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Category (Enter the category in which the project was done. E.g. Operations Research, Simulation)	Simulation

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Simulation Modelling of the Cargo Drawing Process at the Airport

by

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Submitted in partial fulfilment of the requirements for the degree of

BACHELORS OF INDUSTRIAL ENGINEERING

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Executive Summary

Bidvest Panalpina Logistics (BPL) provides world-class supply chain solutions. It is considered a leader in global supply chain logistics. This project focuses on the BPL de-group facility which is located at OR Tambo international airport. The goal of the project was to provide a working simulation that analyzes the airport operations, investigate the root cause of problems encountered, and provide recommendations on how to improve the airport operations. The airport operations have a number of problems such as delays and long idle times.

This project analyzed the existing literature on simulation modeling and then a simulation model that emulates the BPL de-group facility was constructed using Simio software package. The constructed simulation model was capable to realistically imitate the current scenario. To evaluate the solution, different scenarios were generated using the simulation model. The first alternative scenario of reducing the number of current vehicles to eight instead of ten vehicles clearly showed that the utilization of vehicles can be improved while the system still meets the delivery demands.

A clear conclusion from the scenario of shifting some of the cargo allocators to the Customs operations showed that the utilization of workers can be balanced. A clear conclusion that can be drawn from the simulation results is that, the simulation model can be helpful for predicting the effects of the future changes to the BPL de-group facility (Import department).

List of Abbreviations

BOE   - Bill of Entry

BPL   - Bidvest Panalpina Logistics

HAWB   - House Airway Bill

ORT   - OR Tambo International Airport

RIB   - Remove in Bond

SAA   - South African Airways

SARS   - South African Revenue services

VOC   - Voucher of Correction

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Chapter 1: Introduction and Background

1.1. Company Background

Bidvest Panalpina Logistics (BPL) is a third party logistics company that specialises in international supply chain management and consulting services, customs clearing, system integration, forwarding, logistics and financial services. The company's supply chain operations focus on airfreight, sea freight, warehousing and transport. Figure 1 below shows the business structure of BPL.

As part of the airfreight supply chain solutions, BPL works in partnership with best in class global airlines (airfreight carriers). It adds significant reach with an international network of over 500 branches in 80 countries.
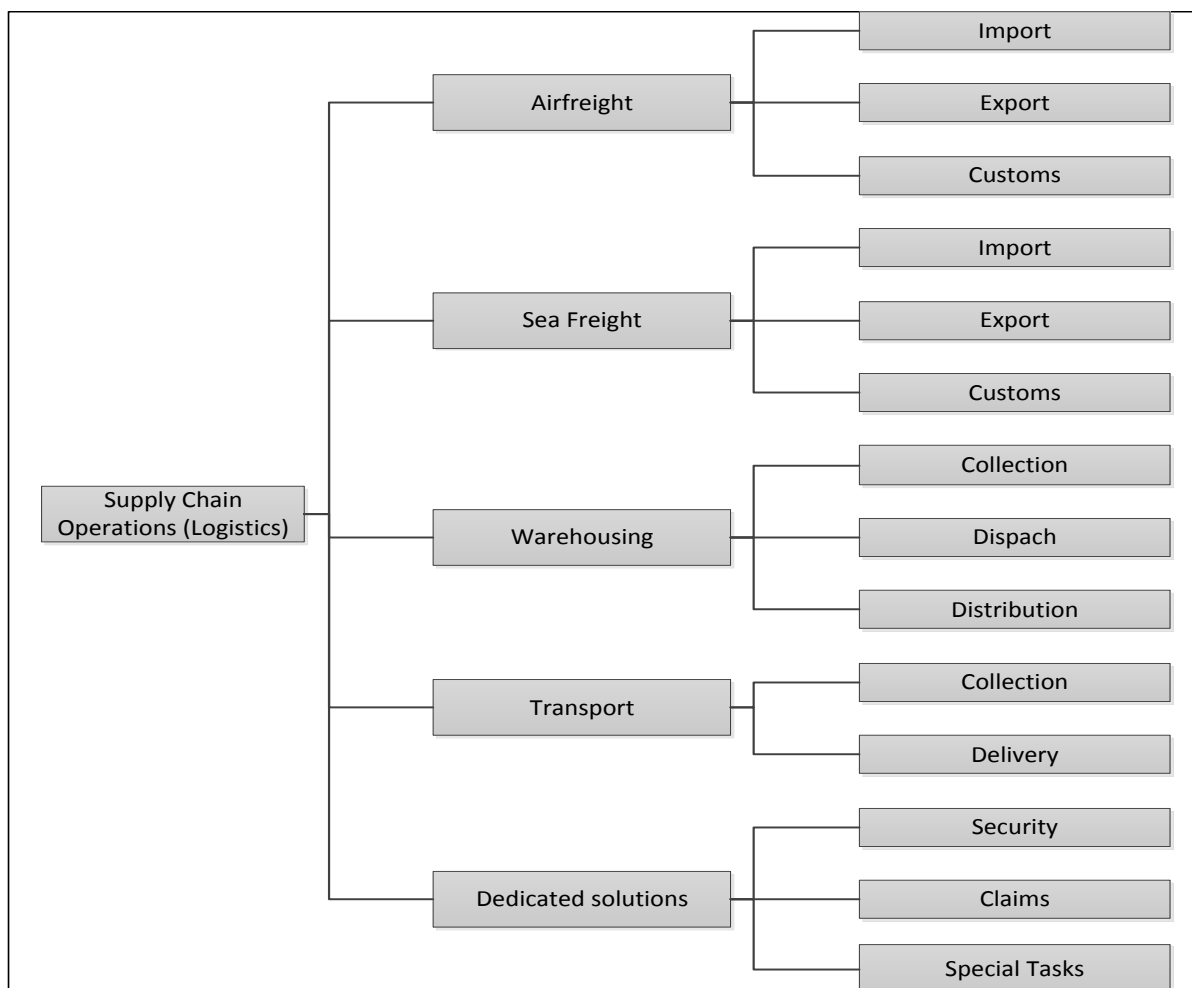
Figure 1: Business Structure

Figure 2: Picture of the BPL facility

South African locations:

- OR Tambo International Airport
- Cape Town International Airport
- King Shaka International Airport
- Local regional hubs

This project focuses on the BPL de-group facility (Import department) which is located at OR Tambo international airport. This facility is a cross dock warehouse mainly for airfreight. The function of this facility is to draw cargo from airplanes and deliver that cargo to either BPL unit 2 warehouse or clients as soon as possible. Currently the operations at BPL de-group facility experiences a number of problems such as delays and long idle times of vehicles. The performance of the facility is dependent on the cargo drawing activities at the airport.

When there is less number of vehicles, the demand of some deliveries cannot be met and this results in the decrease of revenue. However, the use of excess vehicles may lead to long idling of vehicles. Therefore, to evaluate the solution, this project will mainly focus on using simulation model.

1.1.1. BPL Airfreight

BPL provides international and local airfreight solutions. The BPL network consists of hubs that are placed at all international airports to assure a door-to-door delivery of all types of cargo. BPL works in partnership with global air freight carriers (Handling agents) to offer the most reliable and effective logistics solutions.

The Airfreight department consists of four sections. Figure 3 below shows the structure of the airfreight department and clearly depicts sections within the airfreight department. Under BPL airfreight department, this project will focus on improving the import department which is located at OR Tambo international airport. This department adds significant value.

Airfreight value added services:

- Customs clearance
- Normal, abnormal and project based cargo
- Door-to-door delivery
- Online real time shipment tracking, invoicing, costing and status reports
- Extended logistics services including sea, air, transport, warehousing and supply chain
- Offices and/or hubs at all strategic international airports
- Financial services
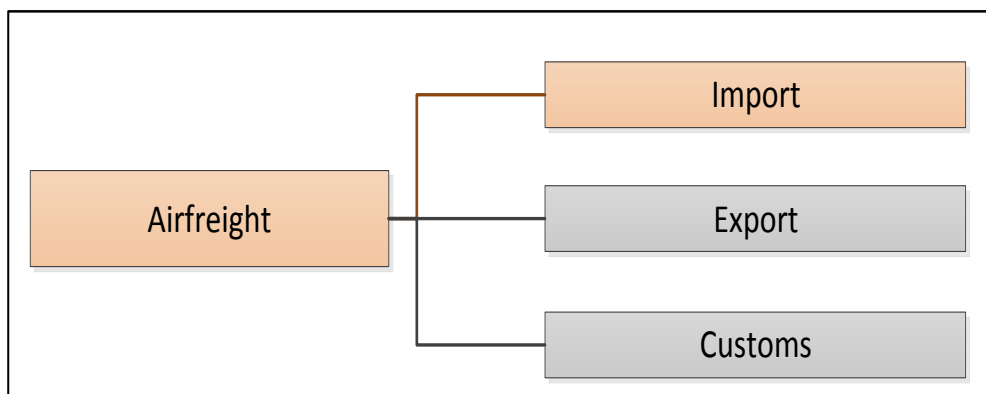
Figure 3: BPL Airfreight Business Structure

1.1.2.   BPL Import Department

The import department is accountable for clearing and capturing of cargo transactions and is aware of when, where and how a shipment is coming into South Africa. BPL import department strives to increase performance by delivering cargo on time and with no faults to their clients. All cargo being imported to South Africa must be declared on the prescribed bill of entry. In the process of import declaration, the import department must obtain information from different documents. Some of these documents are:

- Invoice
- Transport documents
- Contract if applicable
- Exchange control forms
- Certificate/ permits
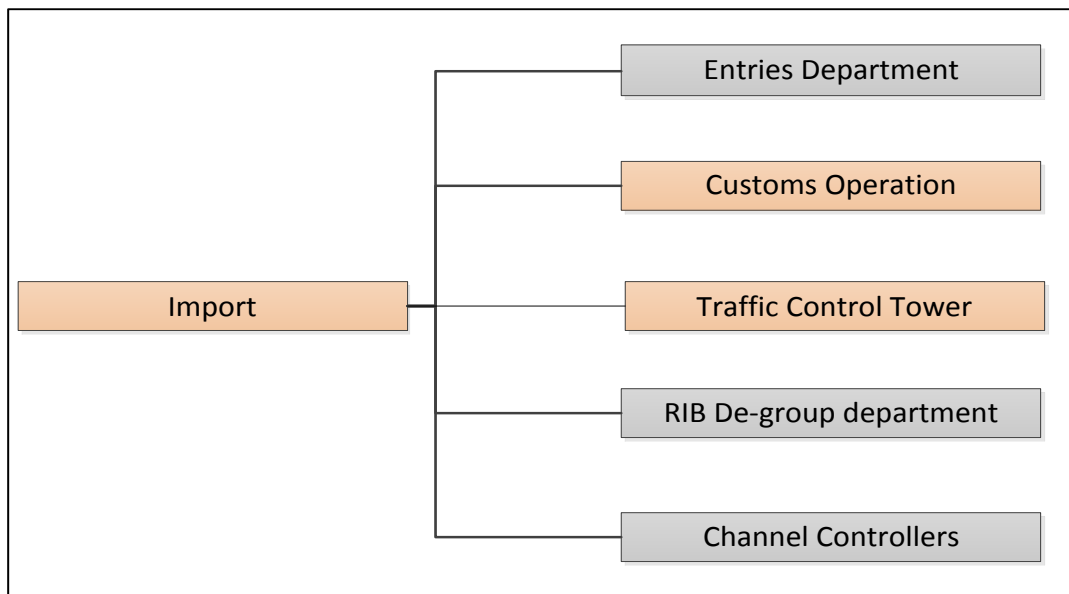
Figure 4: BPL Imports Business Structure

The import business structure shown on figure 6 above depicts four sections within the import department. However, on the import department the project will focus on customs operation and the Traffic Control Tower (TCT)/ Cargo drawing section.

These sections within the import department directly interact with airfreight carriers (handling agents).

1.1.3. Airfreight Carries (Handling Agents)

Air transport is an important element of the international logistics network, absolutely necessary for controlling and managing the flow of cargo and other resources. Airfreight carriers are dedicated to the transportation of cargo. Airfreight carriers that work in partnership with the BPL import department:

- Airlink
- Aero Ground
- Bidvest Cargo
- British Cargo
- Cargolux
- DHL
- KLM
- Lufthansa
- South African Airways
- Swissport

Figure 5: Loading of cargo at the BAC Airfreight Carrier

1.2. Project Aim

The objectives of the project are the following:

- Provide a simulation model of airport operations that can potentially improve the utilization of the resources.
- Investigate and document the current process for the airport operations.
- Highlight the bottlenecks in the airport operations.
- Investigate the root cause of problems encountered and bottlenecks in the operations.
- Highlight the impact of the problems on operations.
- Scenario investigations of the following:
  - ➢ Change in volumes (change in number of vehicles or workers)
  - ➢ Change in fleet configuration (type of vehicle)
  - ➢ Change in process

1.3. Project Scope

The project will cover the consolidated and straight shipments from the OR-Tambo International airport. The project will focus on analysing and solving problems of the airport operations.

1.4. Deliverables

The deliverables of the project are the following:

- A working simulation of the airport operations from flight arrival until delivery to the client or Unit 2 facility.
- Scenario outcomes and root cause analysis.
- Recommendations on the optimal resources for the operation with the following details included:
  - ➢ Fleet size requirements.
  - ➢ Increase in vehicle utilization.
  - ➢ Reduction of vehicle idle time.

Chapter 2: Literature Review

2.1. Overview

To commence any project it is necessary for an Industrial Engineer to be informed with the latest knowledge on techniques, processes and methods. This literature review will focus on the in depth evaluation of simulation modelling. The motivation for this study is to determine an appropriate method to solve the airport operation problems such as delays, unavailable vehicles for drawing and long idle times.

To find solutions to the problem faced by BPL, appropriate simulation tools, methods and techniques will be investigated. Figure 7 below has been created to depict the literature review breakdown.

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                    ┌──────────────────┐
                    │    Literature    │
                    │      Review      │
                    │   2.1 Overview   │
                    └──────────────────┘
        ┌───────────────────┼───────────────────┐
┌───────────────┐   ┌───────────────┐   ┌───────────────┐
│ 2.2. What is  │   │ 2.3. Simulation│   │ 2.4. Simulation│
│  Simulation   │   │  Methodology  │   │   Packages    │
└───────────────┘   └───────────────┘   └───────────────┘
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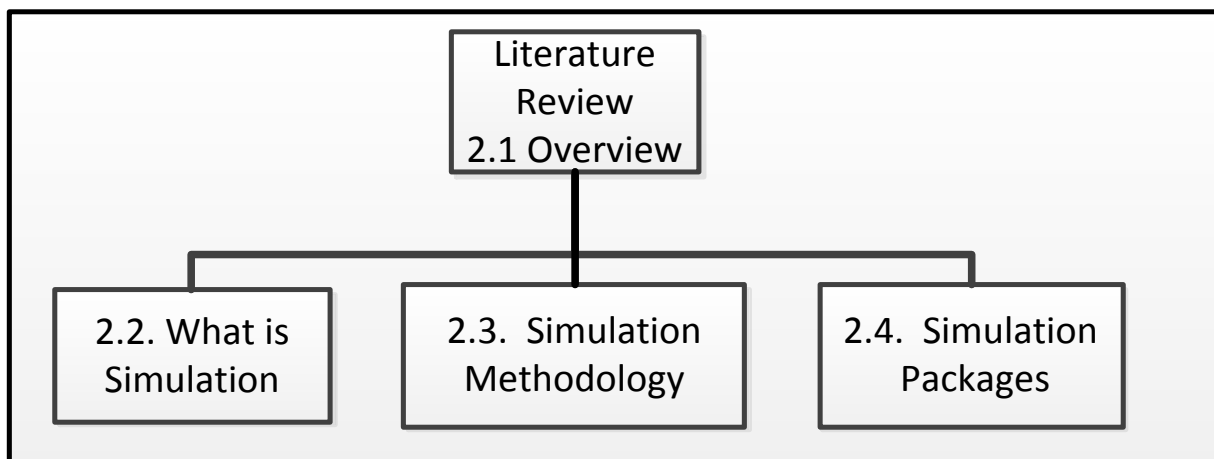
Figure 6: Literature Review breakdown structure

2.2. Simulation

2.2.1. What is simulation?

Simulation refers to a broad collection of methods and applications to imitate the behaviour of the real systems and it is the process of developing a mathematical model that will emulate the performance of a design or operation (Kelton, Sadowski & Swets, 2010: 1). The running simulation model provides statistical outputs that give timely measures of system performance and allows one to ask "What if?"

about a system by performing different scenarios without having to experiment on the actual system itself.

Simulation involves systems and models. A system is defined to be a collection of entities, for an example people or machines, which interact together toward the accomplishment of some logical end (Averill & kelton, 1982: 2). A model is defined to be a representation system development for the purpose of studying that system (Averill & kelton, 1982: 2). Simulation is used before the current system is altered or a new system is built, to reduce the probability of failure to meet specifications, to prevent under or over-utilization of resources, to eliminate unpredicted bottlenecks, and to optimize system performance (Anu Maria,1997: 7).

2.2.2. Computer Simulation

Computer simulations comprise of graphics that allow the user to view the model as an animation. Computer simulation is a process of creating a computerized model of real or proposed system for conducting numerical experiments to give a better understanding of the behaviour of that system for a given set of conditions (Kelton Sadowski and Swets 2010: 5). Until recently, simulating a system involved programming lines of code in special simulation languages. Current simulation programs are easier to use and more concise with ready-made subroutines for conventional materials handling equipment. The actual programming involves dragging and dropping graphical programming logic in the layout and entering the correct information.

2.2.3. History of Simulation

A brief history according to Kelton, Sadowski and Swets (2010: 12) of computer simulation is discussed below:

In the late 1950s and 1960s the use of simulation was expensive and required specialised training due to the limited number of computers which at that time were expensive to acquire and run. In the 1970s and 1980s with computers becoming faster, cheaper and more people being familiar with computers, many industries started using simulation. During this time simulation became part of the Industrial Engineering curriculum at many universities.

In recent years the use of simulation is not only used by large companies but also small enterprises have started using it. The manner in which simulation is used has also changed and is now used earlier in the design phase and updated as changes are made. The future of simulation in most industries seems positive with the increased speed of computers and ease of integration of simulation with other software packages.

2.2.4. Advantages and disadvantages of simulation

Simulation is one of the most widely used techniques in Operations Research and Management Science, and by all indications its popularity is on the increase. According to Averill and Kelton (1982: 8), the following advantages of simulation are the reasons for the popularity of simulation:

- Most complex, real-world systems with stochastic elements cannot be accurately described by a mathematical model which can be evaluated analytically. Thus, a simulation is often the only type of investigation possible.
- Simulation allows one to estimate the performance of the current system under some anticipated set of operation conditions.
- Alternative proposed system or process designs can be compared by means of simulation to evaluate and see which best meets the specified requirement.
- In a simulation one can maintain better control over experimental conditions than would normally be possible when experimenting with the system itself.
- Simulation allows the study of a system with a lengthy time frame.

However, Simulation has its disadvantages. The following are some of its disadvantages according to Averill and Kelton (1982:2):

- Simulation models are often expensive and time-consuming to develop.
- On each simulation run a stochastic model produces only estimates of a model's true characteristics for a specific set of input parameters. Hence, several independent runs of the model will probably be essential for each set of input parameters to be studied.
- The large volume of numbers produced by a simulation study often creates a tendency to place greater confidence in a study's results than justified. If a model is not a valid representation of a system under study,

the simulation results, no matter how remarkable they may appear, will provide scant useful information about the actual system.

2.2.5.   Different kinds of simulation

There are many ways to classify simulation models, but the following three dimensions usefully classify simulation models (Kelton, Sadiwski & Swets, 2010: 7):

- **Static vs. Dynamic**- Time does not play a natural role in static models but does in dynamic models. Most models are dynamic.
- **Continuous vs. Discrete-** In a continuous model, the state of the system can change continuously over time. In a discrete model change can only occur at separate points in time. The same model can consist of both continuous and discrete.
- **Deterministic vs. Stochastic-**Models that have no random input are deterministic. Stochastic models operate with some inputs being random. A model can have both deterministic and stochastic inputs in different objects/components.

2.2.6.   Simulation Study

Figure 8 depicts the simulation study schematically. In a simulation study, human decision making is required at all stages, namely, model development, experiment design, output analysis, conclusion formulation, and making decisions to alter the system or process under study (Anu Maria,1997).

The simulation run is the only stage that does not require human decision making, and most simulation software packages perform this stage efficiently. The absence of the simulation software package can affect a simulation study, but its existence will not ensure success (Anu Maria,1997).
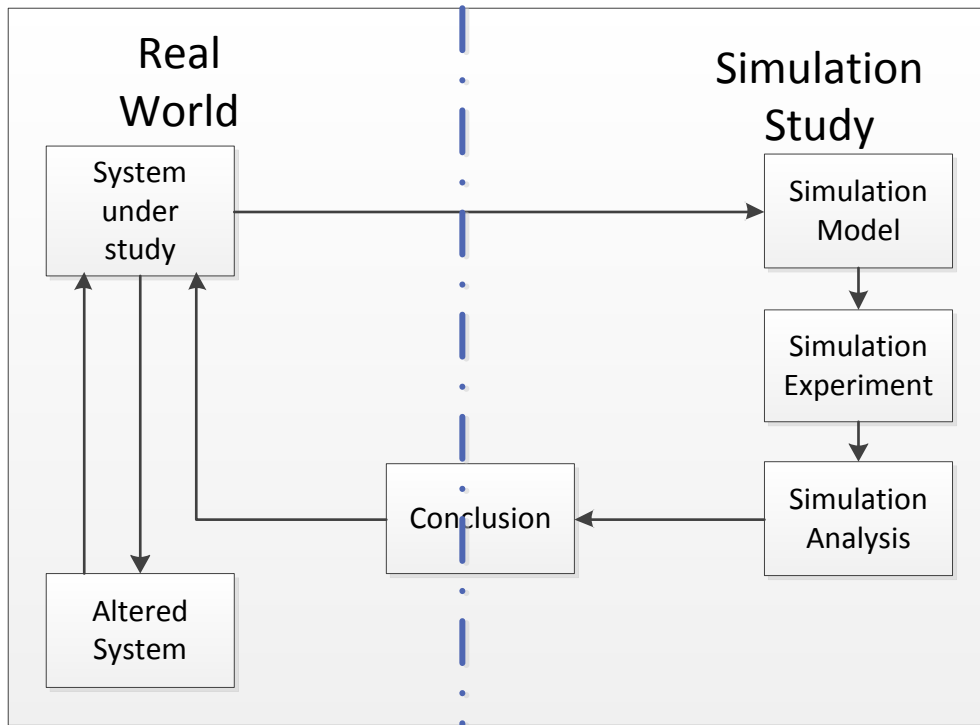
Figure 7: Schematic view of the simulation study

2.3. Simulation Methodology

2.3.1. The steps involved in developing a simulation model

The steps involved in developing a simulation model, designing a simulation experiment, and performing simulation analysis according to Maria (1997: 8) are:

Step 1: Identify the problem.

Step 2: Formulate the problem.

Step 3: Collect and process real system data.

Step 4: Formulate and develop a model

Step 5: Validate the model.

Step 6: Document model for future use

Step 7: Select appropriate experimental design.

Step 8: Establish experimental conditions for runs.

Step 9: Perform simulation runs.

Step 10: Interpret and present results.

Step 11: Recommend further courses of action.

The steps above are shown in a logical ordering of steps, but iteration at various steps may be required to achieve the objectives of a simulation study. Not all steps may be possible and/or required. However, additional steps may have to be performed. The following three sections (2.3.2 to 2.3.4) describe these steps in detail.

2.3.2. How to develop a Simulation model?

Modelling is the most significant part of a simulation study. Simulation modelling includes the following steps according to Anu Maria (1997):

Step 1: Identify the problem. Determine the number of problems with an existing and produce requirements for a proposed system.

Step 2: Formulate the problem. Select the limits and bounds of the system to be studied. Define overall objective of the study and specific concerns to be addressed. Define performance measures and decide the time frame of the study.

Step 3: Collect and process real system data. Collect data on system specifications, input variables, as well as performance of the existing system. Identify sources of randomness in the system, for an example, the stochastic input variables. Select a suitable input probability distribution for each stochastic input.

Step 4: Formulate and develop a model. Develop schematics, process flows and network diagrams of the system. Translate these conceptual models to simulation software. During this step the simulation model must be verified that it executes as intended.

Step 5: Validate the model. Compare the model's performance with the performance of the real system and perform statistical tests. Perform statistical

readings and inference tests. This step ensures that the model assumptions are consistent, complete and correct, but also increases confidence in the model.

Step 6: Document model for future use. Document objectives, assumptions and input variables in detail.

2.3.3.   How to Design a Simulation Experiment?

A simulation experiment is a test or a series of tests in which meaningful changes are made to the input variables of a simulation model so that one may observe and identify the reasons for changes in the performance measures (Anu Maria, 1997). Design of a simulation experiment involves answering the question: what data needs to be obtained, in what form, and how much? The following steps according to Anu Maria (1997) illustrate the process of designing a simulation experiment:

Step 1: Select appropriate experimental design. Select performance measure, a few input variables that are expected to influence it, and the levels of each input variable.

Step 2: Establish experimental conditions for runs. Address the question of obtaining accurate information and the most information from each run. Determine if the system is stationary (performance measure does not change over time) or non-stationary (performance measure changes over time).

Decide the number of independent runs - each run uses a different random number stream and the same starting conditions -by considering output data sample size. Sample size must be large enough (at least 3-5 runs for each configuration) to provide the required confidence in the performance measure estimates.

Step 3: Perform simulation runs. Perform runs according to steps 1 and 2 above.

2.3.4.   How to perform System Analysis?

Most simulation software packages provide run statistics (mean, standard deviation, minimum value, and maximum value) on the performance measures, e.g. waiting time, throughput time or inventory on hand. According to Anu Maria (1997) analysis of simulation output data consists of the following steps:

Step 1: Interpret and present results. Compute numerical estimates of the desired performance measure for each configuration of interest. Test hypotheses about

system performance and build graphical displays of the output data. Then document results and conclusion.

Step 11: Recommend further courses of action. This may include further experiments to increase the precision and reduce bias of estimators, to perform sensitivity Analysis.

2.4. Simulation Packages

Most simulation studies today are accomplished using a simulation package. In most cases the question of how to select the best simulation software for an application arises. For the evaluation of the software packages the following factors are considered, namely: modelling flexibility, ease of use, modelling structure, code reusability, graphic user interface, animation, dynamic business graphics, hardware and software requirements, statistical capabilities, output reports and graphical plots, customer support, and documentation (Maria, 1997). There are many simulation packages on the market, but this literature study only considers Arena and Simio simulation packages.

Figure 8: Simulation software packages

2.4.1. Arena Simulation Package

Arena models are built using a single modelling paradigm referred to as a process orientation. One defines elements that hold the state of the system, and builds process flows using blocks that perform actions on the elements. The blocks are inert and are activated by the arrival of an entity. Entities move from block to block and change the state of the model over time. The elements, blocks, and entities define the process model (www.simio.com).

One animates the model in 2D as a 2-step process. Firstly, a process flow of the model must be drawn, and then the animation for the facility is drawn in a separate area of the same drawing space. This is sometimes done by first importing an AutoCAD drawing as a static background for your animation. One then adds levels, animated routes, etc. that are linked back to the process model. The tasks of modelling and animating the model are typically done separately (www.simio.com).

2.4.2.   Simio Simulation Package

Although it is possible to construct process models in Simio, models are typically built using an object orientation. One drags objects into the facility view and connect them together in a 3D drawing space. The objects define both the animation and the logic for the model. Modelling and animation are done as a single step process (www.simio.com).

Modelling with objects needs a shift in perspective. In the Arena process view one thinks in terms of a logical process comprised of blocks that are activated by an entity. The blocks represent logical actions such as seizing a resource, delaying by time, etc. In the Simio object view one thinks in terms of the physical objects in the system, for an example, the machines, robots, conveyors, etc. that make up the system. One places these objects in the facility model and they interrelate based on their internal logic (www.simio.com).

In Arena a model is referred as the Arena process model. This is the only modelling approach supported in Arena. However, Simio is a multi-paradigm modelling tool that supports both an object orientation and process orientation. One builds an object-based model in the facility window, and/or a process based model in the process window.

The facility window for Simio is a 3-D drawing space where objects represent the physical components of the system. The process window is a 2-D drawing window whereby one constructs Arena-like process flows. Although the object paradigm is the primary modelling approach in Simio, one may freely mix the two modelling approaches together in the same overall model (www.simio.com).

Chapter 3: AS-is Process Flow

3.1. Process Mapping

To begin any simulation modelling project, the process that is identified for improvement must be accurately understood. The mapping of the process involves documenting and identifying the information flow and the physical flow. Process mapping is advantageous to simulation modelling, since it defines and outlines the scope of the process.

3.1.1. High-level process map

A high-level Process map indicates and describes all core process within a department. A process flow map is focused on information flow, activity flow, interactions and sequence. Figure 7 below shows the core flow of information and cargo within the import department. In this figure, information flows are designated with a dotted line, and cargo (material) flows indicated with a solid line.
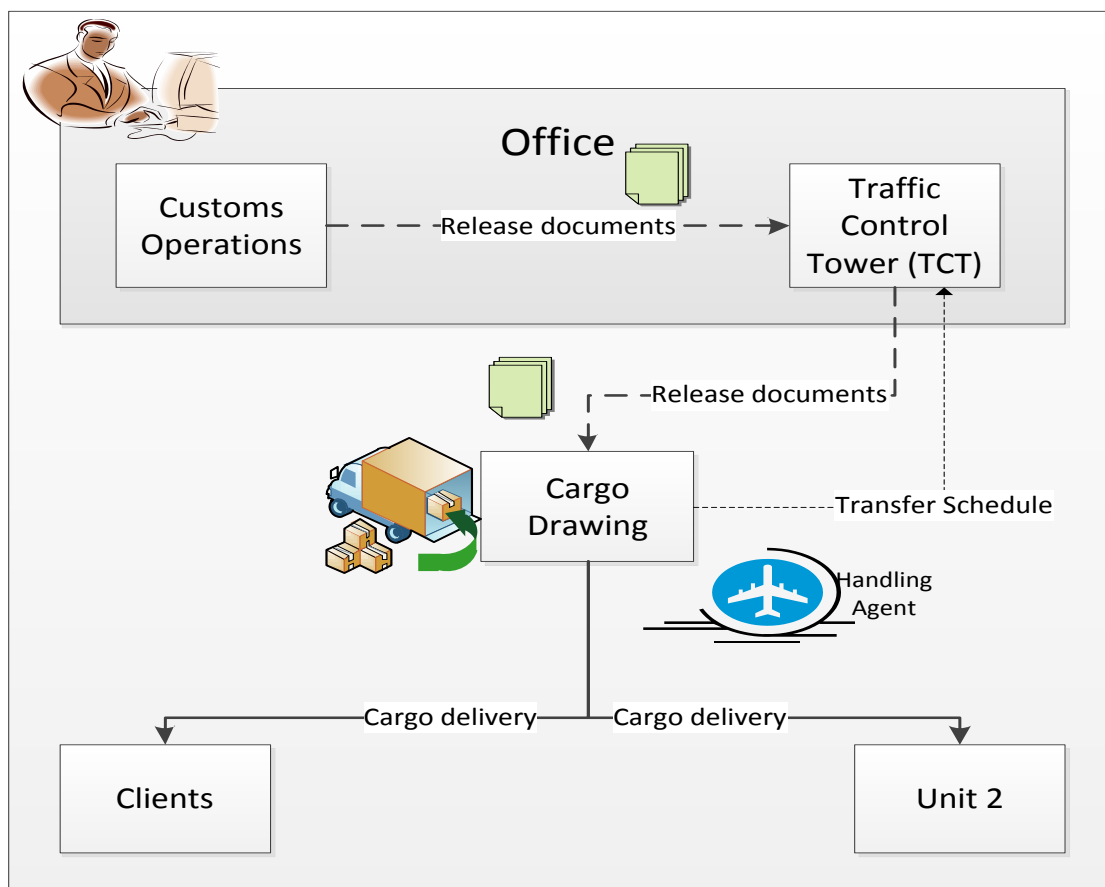
Figure 9: High-Level Process map

Firstly at a basic level, customs operations sends release documents to TCT. Secondly, TCT allocates cargo drawing then send release documents to cargo drawers. The release documents consist of cargo manifest, bill of entry and airway bill documents. Thirdly, cargo drawers draw cargo from handling agents, then cargo drawn is delivered to either BPL unit 2 warehouse or clients. For more details on the processes of each section, a low-level process map that is very detailed will further explain processes.

3.1.2.   Low-Level Process Map

A low-level process map depicts the part of a high-level process map that has been zoomed into for more details. Each section on the high-level process map forms a low-level process map. Figure 10 to 13 below show the low-level process for Customs operations, Traffic Control Tower and Cargo drawing.

Collection of original documents from airfreight carrier

Customs operator collects cargo manifest, bill of entry and airway bill documents from SAA. These documents can either be straight shipment documents or removal in bond (RIB) documents. After the documents have been collected, the customs operator records the MAWB number from the documents and then sends the original documents to the BPL entries department where they will be further processed. Entries department ensure that the prescribed bill of entry is framed and submitted to customs/SARS with the correct information provided for customs clearance. Refer to figure 10, which shows the process flow of the collection of original documents from airfreight.

Documentation and customs clearance

Firstly Customs operations department receives documents from entries department. The documents consist of cargo manifest, bill of entry (BOE), customs declaration and airway bill. The documents can either be straight shipment documents or removal in bond (RIB) documents. Straight shipment documents are for the cargo that is drawn from airfreight carrier and then directly delivered to clients. Removal in Bond (RIB) documents are for cargo that is drawn from airfreight carriers and then delivered to BPL unit 2.

Customs Operations

Legend

Process
Description
System Mechanism
Documents used
Information used

Sub-Process
Description
System Mechanism
Documents used
Information used

S - Start

E - End

Original Document Collections
Customs operator collects RIB and Straight shipment Documents from airlines
System Mechanism
Cargo Manifest & Airway Bill
MAWB, Flight NO, Waybill No, CONSOL No, De-group RIB No

Record Documents
Record MAWB
Excel spread sheet & Book-
Manual
Documents used
MAWB, Flight NO, Waybill No, CONSOL No, De-group RIB No

Straight Shipment?
NO →
YES ↓

Send Original Documents to Wrench Road
Customs operator hand over original documents to vehicle drives
Physical Handover
RIB & Straight shipments

Arrange and sort documents
Put the original Airway Bill Document on the sorting desk then send Cargo Manifest to Break Bulk
Manual
Original Airway Bill
MAWB

Receive RIB Document
Receive Cargo Manifest and Airway Bill documents from ACM
Email
Cargo manifest & Airway Bill

Print Customs Declaration forms
Customs Declaration for the RIB shipment
Manual
Customs declaration
MAWB, Flight NO, Waybill No, CONSOL No, De-group RIB No

Sign Customs Declaration forms
Manual
Customs declaration

Make Copies of Documents
Make five copies
Copy machine- Manual
Customs declaration, Cargo Manifest & Airway Bill

Verify Documents
Verify and check whether information Corresponds
Manual
Customs declaration & Airway Bill
MAWB, Flight NO, Waybill No, CONSOL No, De-group RIB No

Stamp documents
Stamp documents to indicate that documents are original documents
Manual
Customs declaration

Send Document to Customs
Send all six documents to customs for clearance
Physical Handover
Customs Ddeclaration, Cargo manifest & Airway Bill

Process flow continues on the next page

Figure 10: Customs Operations- Process flow part 1

Secondly, in case of documentation and customs clearance, the customs operator checks and confirms information on the documents and then hands the customs declaration form to the Customs/SARS department for approval and declaration of cargo. Finally, after the cargo has been declared, the customs operator creates a draw-sheet, compiles release documents together with the draw-sheet and then sends the compiled documents to TCT. Refer to figure 10 and 11, whereby the process flow for the documentation process and customs clearance are shown.

Cargo allocation process

Firstly, Traffic Control Tower (TCT) operator receives release documents from customs operations. Secondly the TCT operator verifies information on the release documents, then signs customs declaration forms and checks flight dates and times. When the date on the release document is a current date, the cargo is allocated immediately, and when it is a future date on the release document, the documents are kept. The following procedure is taken prior to flight arrival:

- Sign the security seal register upon receipt of the security seals. The seal is used to close the vehicle after cargo has been loaded

- Complete the Cargo Draw Sheets, prioritize and allocate the Cargo Draw Sheets per Cargo Drawer per airline, transits shed and off airport de-group facilities.

- Ensure appropriate vehicle is available on-site at airline/ground-handling agent.

Refer to figure 11, which shows the process flow for the cargo allocation process.

Cargo collection from airfreight carrier/handling agent

- The cargo drawer gives the SARS/Customs Release notification forms to the nominated airfreight carrier/handling agent to draw the cargo from the air freight carrier Bond store.

- After the cargo has been handed over by the handling agent, the cargo drawer performs a cargo check to confirm if there are any incongruities or discrepancies with regard to the number of units and checks for any damages to the packaging of the cargo.

- If and when any cargo discrepancies or damages are identified:

- The cargo drawer immediately notifies the TCT operator.
- The cargo drawer requests a damage report from the handling agent.
- The cargo drawer must photograph the damaged cargo and complete the damage deport.
- Then the cargo drawer takes a digital photo image of the damaged cargo, and sends it electronically to the TCT operator and Claims Department.

- In the case of incorrect information on the release documents, the cargo drawer will send documents to TCT and then the TCT operator will record it, and send the documents to Customs operations. The customs operator will view and record the documents, and then prepare a Voucher of Correction (VOC).

Refer to figure 12, which shows the process flow of cargo drawing from airfreight carriers/Handling agents.

Loading cargo to vehicle

- After the cargo has been checked by the cargo drawer and documents have been correctly processed, the vehicle driver signs acceptance for cargo on the transfer schedule and confirms any cargo damages, then hands a copy of the transfer schedule to the cargo drawer.
- The cargo drawer records the time of the vehicle loading.
- The cargo drawer records the security seal number on the transfer schedule and seals the vehicle with the security seal while the security driver observes.
- Immediately when the vehicle departs from the handling agent, cargo drawer notifies the TCT operator and then sends the copy of the transfer schedule to the TCT operator.

View figure 13 which shows the process map for the loading of cargo.

Figure 11: Customs Operations-Process flow part 2

Search for MAWB
Cargo Wise
Airway Bill
MAWB

MAWB Found?

Compile Documents
Compile Airway Bill with the Release Documents
Manual
SARS Release forms & Release Documents

Create Draw-sheet electronically
If MAWB is found on the Cargo Wise update information and record information on CompuClear System
Cargo Wise & CompuClear
Customs declaration, Cargo Manifest & Airway Bill
MAWB, Client Details, Transport provider

Send documents To TCT
Send two copies of each document to TCT
Physical Handover
SARS Release forms, Airway Bill BOE and Draw sheet
HAWB

Print SARS Release Forms
Customs Declaration for the RIB shipment
Email-paperless System
SARS Release forms

Create Manual Draw-sheet
If MAWB is not found on the Cargo Wise
Manual- Excel Spread Sheet
Customs declaration, Cargo Manifest & Airway Bill (Release documents)
MAWB, Client Details, Transport provider

Print Draw-sheet
Manual- Copy Machine

Record Straight Shipment
Record Straight Shipment information on a book
Manual-Write MAEB
SARS Release forms, BOE, Cargo Manifest & Airway Bill
MAWB, Date and Time

Receive Straight Shipment Document
Receive Cargo Manifest and Airway Bill documents from ACM
Email
SARS Release forms

Print Draw-sheet
Manual- Copy Machine

Stamp and Sort documents
Verify then sort documents according to HAWB
Manual
SARS Release forms, BOE and Draw sheet
HAWB

Make Copies
Make three copies of each document
Manual- Copy machine
SARS Release forms, BOE, Cargo Manifest & Airway Bill

Compile Documents
Compile Airway Bill, SARS Release & BOE
Manual
SARS Release forms, BOE, Cargo Manifest & Airway Bill

YES

NO

S

E

Traffic Control Tower

Cargo allocator at TCT receives Release documents from Customs Operations

S

Receive Release forms
Cargo allocator receives Release forms
Physical handover
Draw-sheet, Customs Clearance, Cargo Manifest, SARS Release forms, Airway Bill BOE, Straight shipment book or RIB Book
Bulk no/CONSOL No, Master Date, Master Waybill No, House Waybill No, Flight No, De-group RIB No

Verify Draw-sheet information
Checks and signs the RIB or Straight shipment book which is sent by customs operator
Manual checking
Draw-sheet, Customs Clearance, Cargo Manifest, RIB Book or Straight shipment Book
Bulk no/CONSOL No, Master Date, Master Waybill No, House Waybill No, Flight No, De-group RIB No

Signs release forms
Verifies information on release forms
Manual
Draw-sheet, Customs Clearance, Cargo Manifest

Check flight dates and times
Check flight dates on the release forms, if current date then allocate vehicle for cargo drawing. If Future date, then don't allocate immediately
Manual
Draw-sheet
Master Date, Master Waybill No, House Waybill No, Flight No,

Current date?

No

YES

Keep Release forms
Keeps release forms with future dates
Manual (sorting forms)
Draw-sheet, Customs Clearance, Cargo Manifest

Allocate drawing
Assign cargo to trucks, signs security seal
Physical handover
Draw-sheet, Customs Clearance, Cargo Manifest
Bulk no/CONSOL No, Master Date, Master Waybill No, House Waybill No, Flight No, De-group RIB No

Release form Collection by Cargo drawer
Cargo drawer release forms from the cargo allocator
Physical handover
Draw-sheet, Customs Clearance, Cargo Manifest

Sends Docs to Handling Agents
Cargo drawer walks to the handle agent BPL uses different Handling agents
Physical Handover/ Email
Draw-sheet, Customs Clearance, Cargo Manifest
Bulk no/CONSOL No, Master Date, Master Waybill No, House Waybill No, Flight No, De-group RIB No

Process flow continue to next Page- if queue available Cargo drawer must wait.

Figure 12: Traffic Control Tower- Process flow

Cargo Drawing Process

Process continues from Previous page after cargo drawer has verified that it is the correct cargo

Cargo allocator Calls Truck Driver
Cargo allocator informs driver about the pickup point
Draw-sheet, Cargo Manifest
Bulk no/CONSOL No, Master Date, Master Waybill No, House Waybill No

Cargo Drawer checks Cargo
Checks for damages on the Cargo
Manual Checking (Observation)

Damages available?

NO → **Truck Driver Drives to Pickup point**
Collection of Cargo from handling agent to trucks

YES

Cargo Drawer Takes Pictures
If damage is available, Cargo drawer takes Pictures
Digital Camera
Bulk no/CONSOL No, Master Date,

Send Pictures
Cargo Drawer send pictures to TCT
Digital Camera
Bulk no/CONSOL No, Master Date,

E

Picker Loads Cargo
Picker uses forklift to load cargo to truck
Forklift pickup

Truck Driver Signs Transfer Schedule
Driver checks Number of damages and pieces of cargo
Manual
Transfer Schedule
Driver's name, File No, Master Date, Number of pieces, Damage report, Seal No, Date and Time of Pickup

Cargo Drawer Receives Transfer Schedule
Cargo drawer validate Transfer Schedule
Manual
Transfer Schedule

Cargo Drawer Sends Transfer Schedule
Cargo drawer Walks back to TCT
Manual
Transfer Schedule

Cargo allocator captures information to Cargo-wise
Cargo drawer Walks back to TCT
Manual
Transfer Schedule
Driver's name, File No, Master Date, Number of pieces, Damage report, Seal No, Date and Time of Pickup

E

Truck Driver Delivers cargo to either unit 2 or clients

Delivery of Cargo
Truck Driver Delivers Cargo to either Unit 2 or Clients
Transport (Truck)
Draw-sheet and Customs clearance
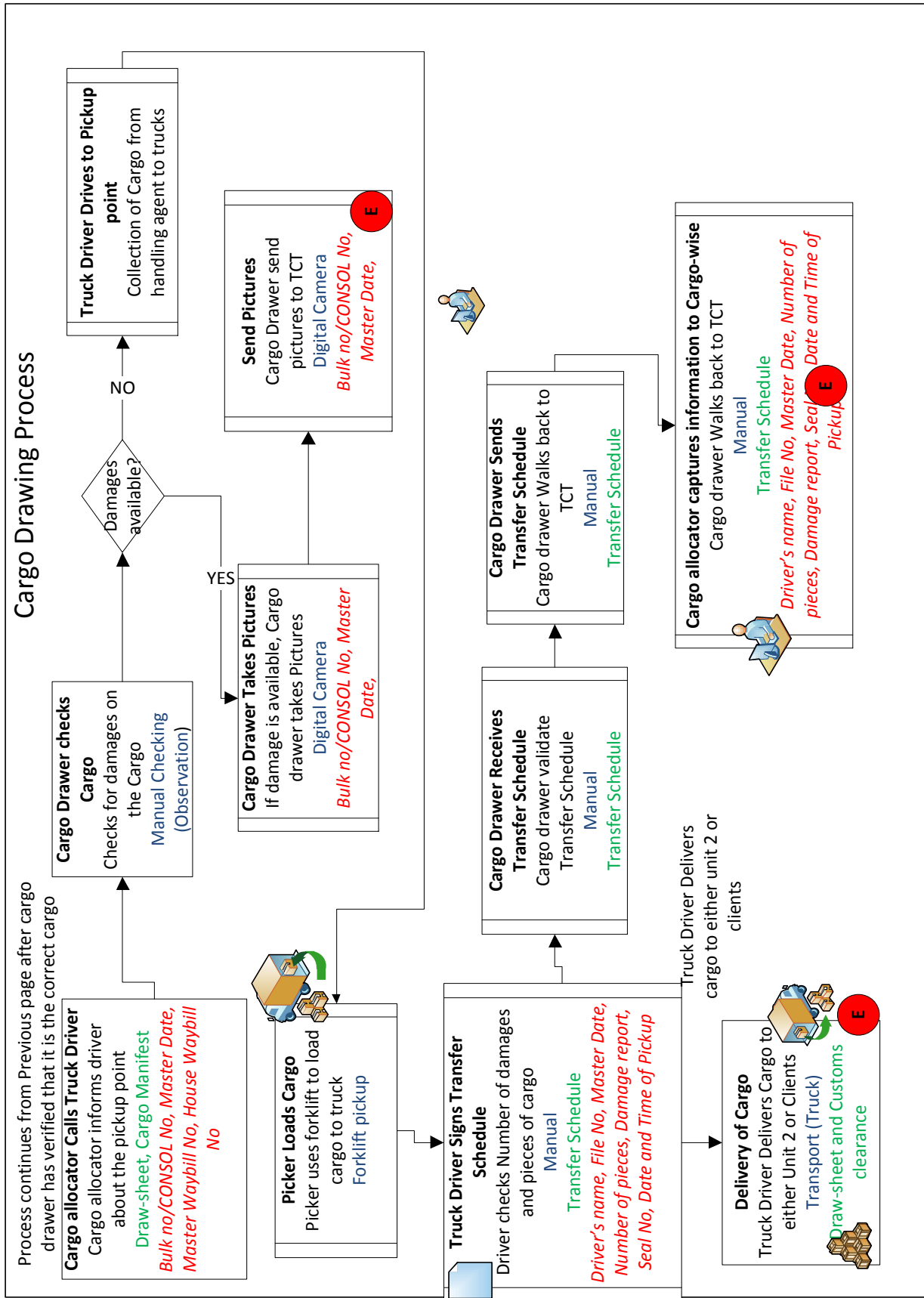
E

Figure 13: Cargo Drawing Process- Process flow

3.2. Problem Analysis on the Current Process

3.2.1. Fishbone diagram

The fishbone diagram is also known as Ishikawa diagram and is a brainstorming tool that allows problems and challenges to be categorised. Figure 14 below shows the possible causes of the problems experienced that create gaps in the process.
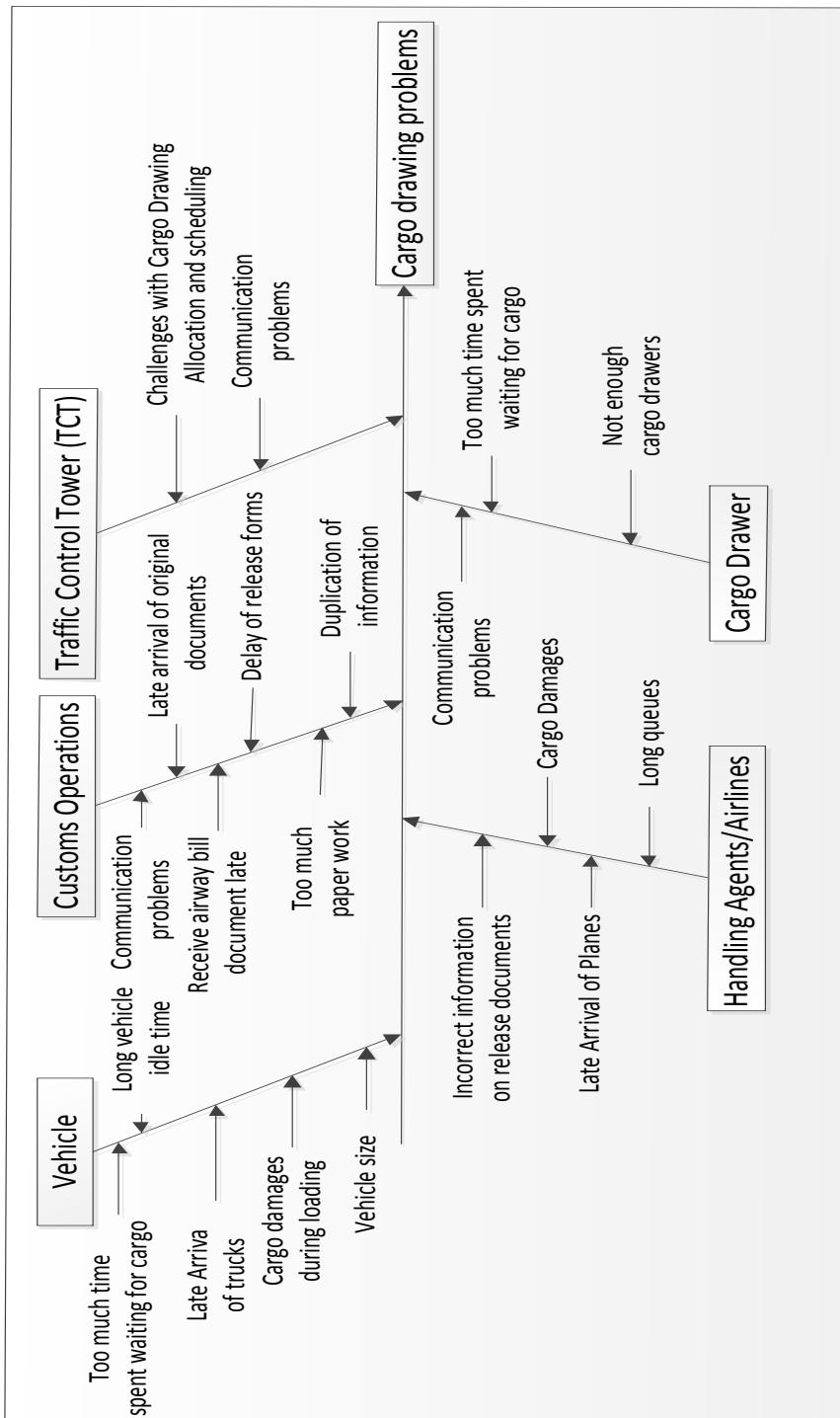

Figure 14: Fishbone Diagram

Chapter 4: Data Analysis

4.1. Data Requirements

To identify the data that is needed to support the model is one of the initial steps in the planning of simulation project. Understanding the quality of input data in the data gathering phase can help one to know how much detail to include in the model logic. During the data gathering phase, important data was identified that will help build a successful simulation model. The following Input data list is required:

- Average number of RIB and Straight shipment documents collected from South African Airways per day
- Number of Resources (Vehicles and workers)
- Process times
- Vehicle loading and unloading times
- Travel times
- Average cargo size
- Distance travelled from airport to Unit 2 warehouse and clients

4.2. Collection of data

Data was gathered from the cycle time sheet, transfer schedule, through observation, customer report cards and by making use of time study methods. Most of the data was gathered using thorough time studies since the model requires good information concerning process times and time delays. Some of the processes required estimates of probabilities, such as percentage generated from an operation, or the probability that cargo is transported to the unit-2 warehouse.

Time studies were also used to analyze and determine the turnaround time of the trucks, the arrival time for the clearance documents, and other time related inputs for the model. Input analyzer from Arena simulation package was used to find the distribution of the times which were gathered using time studies.

4.3. Resource

In Simio simulation package, resource refers to a generic object that can be seized and released by other objects. Resources may represent workers, equipment or vehicles. An entity in the system seizes a resource when available and releases it when finished. The data on the number of resource for the BPL import department will provide the primary input into the simulation model.

4.3.1. Number of workers

In Simio simulation package, a worker refers to a moveable resource that may be seized and released for tasks as well as used to transport entities between node locations. BPL import department currently has three types of workers: custom operators, TCT drawing allocators, and cargo drawers. The custom operators collect and prepare release documents. The TCT drawing allocators ensure that appropriate vehicle is available to draw cargo. The cargo drawers send release documents to airfreight carriers. Table 1 below shows the number of workers in each department.

Department	Job Title	Number of worker
Traffic Control Tower (TCT)	TCT Drawing Allocator	4 workers
	Cargo Drawer	11 workers
Customs Operations	Customs Operator	4 workers

Table 1: Number of workers on each department

4.3.2. Fleet description

Currently BPL has ten vehicles which are used for cargo drawing at the airport. Table 2shows the fleet number, vehicle description, capacity and the maximum number of pallets that each vehicle can carry. In Simio simulation package, a vehicle refers to a transporter that can follow a fixed route or perform on demand transport pickups/drop offs.

Fleet No.	Vehicle Description	Capacity (Tonnes)	Max Pallets
F112	Van	1	2
F413	Pantech- Tail lift	4	8
F808	Pantech- Pneumatic roll	8	12
F810	Pantech- Pneumatic roll	8	12
F814	Dropside- Pneumatic roll	8	12
F821	Dropside- Pneumatic roll	8	12
F822	Curtain side- Pneumatic roll	8	12
F825	Pantech- Pneumatic roll	8	12
F826	Pantech- Tail lift	8	12
F1806	Horse and Trailor	18	16

Table 2: Fleet description

4.4. Process Times

Time Studies were used to analyze and determine the process times, turnaround time of the trucks, and the arrival time for the clearance documents. Input analyzer was used to fit the distribution of the times, some output of the input analyzer are shown in Appendix D. The input analyzer fits a distribution to the data and provides an expression and an estimate of the parameter values for the model (Kelton, Sadowski & Swets).

The system operates for one shift per day, seven days per week. The shift is eight hours long and work starts up where it left off at the end of the previous shift. Documents arrival rates are given in table 3 below. The arrival process for both RIB and straight shipment documents are Poisson process, and are independent of each other. Both documents arrive at the Customs operations.

Document	Arrival rate (documents/hour)	Recording-Time Distribution (minutes)
RIB	8	Uniform(3,5)
Straight shipment	6	Uniform(3,6)

Table 3: Arrival and Recording data

Finding precise input data and analyzing this data is usually the most challenging task in a simulation project. This task is mostly challenging when modeling large scale systems. Most of the input data for this simulation was gathered from the cycle time sheet, transfer schedule, through observation, customer report cards and by making use of time study methods.

	Document	Process-time distribution
Documentation and customs clearance	RIB	Triangular(10,12,15) minutes
	Straight shipment	Triangular(8,10,12) minutes

Table 4: Documentation and Customs clearance: Process times

Table 4 and 5 depicts an overview of the summary statistics indicating which distribution best fits each process time including the parameters for each distribution. The process time distributions were fitted using the input analyser from Arena simulation software package. The triangular distribution indicates the minimum, average and maximum time for each process. The uniform distribution indicates the minimum and maximum time for each process. This analysis of process times will provide the crucial inputs into the simulation model built using the Simio simulation software package.

	Process	Process-time distribution
Cargo allocation Process	draw-sheet process	Uniform(1,3) minutes
	Cargo allocation	Triangular(2,5,7) minutes
Submission of release documents	Sending documents to airfreight carrier	Uniform(5,7) minutes
	Verification of release documents	Triangular(5,8,12) minutes
Cargo verification	Verification of cargo size (Number of pallets)	Uniform(1,2) minutes
	Manual checking for damages	Uniform(2,3) minutes
Delivery of Cargo	Vehicle Loading time	Triangular(8,15,20) minutes
	Vehicle unloading time	Triangular(8,15,20) minutes
	Travelling time (Unit 2)	Uniform(25,35) minutes
	Turnaround time (Clients)	Triangular(25,60,95) minutes

Table 5: Cargo collection: Process times

5.1. Conceptual Translation

The initial step in the design of simulation model is to define the conceptual translation of simulation. The conceptual translation of a model puts an important foundation in the design phase and is also known as pieces of a model. The function of the conceptual translating of a simulation model is to convey and formulate the model approach and design before the actual building of the Simio model.

The conceptual translation ensures that all Simio software components are considered. Data constraints, the analysis to be performed, the type of animation and the replication length of the simulation should be taken into consideration during the formulation of the model approach. The conceptual translation for Simio simulation consists of following objects shown on table 3 below, these objects will be used to construct the simulation model for BPL operations. Simio provides a standard library of objects. These objects can be used to: process, create, transport or destroy the entities that mimic real world processes (Simio LLC, 2010).

Object	Description
Source	Generates entity objects of a specified type and arrival pattern.
Sink	Destroys entities that have completed processing in the model.
Server	Represents a capacitated process such as a machine or service operation.
Workstation	Models a complex workstation with setup, processing, and teardown phases and secondary resource and material requirements.

Combiner	Combines multiple member entities together with a parent entity (e.g. a pallet).
Separator	Splits a batched group of entities or makes copies of a single entity.
Resource	A generic object that can be seized and released by other objects.
Vehicle	A transporter that can follow a fixed route or perform on demand transport pickups/drop offs.
Worker	A moveable resource that may be seized and released for tasks as well as used to transport entities between node locations.
BasicNode	Models a simple intersection between multiple links.
TransferNode	Models a complex intersection for changing destination and travel mode.
Connector	A simple zero-time travel link between two nodes.
Path	A link over which entities may independently move at their own speeds.
TimePath	A link that has a specified travel time for all entities.
Conveyor	A link that models both accumulating and non-accumulating conveyor devices.

Table 6: Simio Model objects

5.2. Simulation Model Design (Current Scenario)

The focus of the simulation model is to study individual functional areas of the BPL import department. The Simulation model was divided into two functional areas. The functional areas consist of the office model and the cargo drawing model. The office model was designed to emulate the process of the Customs operations and the Traffic Control Tower. The cargo drawing model was designed to emulate the cargo drawing process.

Currently the operations at BPL de-group facility (import department) experience a number of problems such as delays, unavailable vehicles for drawing and long idle times. The Simulation model was used to generate different scenario outcomes, highlight the impact of problems and identify bottlenecks. The generated scenario outcomes will be used to formulate recommendations on how to increase vehicle utilization and reduce vehicle idle times.

The simulation was modelled using Simio version 4.68.8352.The reasons for choosing this Simio simulation software package were based on the fact that Simio library contains object definitions that represent the physical components of a system, and the fact that the full version is available with slight limitations. In addition, Simio offers a three-dimensional drawing space for the user to work in.
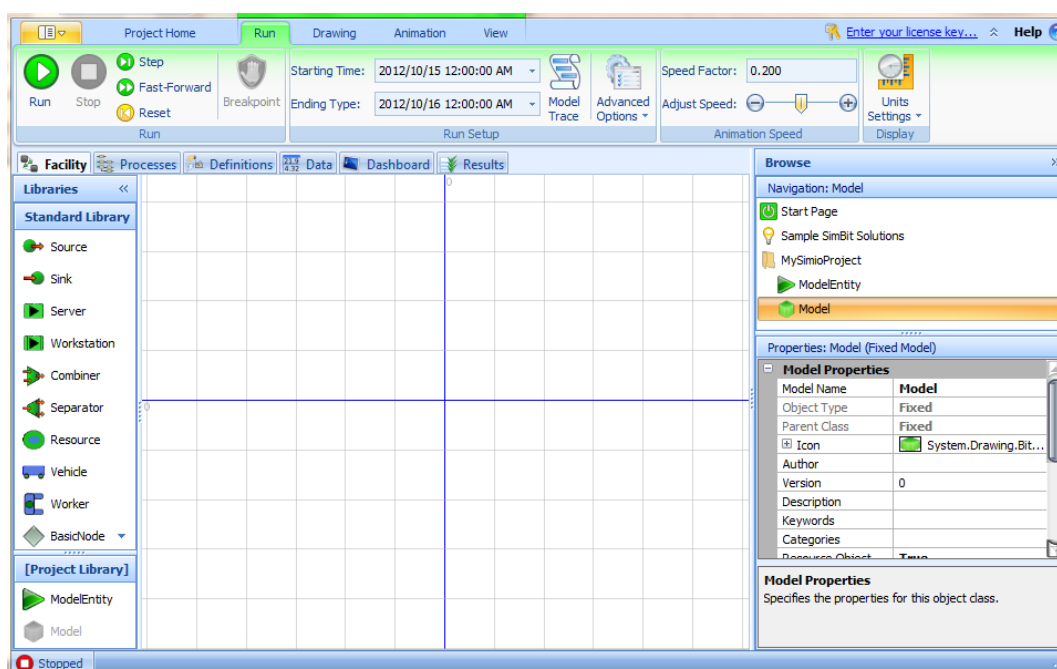
Figure 15: Screen shot of a Blank Simio Modeling Facility

The initial view of the Simio project is shown in Figure 15. The fundamental areas in the screen shown in figure 16 include the ribbons across the top, the standard libraries on the left, the facility window in the center, and the browse panel on the right. The facility window provides a space to create the object based logic and the animation of the model.

5.2.1. The Office Model Design

The office model was designed to emulate the process of the Customs operations and the TCT. During the construction of the simulation, the process mapping which was shown in the earlier chapter was used to model the chronological sequence of events at specific times. Figure 16 below shows the facility view of the office model. This model mimics the documentation and customs clearance process, and cargo allocation process.
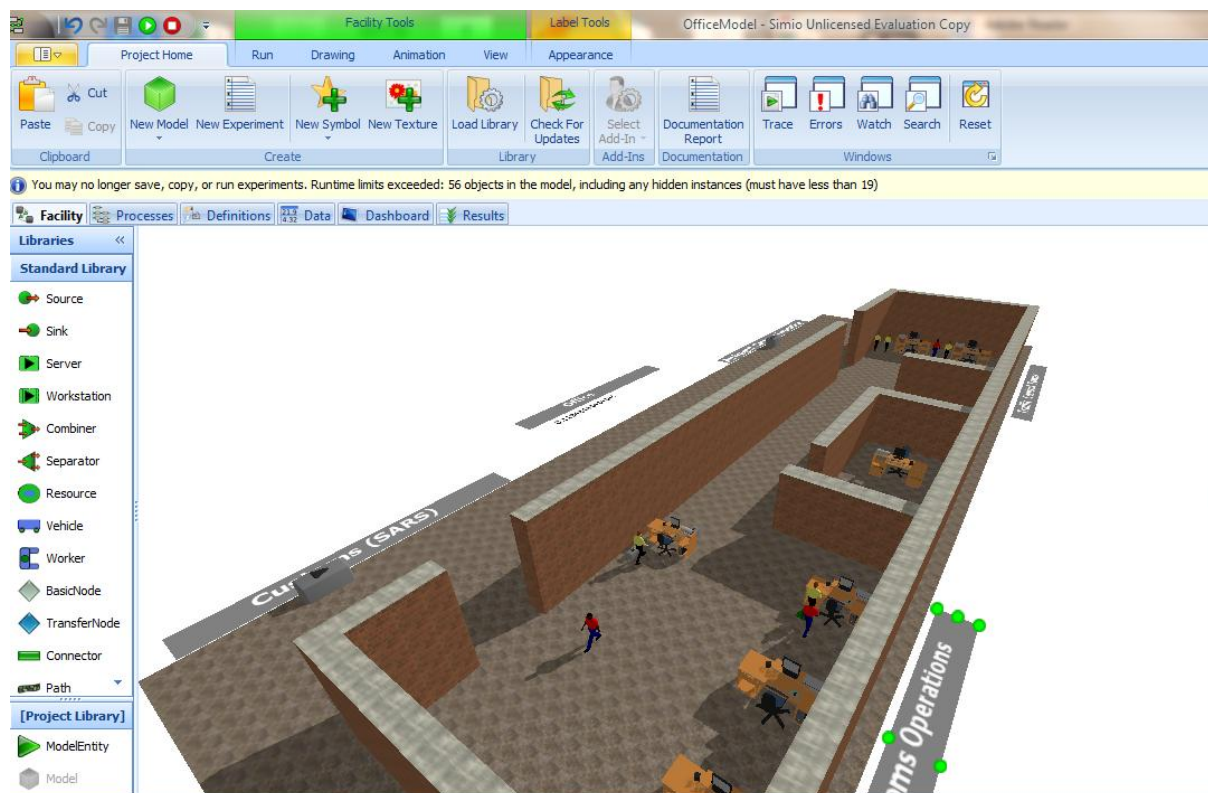
Figure 16: Facility view of the office model

The first part of the office model that required to be constructed was the arrival of documents at the customs operations department. The entities of the model represent the RIB and straight shipment documents (release documents). In Simio, the entities that are created and destroyed are the driving force of any model. The

source object was used to generate the arrival of entities. The arrival rate data of the documents was used as input on the properties of the source object. In this office model the primary focus was on the workers who process the documents. The worker object was used to represent the customs operator, the TCT allocator, and the cargo drawer. In Simio a worker object is a moveable resource that may be seized and released for tasks as well as used to transport entities between node locations. In this model the workers were modeled as transporters for the documents. The workers move to different server objects using transfer nodes and time path objects.

To emulate the documentation and customs clearance process, four server objects were used and to emulate the cargo allocation process, three servers were used. A server object represents a capacitated process such as a service operation. The process time distributions formulated in the data analysis were used as input for the server objects. In Simio, the sever object has a built in object called transfer node. This node prescribes or dictates where the entity must be transferred (destination), how it should be transferred (routing logic), and whether it should use a transporter or not (transport logic). By using the built in transfer nodes, the documents (entities) were assigned to ride on the worker objects. The connector, path and time path objects were used as links to and from server objects.

Once documents (entities) have been processed by the server objects that represent the cargo allocation process, the worker object (cargo drawer) transfers documents to the sink object. The sink objects represent the airfreight carrier. The sink object destroys entities that have been completed processing in the model. The next section describes the simulation model design for the cargo drawing process. The following assumptions were used in the model:

1. No absenteeism of workers.
2. 28 days in a month.
3. Each worker processes one release document at a time.
4. Processing of documents is during working hours only (8 am to 5pm).

5.2.2. Cargo drawing Model

The cargo drawing model was designed to emulate the cargo drawing process at the airfreight carrier. The facility that performs the cargo drawing process is a cross-dock facility mainly for airfreight. The function of this facility is to draw cargo from airplanes and deliver that cargo to either BPL unit 2 warehouse or clients as soon as possible. The cargo is delivered by trucks. The cargo drawing model mainly focuses on the utilization of trucks. Figure 17 below shows the facility view of the cargo drawing model.
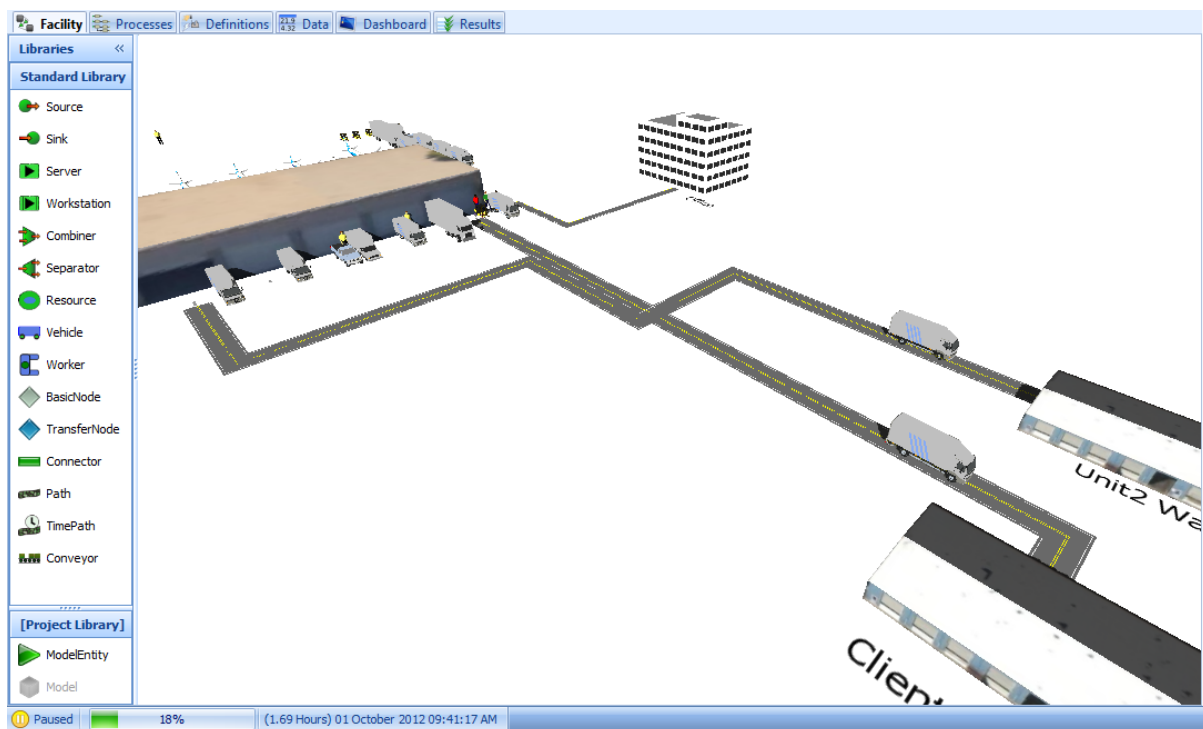
Figure 17: Facility view of the Cargo drawing process

The first part of the cargo drawing model to be constructed was the arrival of release documents from TCT. This was accomplished by using a source object that creates release documents an entity. For this simulation the objective that needs to be achieved, is to provide recommendations that will decrease the idle time of trucks.

The next section that required to be constructed was the logic behind how the simulation model would be driven. As noted in the previous section, the entities are the driving force behind any model. In this model, the primary focus is on the vehicle objects carrying the cargo. In this model it was decided that the cargo that is transported should be the driving force in the model and the vehicle object modeled

as the transporter for this cargo. Five sever objects were used to represent the process that is performed by the airfreight carriers (handling agents). In this model, the loading of cargo at the server objects that represent airfreight carrier, is performed by the forklift object. The loading of cargo to the vehicles was based on the loading and unloading time distributions that were established during the data analysis.

Once loading of vehicles has taken place the trucks move along the time-path object or the path object towards the entity's destination. In this model, the destination was either the BPL unit warehouse or clients. These destinations were modeled by a sink object that destroys the entity. The following assumptions were used in the model:

1. The loading or unloading delays are negligible.
2. Loading or unloading only occur during working hours (8 am to 5 pm)
3. No vehicle accidents or breakdowns.
4. No absenteeism of cargo drawers or truck drivers.
5. Each truck goes to either unit 2 warehouse or clients at a time.
6. After delivery, a truck returns empty.
7. 28 working days in a month.
8. Truck travels at a speed of 80km/hour.

Figure 18: Picture Indicating Layout of the Airfreight Carriers

5.3. Validation of the model

The validation of simulation model is achieved by comparing the performance of the model with the performance of the real system. This was done by comparing the simulation model output to the historical data, and by reviewing the animation and the output measures with the BPL managers of the import department. The output results for the simulation model of the current scenario are shown in chapter 6. The animation of the simulation model was used to validate operating processes and procedures.
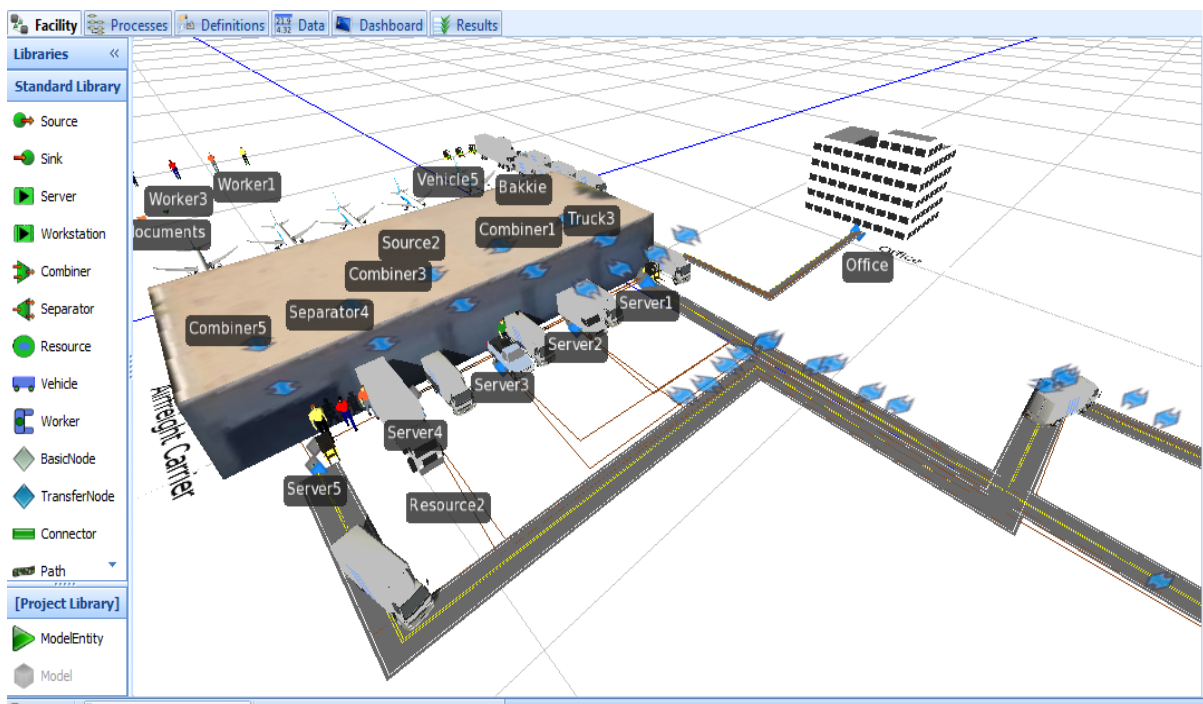
Figure 19: Screen shot for the Simulation Airport operations

5.4. Scenario Development

The running simulation model provides statistical outputs that give timely measures of system performance and allows one to ask "What if?" questions about a system by performing different scenarios without having to experiment on the actual system itself. The scenario development is divided into two sections. These sections consist of the investigations of the following:

- Change in the number of vehicles.
- Change in process and the number of workers.

To evaluate the solution, different scenarios were generated using the simulation model. The generated scenario outcomes will be used to formulate suggestions and recommendations on how to increase vehicle utilization and reduce vehicle idle times. The main objective of formulating different scenarios is to find possibly sets of input parameters, structural assumptions or model specifications that could lead to optimal performance. The simulation model outputs for the scenarios are shown in chapter 6.

5.4.1.   Change in the number of resources

Scenario 1: Reducing the number of vehicles

When there is less number of vehicles, the demand of some deliveries cannot be met and this results in the decrease of revenue. However, the use of excess vehicles may lead to long idling of vehicles. Currently BPL de-group facility (import department) is using ten vehicles. In this scenario, the numbers of vehicles were reduced to find the optimal number of vehicles that can increase utilization. The main objective of this scenario was to study the effect of reducing the number of vehicles. BPL can use some of the vehicles from the cargo drawing process in other departments. This scenario can also be performed by using vehicles routing problem (VRP) tools.

Scenario 2: Shifting some workers from TCT to Customs operations

The performance of the cargo drawing process at the BPL de-group facility is dependent on the activities performed by the Customs operations and the TCT departments. The productivity of the Customs operations and the TCT is directly proportional to the productivity of the cargo drawing process. Therefore, increasing the throughput of release documents from Customs operations and TCT may lead to an increase in utilization of trucks. In this scenario, increasing the throughput of release documents could be done simply by shifting some of the cargo allocators to the Customs operations department. The objective of this scenario is study the effect of shifting workers from TCT to Customs operations department.

Chapter 6: Simulation Results

6.1. Current Scenario Model Output

This section gives the results of the office model and the cargo drawing model that were constructed. Before evaluating decision alternatives by using the model, it is reasonable to question the performance and reliability of the model. If the simulation model is unable to constantly imitate the real system, analyzing decisions in an unreliable system would be irrational. To test and evaluate the model's performance and reliability, the results generated by the model were compared to the historical data. Note that the results depend on a number of assumptions. Therefore, the results might not match exactly with the real system. To meet the objective of the simulation model, the following performance indicators were analyzed:

- Resource Utilization – It is the ratio of the time that a resource is being used in relation to the time available.
- Throughput Time - It includes the time the unit is being worked on together with the time that the unit spends waiting in a queue.
- Time in Process – The time a unit takes to be completed in a specific process.

The office model was designed to emulate the process of the Customs operations and the Traffic Control Tower. By using this model, the data on the utilization of workers and the number of release documents were analyzed. For the experiment, the following simulation parameter controls were used:

- Run length: 252 hours (28 days a month, 9 hours per day)
- Number of replications: 50 for each scenario

6.1.1. Utilization of Workers

The results of the utilization of the customs operators and the TCT cargo allocators for the current scenario are best summarized by table 7. The custom operators collect and prepare release documents. The TCT drawing allocators ensure that appropriate vehicle is available to draw cargo.

Department	Object Name	Resource Utilization (%)
Customs Operations	Customs operator 1	87
	Customs operator 2	91
	Customs operator 3	88
	Customs operator 4	85
Traffic Control Tower	Cargo allocator 1	32
	Cargo allocator 2	42
	Cargo allocator 3	52
	Cargo allocator 4	45

Table 7: Utilization of workers

Figure 20 below graphically shows the utilization of customs operators and the cargo allocators. This graph clearly shows that the cargo allocators are experiencing long idle times. Cargo allocators ensure that appropriate vehicle is available to draw cargo. Therefore, long idle times of cargo allocators contribute to idling of trucks.
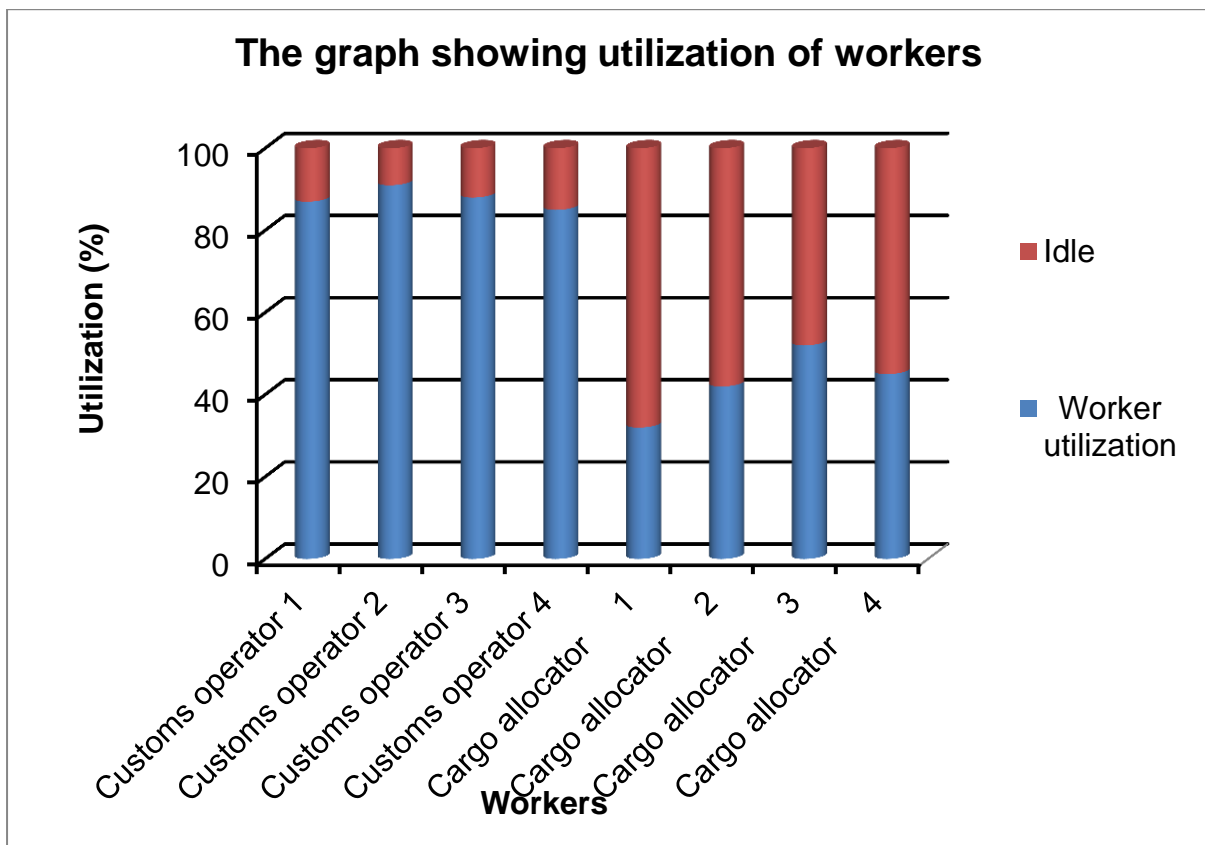

Figure 20: The graph showing the Utilization of Workers: Current scenario

By analyzing the model output of the current scenario shown in figure 20, it is reasonable to conclude that the bottleneck of the current system might be situated at the Customs operations department.

6.1.2. Utilization of Vehicles

The cargo drawing model was designed to emulate the cargo drawing process. Figure 21 below shows the results of the utilization of vehicles that are generated by model. It should be noted that the results do not exactly match reality, due to the fact that the travel time of the vehicles in the simulation do not necessarily reflect the time always travelled by the vehicles in reality. However, this does not invalidate the results. The simulation results of the vehicle utilization roughly reflect reality. Therefore, conclusions may still be drawn from the simulation results.
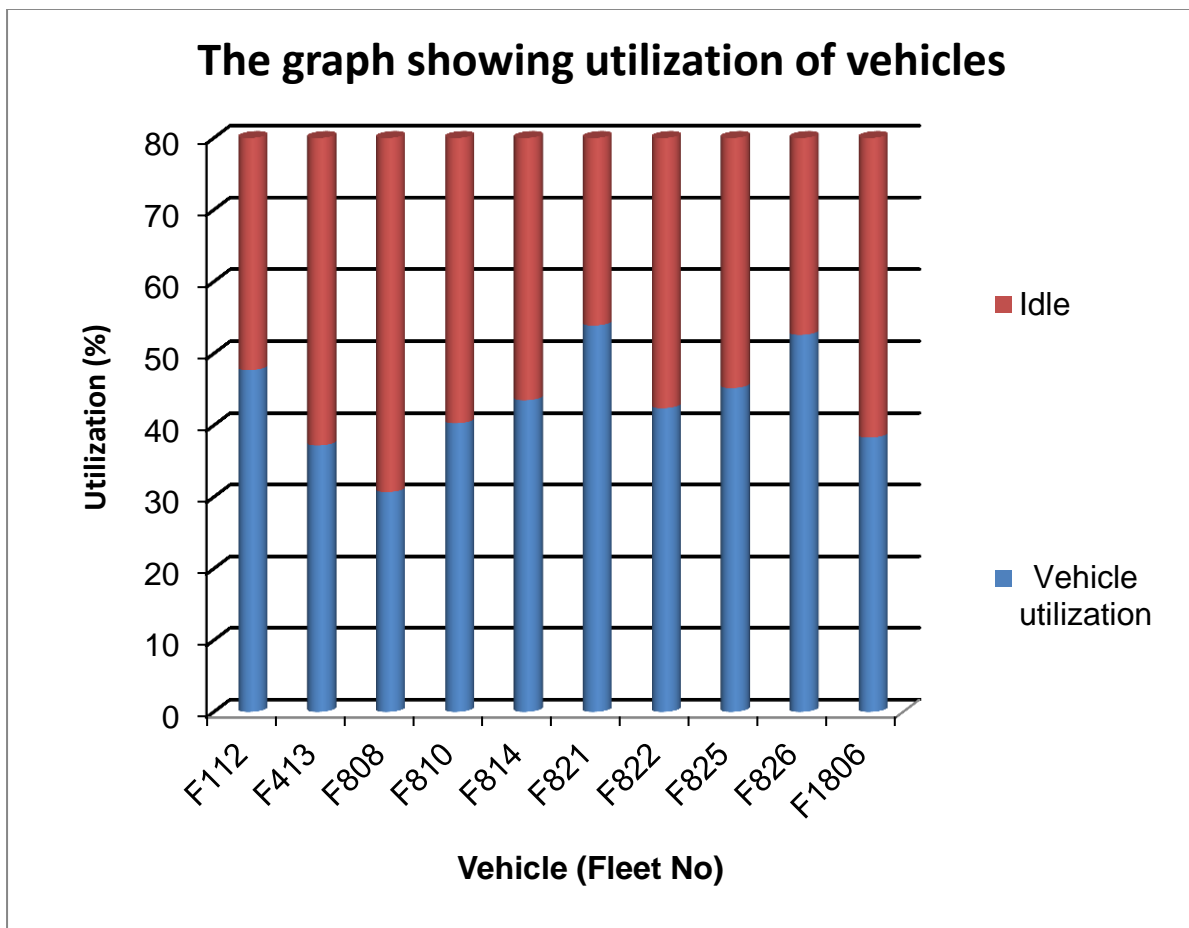

Figure 21: The graph showing the Utilization of Vehicles: Current Scenario

6.2. Results and Analysis of the Scenarios

The section provides the results of scenarios that are described in section 5.4. The generated scenario outcomes will be used to formulate suggestions and recommendations on how to increase resource utilization and reduce vehicle idle times.The scenario experiment uses the same simulation parameter controls that were used in the current scenario.

6.2.2. Results for scenario 1

In this scenario, the main objective of this scenario was to study the effect of reducing the number of vehicles. The cargo drawing process currently uses ten trucks. During the simulation experiment for this scenario, the model was run multiple of times by changing the input data on the number of vehicles and the following results shown on figure 22 and 23 were found:

Object Name	Data Item	Statistic	Average Total
F112	ScheduledUtiliz...	Percent	60.8401
F1806	ScheduledUtiliz...	Percent	60.9873
F413	ScheduledUtiliz...	Percent	61.3009
F808	ScheduledUtiliz...	Percent	81.8525
F810	ScheduledUtiliz...	Percent	37.0639
F814	ScheduledUtiliz...	Percent	53.0086
F821	ScheduledUtiliz...	Percent	43.9894
F822	ScheduledUtiliz...	Percent	66.1266

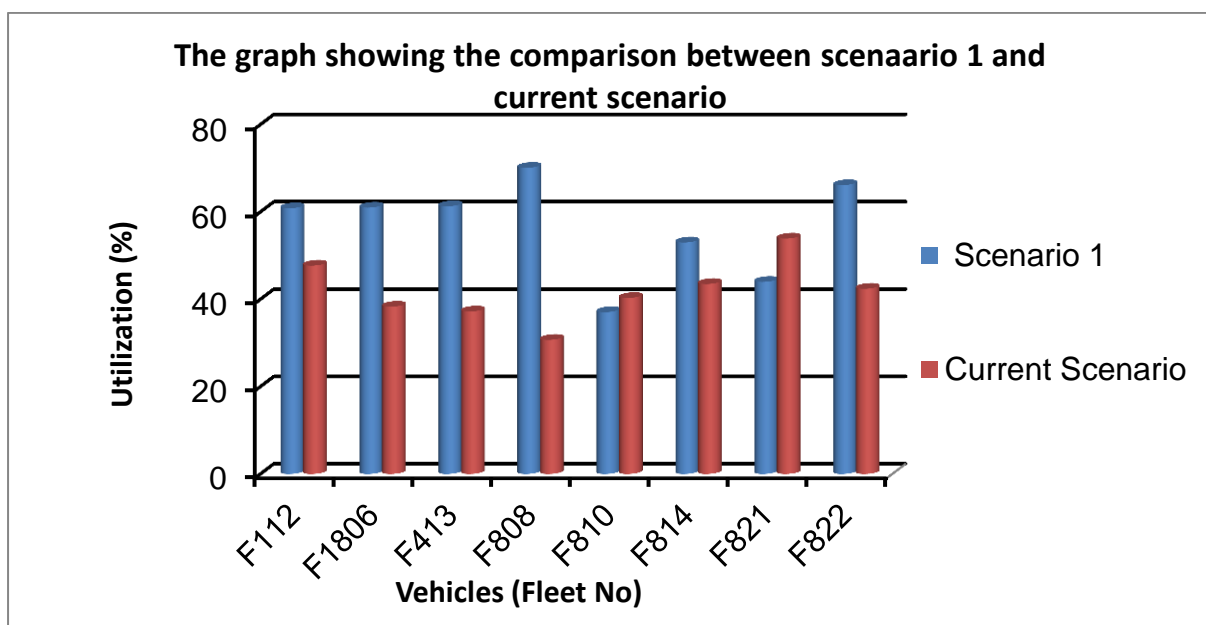**Figure 22: Scenario 1 results: Using 8 vehicles**

Figure 23: Comparison between the current scenario and scenario 1

In this scenario, multiple runs of the simulation model were performed to study the effect of reducing the number of vehicles. The first simulation run was performed by decrementing the number of vehicles by one and the second run was performed by decrementing the number of eight tonne vehicles by two. During the third simulation run when the number of vehicles was reduced to seven, the demand of some deliveries could not be met. The results shown in figure 22 and 23 are for the second simulation run.

6.2.3. Results for scenario 2

In this scenario, increasing the throughput of release documents could be done simply by shifting some of the cargo allocators to the Customs operations department. This scenario intends to balance utilization of workers. Appendix C shows the throughput of release documents for the current scenario. The simulation experiment for this scenario was focused on finding the ratio of customs operators to cargo allocators that might balance utilization. However, the objective of this scenario is study the effect of shifting workers from TCT to Customs operations. During the simulation experiment for this scenario, the model was run multiple times by changing the input data on the number of workers at the Customs operations and TCT. The results for this scenario are shown in figure 24.
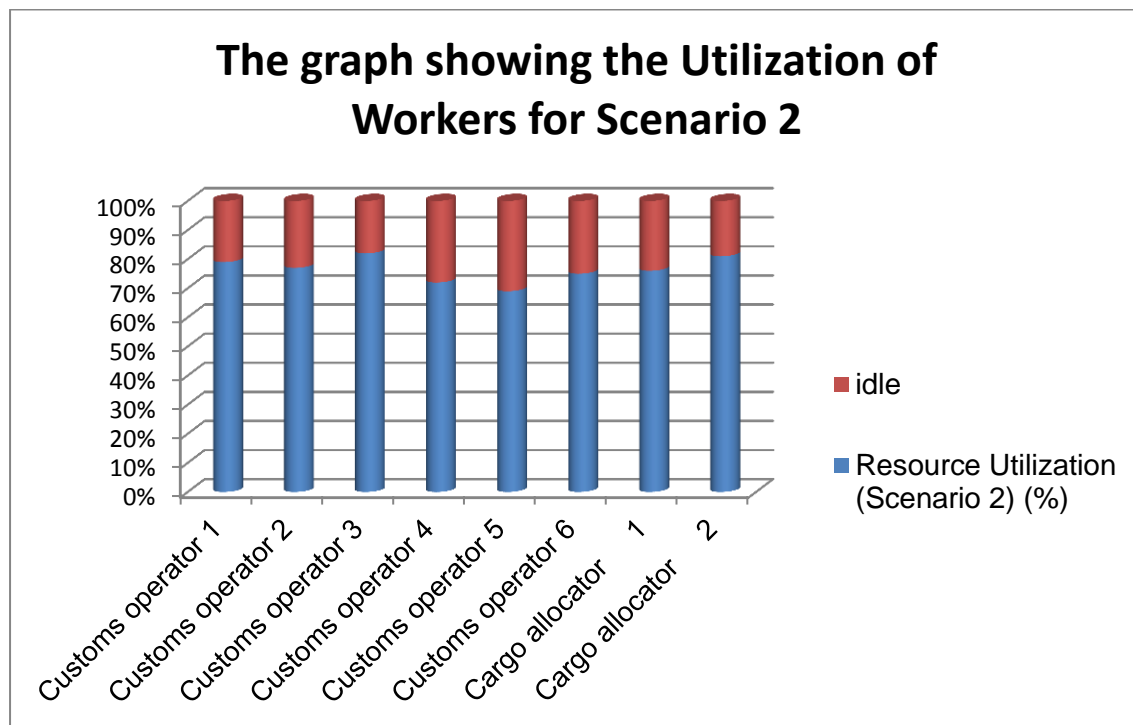

Figure 24: The graph showing the Utilization of Worker- Scenario 2

Chapter 6: Conclusion and Recommendations

Bidvest Panalpina Logistics (BPL) is a third party logistics company that specialises in international supply chain management and consulting services, customs clearing, system integration, forwarding, logistics and financial services. Currently the operations at BPL de-group facility experiences a number of problems such as delays and long idle times. This project objective is to provide a simulation model of airport operations that can potentially improve the utilization resources.

The simulation model was capable to realistically emulate the current scenario. The first alternative scenario of reducing the number of current vehicles to eight vehicles clearly shows that the utilization of vehicles can be improved while the model is still meeting the delivery demands. The alternative scenario of shifting some of the cargo allocators to the Customs operations shows that the utilization of workers can be balanced. A clear conclusion that can be drawn from the simulation results is that, the simulation model can be helpful for studying the effects of the future changes to the BPL de-group facility (Import department). It is recommended that, this constructed simulation model could also be used to:

- Analyze and evaluate continuous improvement strategies. Continuous improvement in most cases results from small incremental improvement that flow through the company. However, these small improvements after some time will eventually generate operations and processes that are extremely effective and efficient. The effects of these slight incremental improvements can be evaluated by using the constructed simulation model.
- Identify areas where shortage resources or problems are likely to occur.

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Appendix A: Screen shot of the office model
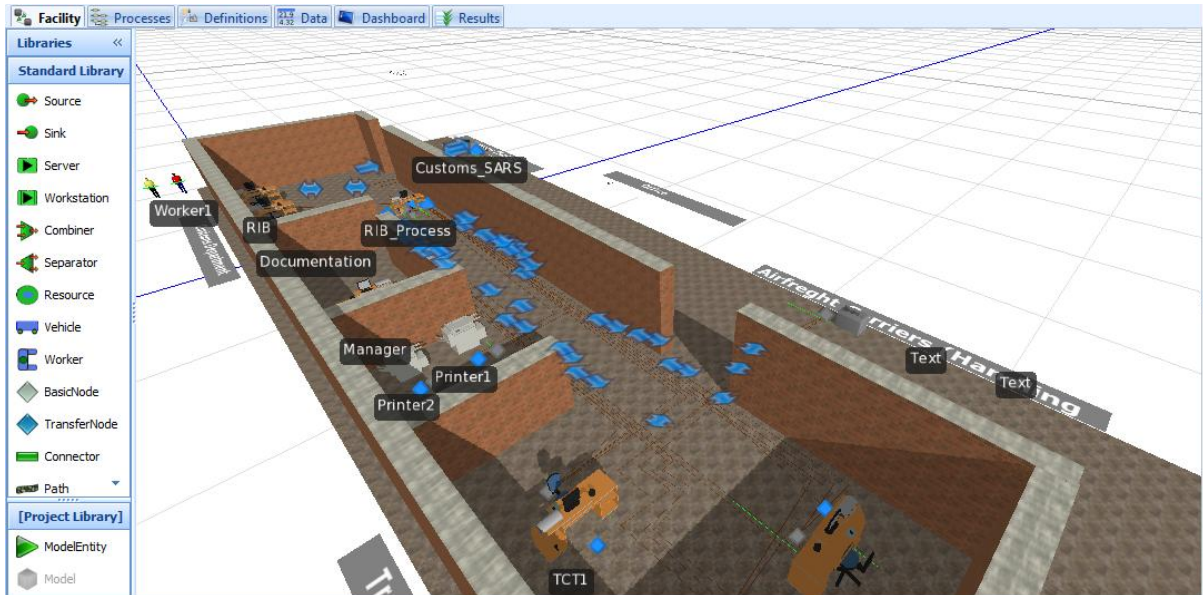
Appendix B: Screen shot of the cargo drawing model
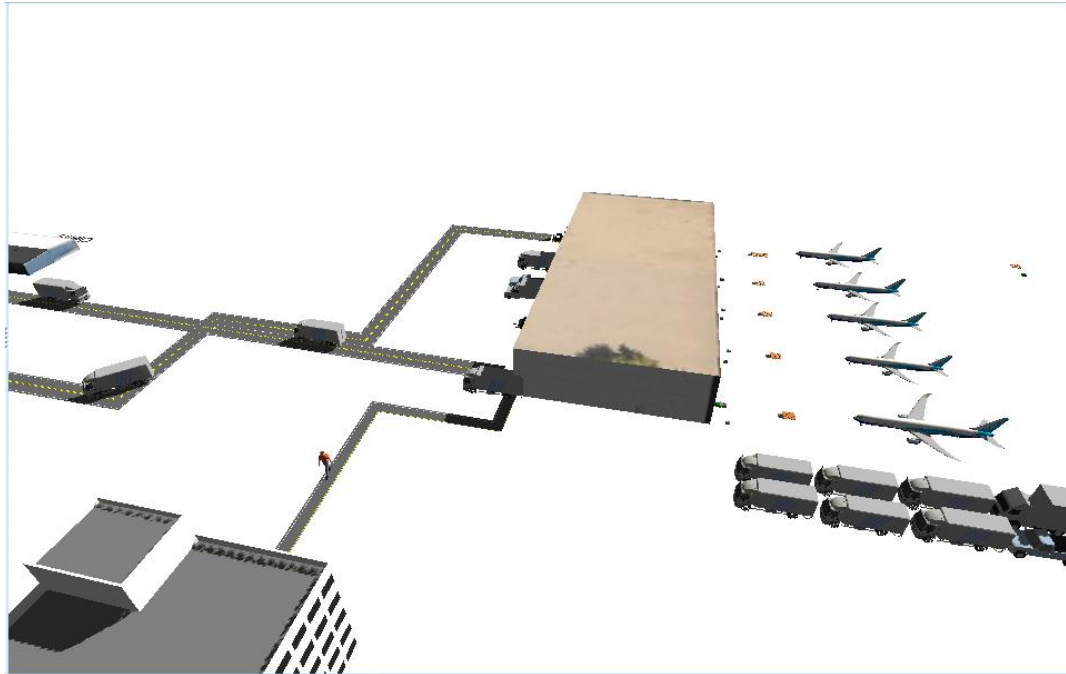
Appendix C: Throughput for Release Documents

The screen shot of results from Simio shown below, depicts the average number released documents processed per day and the throughput time.

Current Scenario

Object Type	Object Name	Data Source	Category	Data Item	Statistic	Average	Minimum	Maximum
ModelEntity	Straight_Docs	[Population]	Content	NumberInSystem	Average	2.0153	2.0153	2.0153
					Maximum	3.0000	3.0000	3.0000
			FlowTime	TimeInSystem	Average (Minut...	35.1261	35.1261	35.1261
					Maximum (Minu...	45.4540	45.4540	45.4540
					Minimum (Minutes)	30.5809	30.5809	30.5809
			Throughput	NumberCreated	Total	32.0000	32.0000	32.0000
				NumberDestroyed	Total	30.0000	30.0000	30.0000
	RIB_Docs	[Population]	Content	NumberInSystem	Average	11.4860	11.4860	11.4860
					Maximum	22.0000	22.0000	22.0000
			FlowTime	TimeInSystem	Average (Minut...	211.7392	211.7392	211.7392
					Maximum (Minu...	319.7141	319.7141	319.7141
					Minimum (Minutes)	94.7613	94.7613	94.7613
			Throughput	NumberCreated	Total	31.0000	31.0000	31.0000
				NumberDestroyed	Total	9.0000	9.0000	9.0000

Scenario 2

Object Type	Object Name	Data Source	Category	Data Item	Statistic	Average	Minimum	Maximum
ModelEntity	Straight_Docs	[Population]	Content	NumberInSystem	Average	1.9892	1.9892	1.9892
					Maximum	3.0000	3.0000	3.0000
			Throughput	NumberCreated	Total	70.0000	70.0000	70.0000
				NumberDestroyed	Total	68.0000	68.0000	68.0000
	RIB_Docs	[Population]	Content	NumberInSystem	Average	23.8214	23.8214	23.8214
					Maximum	46.0000	46.0000	46.0000
			Throughput	NumberCreated	Total	68.0000	68.0000	68.0000
				NumberDestroyed	Total	22.0000	22.0000	22.0000

Appendix D: Process time-distributions

Recording time distribution of RIB

Distribution: Uniform
Expression: UNIF(3,)

Recording-Time distribution of RIB

Distribution: Uniform
Expression: UNIF(3, 5)

Documentation and Clearance

Distribution	TRIA(10, 12, 15)
Min Data Value	= 10.1
Max Data Value	= 15
Sample Mean	= 12.3
Sample Std Dev	= 1.01