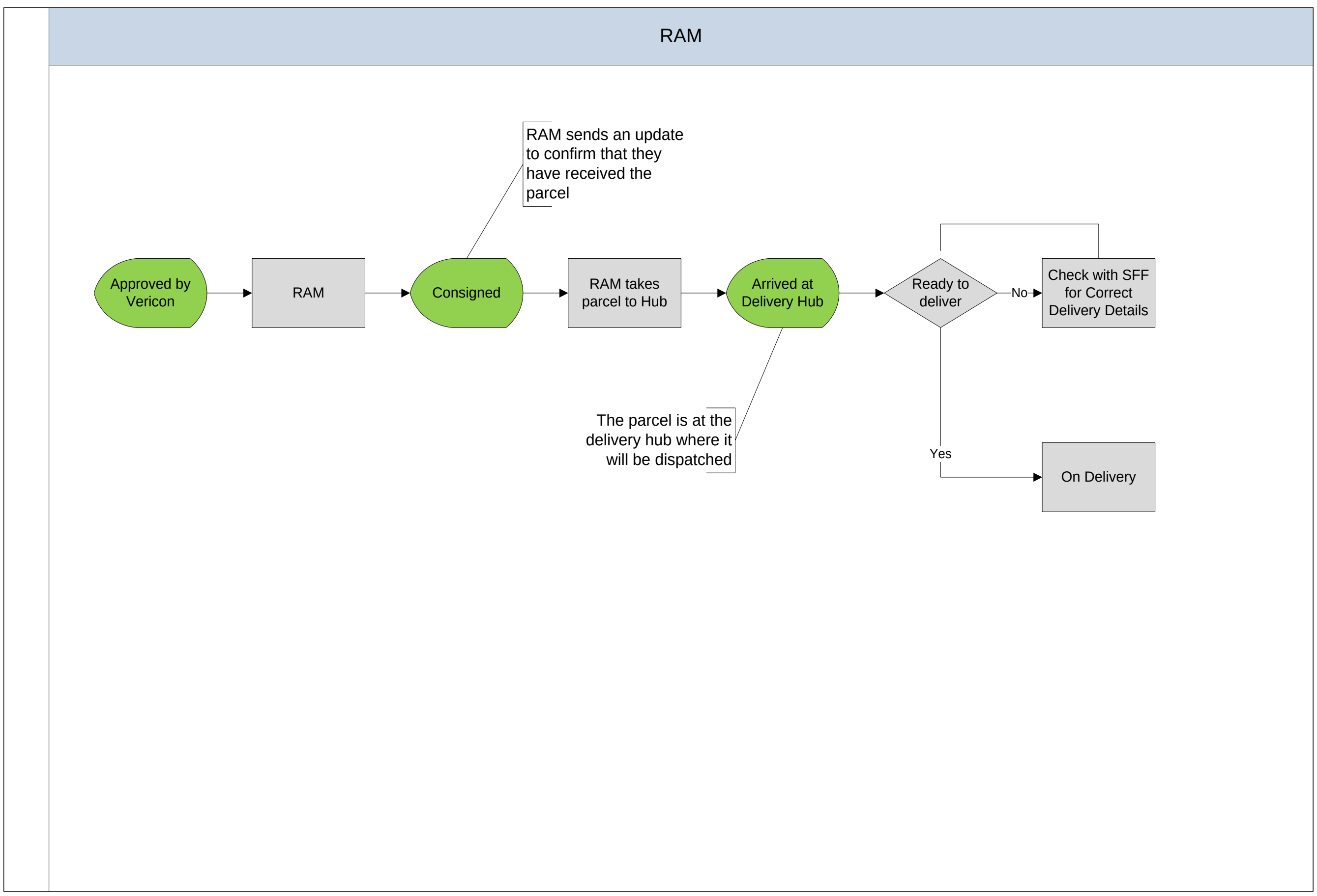


Figure 6 - Phase 5

3.2.2.6 Phase 6

The parcel goes out on delivery. If the delivery is successful, a Proof of Delivery is created (POD) and needs to be returned to Cell C by RAM. If the delivery process fails or the address is invalid, the process will be repeated three more times before it is returned to the warehouse and the order is terminated.

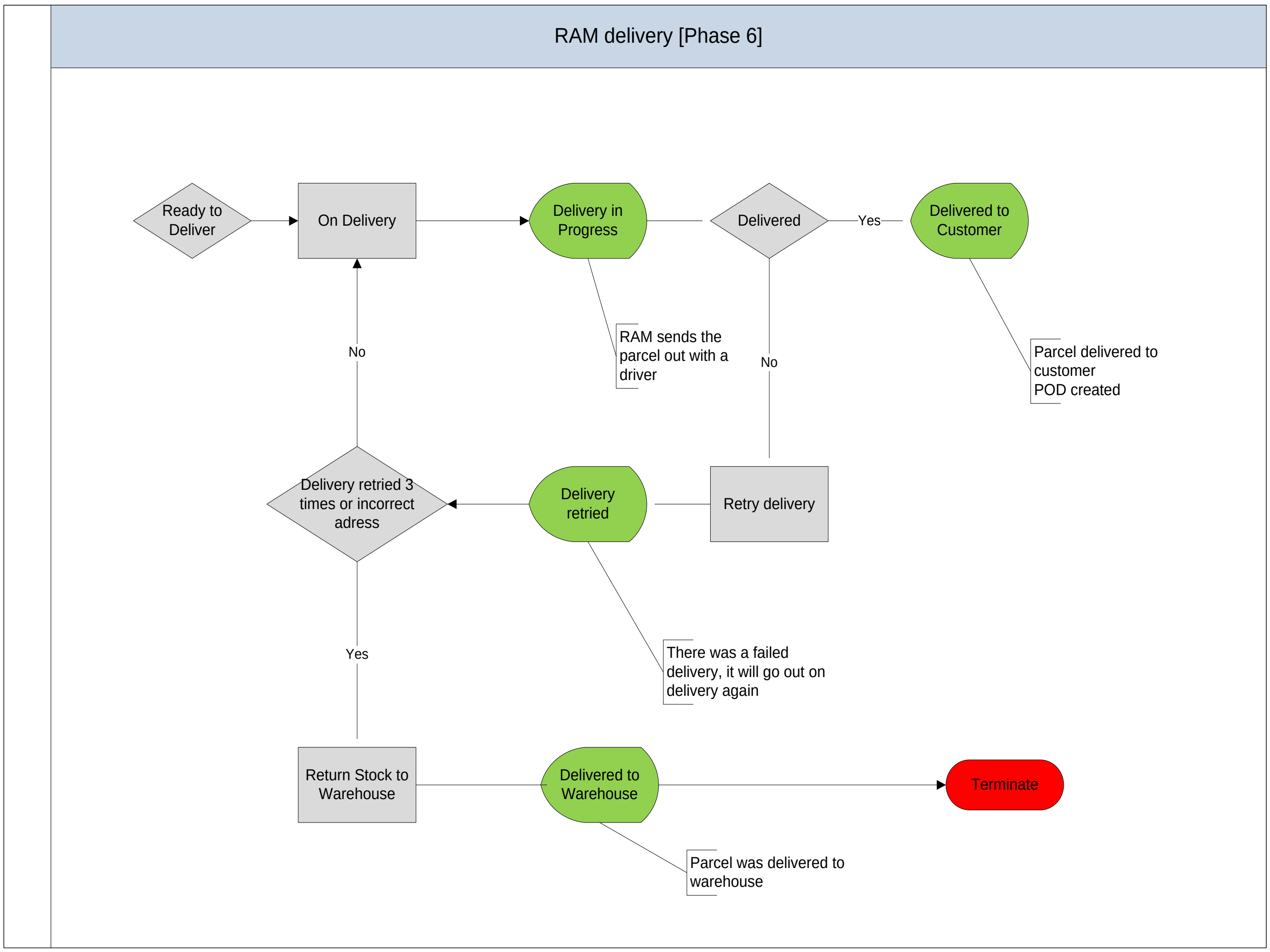


Figure 7 - Phase 6

3.2.2.7 Phase 7

If the system reaches Phase 7, the delivery was successful. The order is now assigned to a line activator to activate the line. If the line is not activated, it will continue with the process of activation until it is fully activated. If the line is successfully activated, the customer must check if the order delivered is complete and fully functional and the order is terminated. If there is an Out of Box Failure (OBF), the parcel is collected by RAM and enters the 'Courier Collected' status after which it will be terminated.

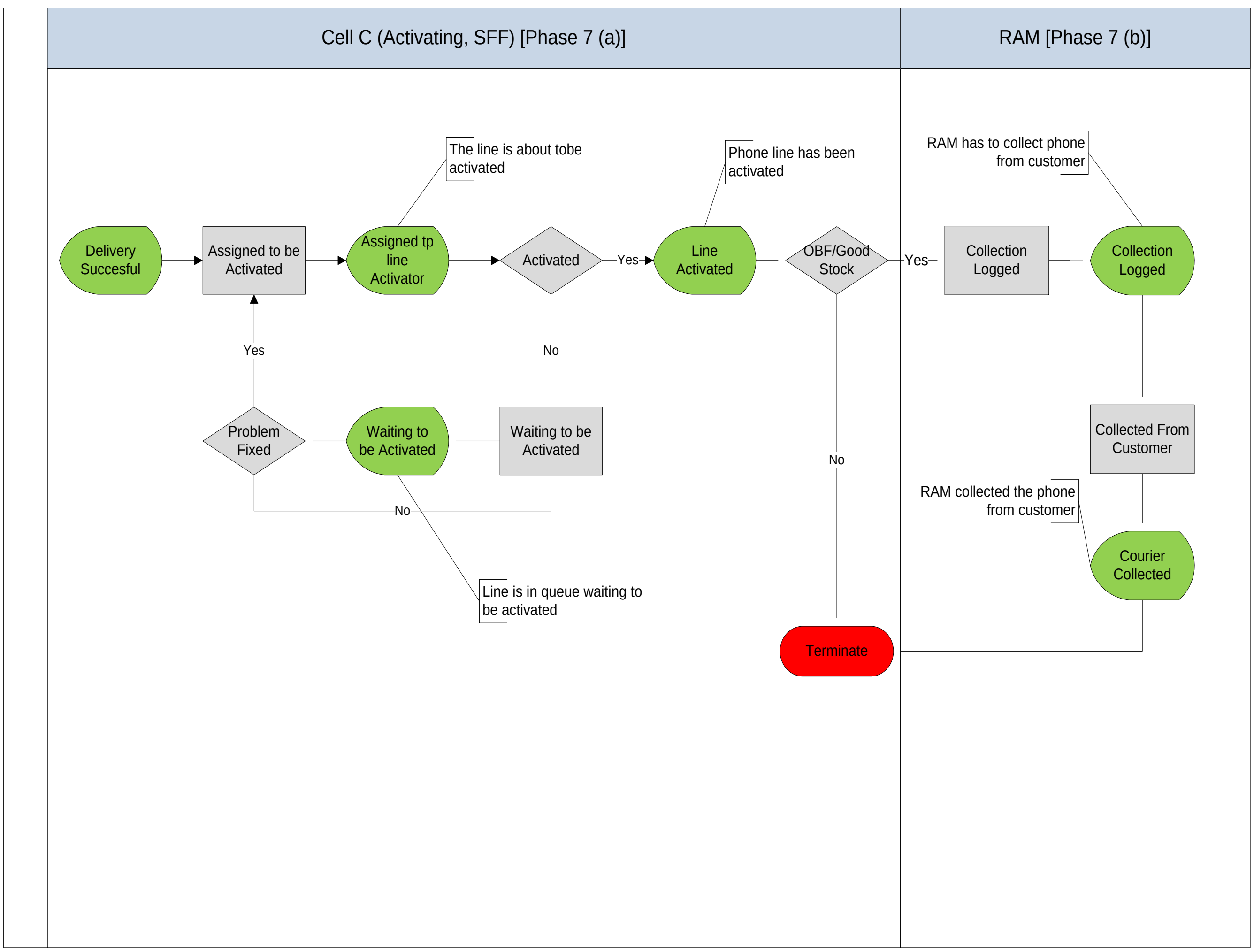


Figure 8 - Phase 7(a) and 7(b)

Chapter 4

4.1 As-Is Design

4.1.1 Status and Process Times

The following states times were derived for the different processes in the system. All of the times follow a Normal distribution with a standard deviation.

No.	Status	Resources	#	Distribution	Average (Minutes)	Standard Deviation (Minutes)
1	Sale Pending	Sales Agent	25	Normal	11	2
2	Sale Rejected	Sales Agent	25	Normal	3	1
4	Quality Control	SFF QC Agent	4	Normal	38	4
5	QC Rejected	SFF QC Agent	4	Normal	32	3
6	Correcting	Sales Agent	25	Normal	8	2
7	QC Approved	SFF QC Agent	4	Normal	14	2
8	Account Created	Oracle	1	Normal	3	1
9	Order Submitted	Oracle	1	Normal	4	1
10	Order Rejected	Oracle	1	Normal	22	3
11	Order Accepted	Oracle	1	Normal	5	1
12	Shipment Confirmed	Warehouse	4	Normal	332	9
13	Issued by Vericon	Vericon	3	Normal	284	4
14	Consigned	RAM		Normal	48	5
15	Arrived at Delivery Hub	RAM		Normal	492	16
16	Out on Delivery	RAM		Normal	205	12
17	Retry Delivery	RAM		Normal	38	5
18	Delivered to Warehouse	RAM		Normal	68	6
19	Delivered to Customer	RAM		Normal	314	14
20	Assigned to Line Activator	SFF Line Activator	4	Normal	18	2
21	Waiting to be Activated	SFF Line Activator	4	Normal	68	13
22	Phone Line Activated	SFF Line Activator	4	Normal	Forever	0
23	Collection Logged	SFF Customer Service	3	Normal	430	22
24	Courier Collected	RAM		Normal	92	14

4.1.2 As-Is Simulation Model

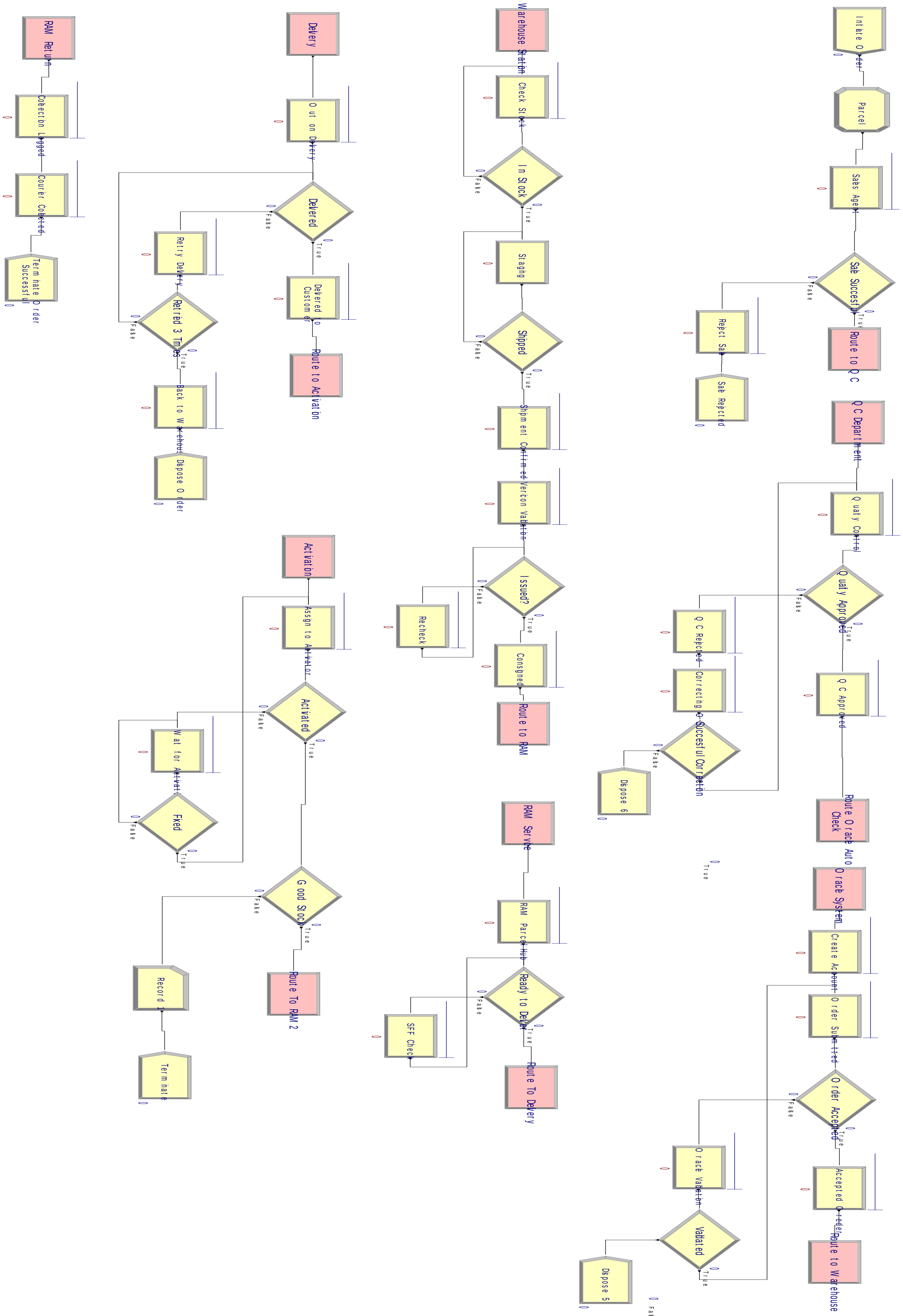
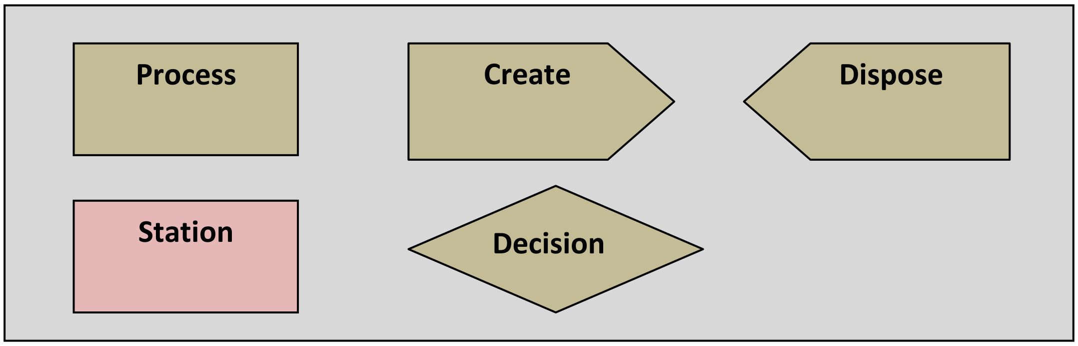


Figure 9 - Arena simulation model of the call center



4.1.2.1 Analysis of Model

Statistics from report generated of running the above model for ten, eight hour working days.

The resources and their corresponding utilization rates:

Resource	*Utilization*
SFF QC Agent 1	0.9988
SFF QC Agent 2	0.8123
SFF QC Agent 3	0.6807
SFF QC Agent 4	0.5475
SFF Line Activator 1	0
SFF Line Activator 2	0.064
SFF Line Activator 3	0.063
SFF Line Activator 4	0
Vericon Agent 1	0.9657
Vericon Agent 2	0.9623
Vericon Agent 3	0.936
Warehouse 1	0.4465
Warehouse 2	0.2449
Warehouse 3	0.092
Warehouse 4	0.0209
Warehouse 5	0.307
Warehouse 6	0.137

Table 1 - Resource Utilization factors

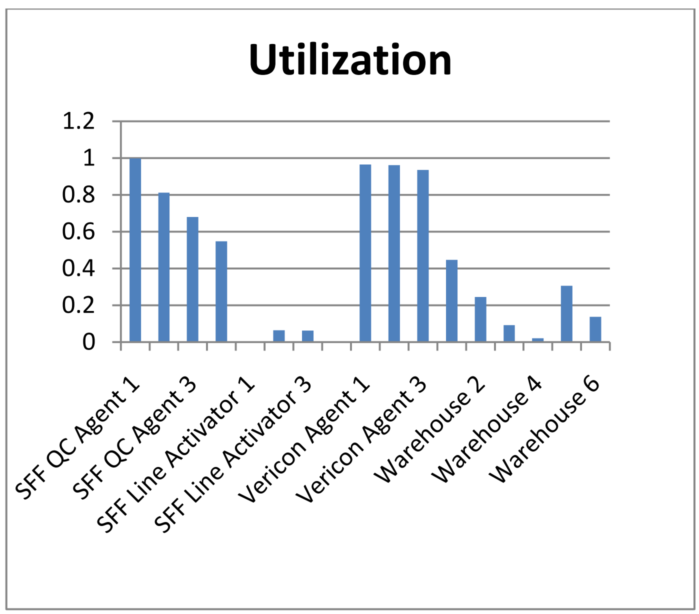


Figure 10 – Graph of Resource Utilization Graph

Using the data gathered the bottlenecks in the system have been identified.

And the processes with their corresponding waiting time and average queue length:

Process	***Waiting Time (min)***	***Number Waiting***
QC Rejected	75.39	2
Quality Control	160.63	19
Recheck	1484.99	4
SFF Check	176.31	2
Vericon Validation	1107.76	34

Table 2 - Process Waiting Times and Number Waiting

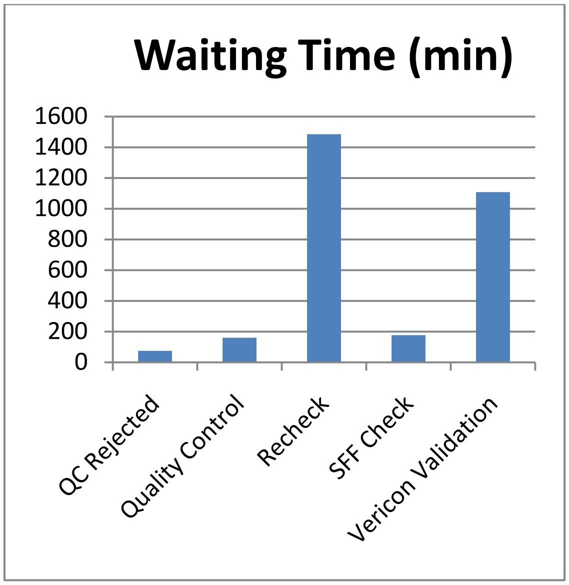


Figure 11 – Graph of Entity Waiting Time

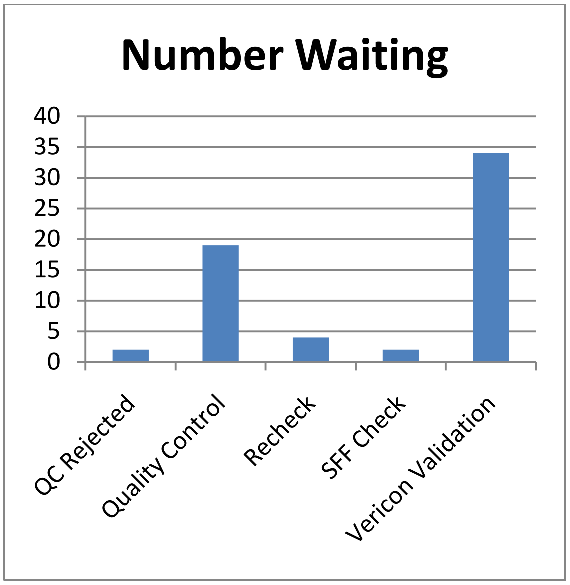
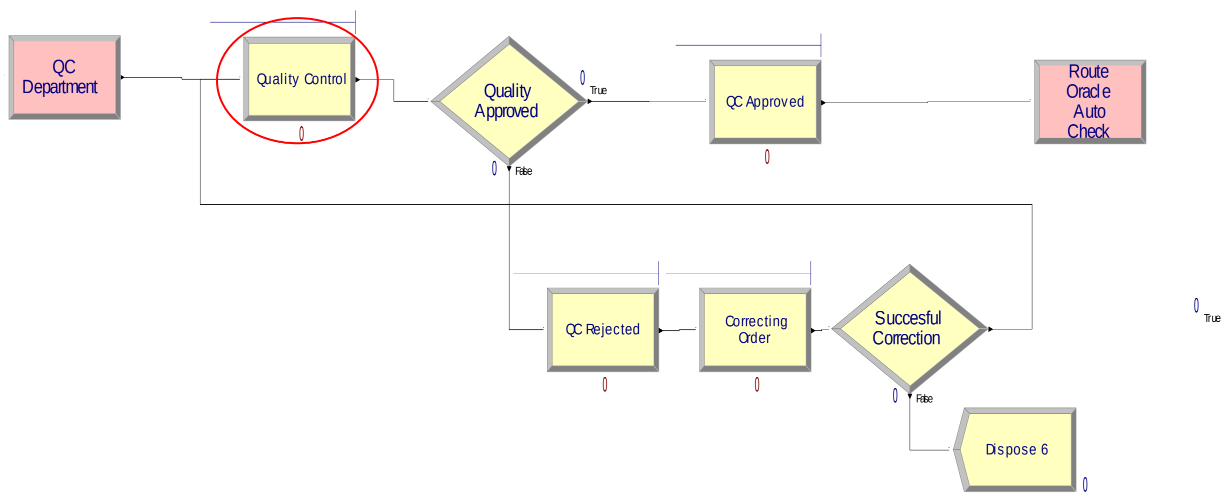


Figure 12 – Graph of Average Queue Length

A few problem areas were detected in the current system. The under and over utilization of resources resulting in either long queues or idle resources. The stations were inserted to keep track of each department individually and monitor performance. The problem areas are as follows:

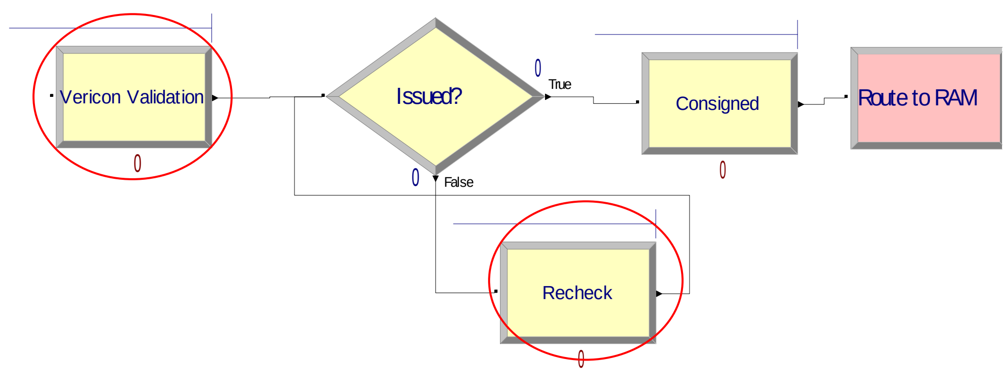
SFF Quality Control process

- Large queue in front of QC
- The average waiting time is reported as 160.63 minutes per order
- Due to the large number of incoming orders but limited QC resources
- Options in reducing processing time is limited
- If the order is rejected, it delays an already over busy QC agent



Vericon validation process

- Large queue in front of Vericon validation
- Vericon is an external service provider
- Only three Vericon agents available at the moment



SFF correct delivery details check

- Utilizes the QC agent for the process
- Order queues until agent is available

SFF line activator

- Extremely underutilized resource because of long QC and Vericon processing times
- The instantaneous utilization of Line activator two is 0.064 and Line activator three is 0.063, while both one and four are 0.

SFF Customer service

- Only utilized if there is an OBF(out of box failure)
- Underutilized and long idle times as the probability of an OBF is 5%

Warehouse

- Discovered an approximate 15% stock shortage
- Mostly caused by high demand of popular phones
- EOQ models and sufficient forecasting

The average time an order takes form initiation to successful delivery is between 6.1 and 8.7 days (eight hour working days) according to the simulation report. Management requests a 4.5 day cycle.

The above mentioned problems can is visually portrayed using the Arena animation tool. The green blocks indicating busy resources and the white blocks with red lining, idle resources.

4.1.2.2 Resource Animation

Figure 13 - Animation of Resources

It is clear that both the SFF QC department and the Vericon validation department is utilized at full capacity resulting in unwanted queues and leaving the SFF Line activating resources idle to a great extent. The warehouse, apart from the Vericon validation process is coping at current capacity.

4.2 Proposed Solution and To-Be Design

4.2.1 Proposed Changes

After evaluating the results of the As-Is system, some distinct changes are made in the new To-Be model. As it is an objective of management to reduce parcel cycle time and decrease idle resources without incurring any further expenses, it was most effective to look at applying the current resources in improving the system, rather than seek for alternative and external solutions. For this purpose, shifting agents and current staff, as well as relocating them to needed departments is selected as the preferred approach. External resources such as Vericon, may however find that they could incur additional costs because of being a critical bottleneck, but do not fall under Cell C management.

SFF Quality Control process

- Add two additional QC agents to SFF Quality Control Department
- Transfer agents from SFF Line Activator Department
- Total SFF QC Department staff equals six.

SFF line activator

- Reduce SFF Line Activator staff from four to two

Vericon validation process

- Add one more Vericon agent
- Monitor utilization rates and queuing times to determine most critical bottleneck

Warehouse

- Reduce the stock-out margin

4.2.2 Results of To-Be System

The results from the new report was plotted against the As-Is report shown above.

Resource	***Utilization (Old)***	***Utilization (New)***
SFF QC Agent 1	0.9988	0.8707
SFF QC Agent 2	0.8123	0.6775
SFF QC Agent 3	0.6807	0.5106
SFF QC Agent 4	0.5475	0.6506
SFF QC Agent 5 (New)	-	0.5557
SFF QC Agent 6 (New)	-	0.3558
SFF Line Activator 1	0	0.1219
SFF Line Activator 2	0.064	0.02212
SFF Line Activator 3	0.063	-
SFF Line Activator 4	0	-
Vericon Agent 1	0.9657	0.9657
Vericon Agent 2	0.9623	0.96
Vericon Agent 3	0.936	0.936
Vericon Agent 4 (new)	-	0.9359
SFF Customer Service 1	0.156	0.2838
SFF Customer Service 2	0.09638	0.1269
SFF Customer Service 3	0	-
Warehouse 1	0.4465	0.5881
Warehouse 2	0.2449	0.4711
Warehouse 3	0.092	0.2892
Warehouse 4	0.0209	0.1201
Warehouse 5	0.307	-
Warehouse 6	0.137	-

Table 3 - To-Be Utilization Rates

The old utilization rates are compared to the new utilization rates. In the graph below, the blue graph indicates the old rates, with the red indicating the new. The average utilization has increased with an average of 15.799% by only applying these few changes. This percentage is influenced greatly by both the SFF Line Activator and the SFF Customer Service departments. Although both of these departments already experienced a decrease in resources, theoretically, it is possible to further reduce the number of resources to 1 only, but in practice it is not advised.

This is mainly due to the fact that the probability of queues as inputs are largely random as well as direct interface with the public in the case of the SFF Customer Service department.

Graph of Table 3 data:

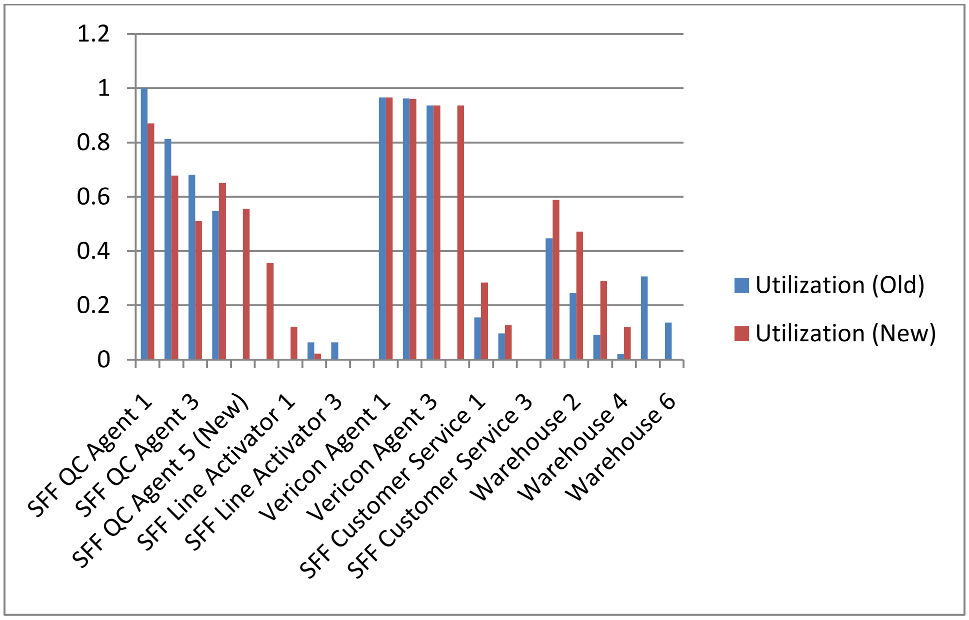


Figure 14 – Graph of Old and New Resource Utilization Rates

SFF Quality Control process

If the number of confirmed contract orders increases, the SFF QC department would be the second most critical bottleneck in the system. With the added two QC agents, the utilization rate has dropped by 14%, yet has a significant impact on the average waiting time. It would compensate for the increased arrival of incoming orders.

Vericon validation process

The Vericon Validation process is the most critical bottleneck in the system and controls the pace of the process downstream. It is because of this pace set by Vericon that the resources, especially in the SFF Line Activator and Customer Service departments, have a very low utilization rate which in return results in high idle times. Even while the resource has been increased from three to four agents, the average utilization rate has dropped only by 0.5267%, indicating the criticality of this process.

The average waiting time:

Process	*Waiting Time Old (min)*	*Waiting Time New (min)*
QC Rejected	75.39	9.8596
Quality Control	160.63	5.0773
Recheck	1484.99	1221.38
SFF Check	176.31	5.2461
Vericon Validation	1107.76	743.8

Table 4 - Old and New Average Waiting Times

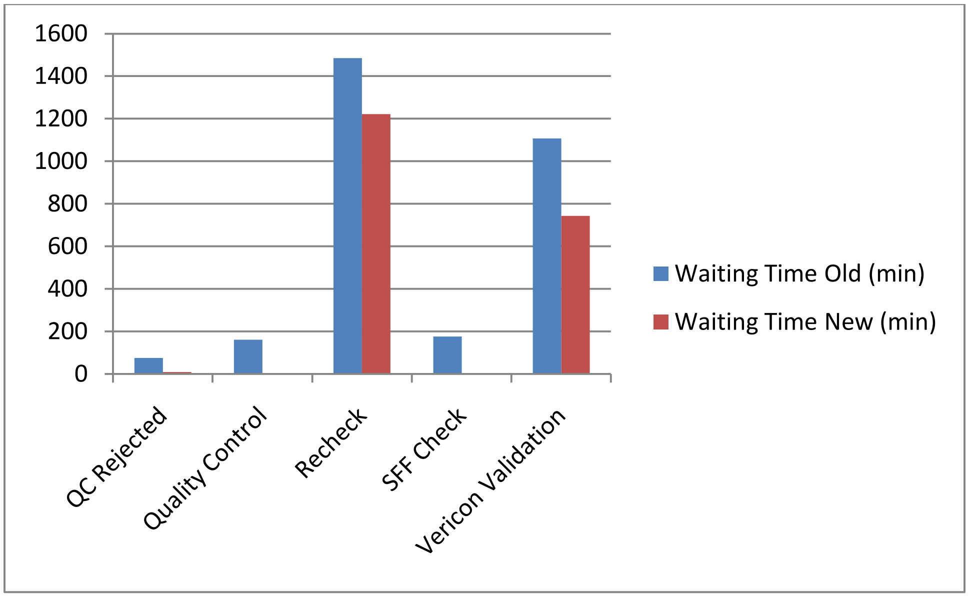


Figure 15 – Graph of Old and New Average Waiting Times

The average waiting time has decreased significantly across the whole graph. Although the single extra resource at the Validation process did not make a great impact on the utilization rates, it did well on the average waiting time. The QC rejected waiting time has dropped dramatically, because it no longer seizes already busy SFF QC agents to finish the process. The Recheck process has not decreased much because it utilizes an already over busy Vericon agent.

The average queue length:

Process	***Number Waiting Old***	***Number Waiting New***
QC Rejected	2	0.02464
Quality Control	19	0.1216
Recheck	4	1.128
SFF Check	2	0.00983
Vericon Validation	34	14.7093

Table 5 - Old and New Average Queue Lengths

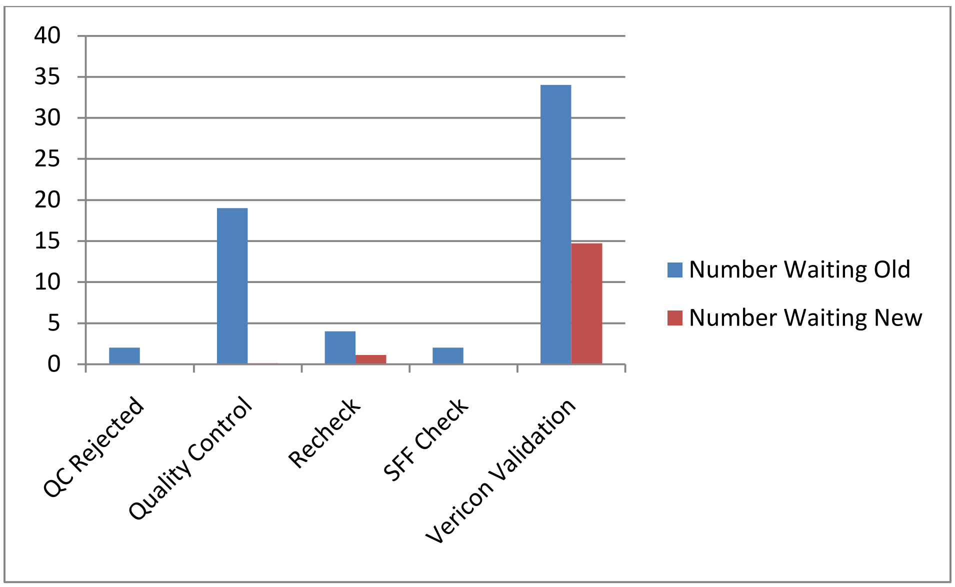


Figure 16 – Graph of Old and New Average Queue Length

As depicted above, the average queue lengths have significantly decreased with the reallocation and addition of resources. Vericon validation is still the most critical department with an average queue length of 15, even after changes have been made.

4.1.2.1 New Resource Animation

As indicated above, most of the resources run close to full capacity and utilization. The SFF customer service and line activator departments however still experience some idle resources. Since the line activator's rate is determined by the processes upstream, the rate of lines to be activated is governed and needs at most two activators. The customer service department is Cell C's interface with the public (customer) and has to meet and service all customer calls without delay to ensure customer satisfaction.

4.2.3 Inbound Call Center Calculations

A quick study has been done on the results of the current inbound call center process in order to inform management on the average utilization, average queue lengths and average waiting time of incoming customer calls. Required data and calculated utilization factor is shown in the table below…

Number of Agents (*S*)	30
Average Arrival Rate (λ)	150
Average Service Rate (μ)	12
Utilization Factor (ρ)	0.41667

Table 6 - Table of Required Queuing Theory Data

The data is further used to calculate the different probabilities of *n* calls entering the system and then the corresponding probability of any agent being idle at any given moment.

Probability			
n	***Calls entering***	***n***	
0	3.72665E-06	16	0.063278954
1	4.65831E-05	17	0.046528643
2	0.000291145	18	0.032311558
3	0.001213102	19	0.021257604
4	0.003790945	20	0.013286002
5	0.009477363	21	0.007908335
6	0.019744506	22	0.004493372
7	0.035258046	23	0.00244205
8	0.055090696	24	0.001271901
9	0.076514856	25	0.000635951
10	0.09564357	26	0.000305745
11	0.108685875	27	0.000141549
12	0.113214453	28	6.31914E-05
13	0.108860051	29	2.72377E-05
14	0.097196474	30	1.1349E-05
15	0.080997062	***Sum***	1

Table 7 - Table of the Probabilities of n Calls Entering the System

Using , the probability of any agent being idle at any given time is 0.9996273.

The information was further used to determine the average queue lengths and average number of calls in the system, as well as the average waiting time in the queue and the average waiting time of a call in the system.

Utilization Factor	L_s	0.4166667
Average Calls in Queue	L_q	1.39E-05
Average Calls in System	L	0.4166806
Probability Calls Greater than Agents	$P(j \geq S)$	1.946E-05
Average Waiting Time in System (hours)	W	0.0027779
Average Waiting Time in Queue (hours)	W_q	9.265E-08

Table 8 - Average Waiting Times and Queue Lengths

Because of the relatively small utilization factor, and the large number of available agents, the queue lengths and waiting times in the inbound call center are very small. This is how the times and lengths should look like given the number of agents, arrival rate and service rate, however, the inbound call center still experience some calls not answered or serviced, which begs the question of how effective and efficient the human factor in the call center is.

4.2.4 E-72 Inventory Problem

The E-72 handset is currently the most popular phone on contract. Due to its popularity and resulting high demand, there exists an approximate 15% stock shortage. The demand is known, but there are some problems with the lead time. An EOQ (Economic order quantity) model is constructed to help assist management in ordering the correct amount at the correct intervals to avoid and ultimately eliminate shortage of stock. The data follows…

Annual Demand	**180**
Holding Cost per Unit per Year	**R 500.00**
Setup Cost per Order	**R 2,000.00**
Shortage Cost per Unit per Year	**R 2,400.00**
Cost per Unit	**R 2,800.00**
Lead Time in Days	**14**

Table 9 - Data for EOQ Model

Using the above data, the economic order quantity, the number of orders to be placed per year, the total cost of placing an order and the reorder point incorporating the Lead time was calculated.

EOQ (Q*)	38
t*	0.211111111
n* (Orders per Year)	4.736842105
TC*	R 18,973.67
TC (Total Cost)	R 522,973.68
R (Reorder Point with Lead Time)	6.904

Table 10 - Economic Order Quantity Results

According to the calculations, Cell C should order 38 E-72 handsets every 2.5513 months to satisfy demand and minimize holding cost. The total cost of an order will cost them R 522,973.68 per year. If Lead time is taken into account, Cell C should place an order of 38 handsets every 1.74 months to receive the order in time.

Chapter 5

5.1 Conclusion and Implementation

It seems that Vericon plays a significant role, yet is an external service provider. This in turn decreases the control Cell C has over the Vericon resource. It is possible to request an extra agent or to implement a system where the orders are sufficiently prepped for validation, that eliminating excess time in acquiring data and handling parcels.

Some resources, like Customer Service agents, can, in theory, be cut further to only one agent, but since customer service can't be sacrificed, and the probability exist that more than one customer can phone at the same time, a minimum of two agents are required to service customers.

After the results of the proposed system, it is clear that the human resource plays a very important role in the overall efficiency of the call center operations end almost all departments is involved. It is suggested that management introduce firmer leadership and training. Management should also monitor the efficiency of the employees on a more regular basis.

In conclusion, Cell C could improve system performance and reduce or eliminate bottlenecks and employee idle times by the simple reallocation of resources. The proposed system indicated an average throughput rate of 4.5 days per parcel, which meets the customer requirements.

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