Simulation of Dispatch Operations at Bidvest Panalpina Logistics Warehouse

by

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Executive Summary

Bidvest Panalpina Logistics is widely considered a leader in the provision of global supply chain and logistics services. Many operations are involved in the transportation of goods worldwide.

The purpose of this project is to provide the company with a detailed simulation model of their dispatch operations from the warehouse to the various customers in the Gauteng region. Various Industrial Engineering techniques such as simulation will be used in identifying and highlighting bottlenecks and the root causes thereof. Upon identification of the bottlenecks, recommendations of necessary improvements will be made. Turnaround time of the cargo in the cage was determined and if it was found to be too long, improvement methods are be suggested.

An in depth literature study was conducted to determine the tools and techniques that are currently available and that are going to be used to achieve project goals. Arena Rockwell Simulation software was used to model the operations at BPL for the as-is process and proposed scenarios at the company.

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1.Introduction and Background

Bidvest Panalpina Logistics is a company that provides an efficient, integrated transport solution for the distribution of goods throughout the supply chain. They provide comprehensive door-to-door solutions for any consignment whether it be by air, sea, road or rail, to and from anywhere in the world and throughout South Africa.

Bidvest Panalpina Logistics operates a fleet of over 100 vehicles, of which +- 30 are located at the Unit 2 Degroup Warehousing Facilityat OR Tambo International airport. These 30 vehicles are used to dispatch shipments that are imported into the country and come into the facility (mostly via airfreight) to various clients in the Gauteng region.

When the cargo arrives from the airport, it is transported to the warehouse. This is where it is dis-assembled into the various customers it belongs to. The goods are then placed in the dispatch cage where they wait for the next vehicle to transport them.

This project will focus on the dispatch operations located at the Unit 2 Degroup Warehousing facility at OR Tambo International airport. The dispatch operations start from the dispatch cage then to the customer and back to BPL with the signed POD (Proof of Delivery).

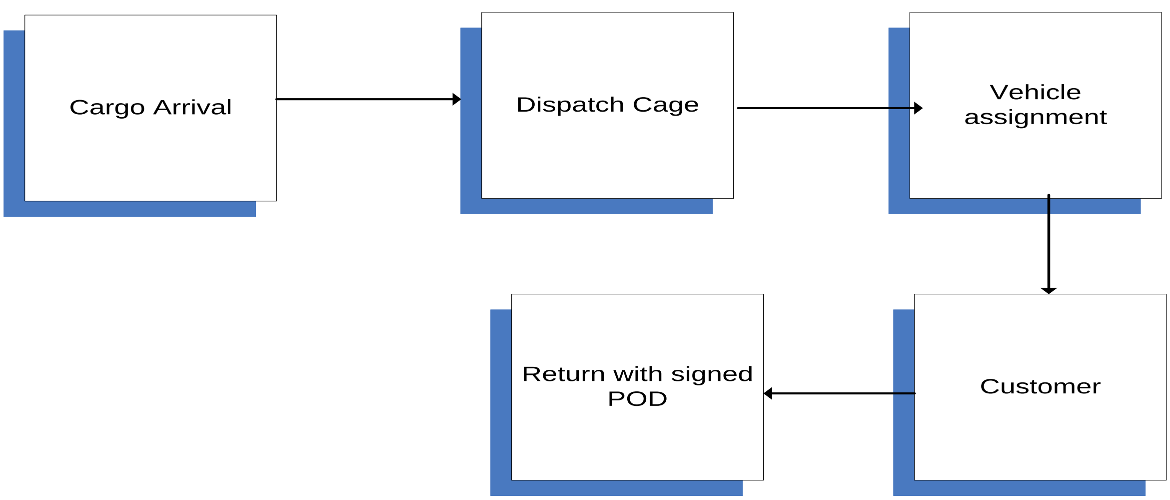


Figure 1 Basic operations

1.1 Problem Statement

The way in which the fleet of vehicles is currently being operated is not at all optimal. Goods currently wait for a long time due to the unavailability of transport. Turnaround times (from arrival to departure) have been found to be too long. The current operations have to be investigated in order to determine the efficiency regarding the time spent in delivery and throughput/productivity delivery.

1.2 Project Aim

The aim of this project is to provide BPL with a detailed working simulation model presenting a real life representation of the dispatch operations. The simulation model will be used to obtain information such as:

- Highlighting the current bottlenecks in the system
- Determining what the effect of changing the variables such as fleet size, fleet composition (how many vehicles and of which size) will have on the system.
- Determining what the effect of adding more workers in a cage will have on the system.

The information from both techniques will assist in the investigation of the overall impact on performance, cost and service.

1.3 Project Scope

The project will focus on the processes involved in the dispatch of goods that are imported into the country to the various customers. The steps that will be followed in achieving the stated aim are:

- An in-depth literature review that will be used as an aid to understanding the problem fully. Various methodologies that have been used in industry and are currently being used will be studied. The most suitable methodologies will be chosen and applied in this project.
- Collection of the input data using realistic time studies that will be used in the simulation model to help analyze current model and also the improved model by changing the variables in the system.

- Build an improved model that will hopefully meet the desired project goals.
- Provide conclusion and recommendations on the findings of the project.

2. Literature Review

A variety of simulation techniques have been proposed to model complex systems to perform experiments and improve systems.

Although literature covers a wide variety of techniques and methods, this review will focus mainly on the definition of simulation, application, uses and some of the software that is being used. The chosen software that is most suitable and applicable to this project will then be discussed in more detail.

2.1 System

A **system** as defined by Chung (2004) is a collection of interacting components that receives input and provides output for some purpose. There are a number of systems that can be simulated which may include: manufacturing,service, and transportation systems. Examples of each of the mentioned systems are as follows:

<u>Manufacturing system</u>

- Machining operations
- Assembly operations
- Materials-handling equipment
- Warehousing

<u>Service system</u>

- Retail stores
- Information technology
- Customer order systems
- Hospitals and medical clinics

<u>Transportation system</u>

- Airport operations

- Port shipping operations
- Train and bus transportation
- Distribution and logistics

2.2 Model

A **model** is a simplified representation of a complex system (Altiok and Melamed 2001) designed to capture certain behavioral aspects of the modeled system. A model can take a number of forms such as:

- Physical model: is defined as a simplified or scaled down physical object. (e.g. a scale model of an airplane), (Altiok and Melamed 2001)

- Logical (or mathematical) models: is a set of approximations and assumptions, both structural and quantitative, about the way the system does or will work (kelton 2007).Mathematical tools like queuing theory, differential- equations or linear programming maybe used to get the answers you want.

- Computer model: is defined as a program description of the system. A computer model with random elements and an underlying time line is called a Monte Carlo simulation model.

2.2.1 Model construction

For the successful construction of a model, a number of steps must be followed. These are:

1. **Problem Analysis and Information Collection:** The first step in building a simulation model is to analyze the problem itself (Altiok and Melamed 2001). Information related to the problem and represents it accordingly must be collected to assist the analyst in reaching a solution. Such information includes input parameters, variables and rules governing the operation of system components.

2. **Data Collection:**data collection is needed for estimating model input parameters. Data collected on system output statistics is compared to their counterparts (Altiok and Melamed 2001). This comparison is done in model validation.

3. **Model Construction:** The analyst can proceed to construct the model and implement it as a computer program only if the problem is fully described and the requisite data is collected, (Altiok and Melamed 2001). The computer language that maybe used may be of general-purpose language (e.g. C,visual basic) or it may be special-purpose simulation language (e.g. Arena, Promodel,GPSS). See section 2.3.4 simulation software.

4. **Model verification:** Altiok and Melamed (2001)said that "The purpose of model verification is to make sure that the model is correctly constructed. Differently stated, verification makes sure that the model conforms to it's specifications and does what it is supposed to do." Verification is done by inspection and comparing model code to specifications.

5. **Model Validation:**"Every model should be initially viewed as a mere proposal, subject to validation", said Altiok and Melamed(2001)Model validation examines the fit of the model to empirical data. A good model fit means here that a set of important performance measures, predicted by the model, match or agree with their observed counterparts in the real-life system, (Altiok and Melamed, 2001)Any significant differences would suggest that the proposed model is inadequate for the project purposes, and that changes are required.

6. **Designing and Conducting Simulation Experiments:**When all model validations and modifications have been conducted and the analyst deems the model to be valid, a simulation maybe be carried out to estimate performance and aid in solving the problem defined.(Altiok and Melamed, 2001).

7. **Output Analysis:**The estimated performance measures are subjected to a thorough analysis, of logical and statistical nature. A statistical analysis would run statistical inference tests to determine whether or not one of the alternative designs enjoys superior performance measures , and so should be selected as the best design,(Altiok and Melamed, 2001).

8. **Final Recommendations:** The results from the output analysis are used by the analyst to formulate recommendations usually done in the form of a report,(Altiok and Melamed, 2001)

2.3 What is simulation?

According to Kelton,Sadowski and Sturrock (2007), simulation refers to a broad collection of methods and applications to mimic the behavior of real systems, usually on a computer with appropriate software. From a practical perspective, simulation is the process of designing and creating a computerized model of a real or proposed system for the purpose of conducting numerical experiments to give a better understanding of the behavior of that system for a given set of conditions.

Another definition of simulation which is in line with the definition above is that “simulation modeling is a common paradigm for analyzing complex systems. This paradigm creates a simplified representation of some system under study. It then proceeds to experiment with it, guided by some prescribed set of goals” (Altiok and Melamed 2001)

2.3.1Purpose of simulation

Simulation modeling and analysis of different systems are carried out with the aim of (Pedgen et al., 1995):

- Gaining insight into the operation of a system
- Developing operating or resource policies to improve system performance
- Testing new concepts and/or systems before implementation
- Gaining information without disrupting the actual system

2.3.2 Advantages and Disadvantages to Simulation

2.3.2.1 Advantages

Over the years simulation has become a very popular operations research tool because of it's ability to solve complex models and predict the future behavior of systems given certain conditions. The following are more benefits of simulation:

- It can compress time so that several years of activity can be simulated in minutes or even seconds. This allows the investigator to run multiple experiments in a short period of time, Fishman (1978). It can also expand time so that the investigator can slow down the process and thoroughly investigate the model.
- In a simulation, control of experimental conditions can be maintained better than they would be when experimenting with the system itself,Kelton and Law (1982). It is also less costly and less dangerous to experiment with a simulation than with the real system.
- In a paper presented by P. A. Farrington, H. B. Nembhard, D. T. Sturrock, and G. W. Evans, at the 1999 winter simulation conference, they stated that Simulation allows you to better understand the interactions among the variables that makeup complex systems. Diagnosing problems and gaining insight into the importance of these variables increases your understanding of their important effects on the performance of the overall system.
- Another advantage of simulation is the reduced analytic requirements as stated by Chung (2004). Before the existence of computer simulation, systems could only be analyzed with a static approach at a given point in time. Yet now, with the advent of simulation methodologies, systems can be analyzed dynamically in real time during simulation runs.
- Bottleneck analysis can be performed indicating where work in process, information, materials, and so on are being excessively delayed, (Pegden, Shannon, and Sadowski 1995)

2.3.2.2 Disadvantages

Despite having numerous advantages, simulation also has some disadvantages.

- Simulation models are often expensive and time consuming to develop, (Law and Kelton 1982)
- Simulation model may contain over simplified assumptions about the system, and unfortunately such assumptions may probably not be a valid representation of the system.(Kelton and Sadowski 2002)
- Chung (2004) states that "Simulation cannot give accurate results when the input data are inaccurate". If not enough time is spent on data collection and the data input into the model is inaccurate, then the investigator cannot possibly expect the model to produce accurate results no matter how good the model is developed.
- "Simulation model building requires specialized training" (Chung 2004). Although simulation languages have evolved into easy-to-use interfaces, a general background knowledge of simulation is still required. Also, simulation results require basic knowledge in statistics as they are presented in a statistical format; Chung (2004).

2.3.3Types of Simulations

Kelton et al (2002) classifies simulation models into three dimensions, which are; Static vs. Dynamic, Continuous vs. Discrete and Deterministic vs. Stochastic.

- **Static vs. Dynamic:** A static simulation model is one which represents a system at a particular point in time. An example of such types of models would be the Monte Carlo simulation models, (Law et al 2005). Time does not play a natural role in such models. Dynamic models on the other hand represent a system as it evolves over time.

- **Continuous vs. Discrete:** A continuous model is one which represents state variables that change continuously over time, Kelton (2002). Sufficientmodeling concepts have been defined so that a discreteeventsimulation model can be defined asone in which thestate variables change only at those discrete points in timeat which events occur, which was defined in a paper presented by P. A. Farrington, H. B. Nembhard, D. T. Sturrock, and G. W. Evans, at the 1999 winter simulation conference. Models consisting of both discrete and continuous change are known as mixed continuous-discrete models.

- **Deterministic vs. Stochastic:**Deterministic models are defined as models that have no random input characteristics, Kelton(2002). Stochastic models, on the other hand operate with random inputs. The output data for a stochastic model themselves random and thus only estimates of the true characteristics of the model, Law et al(1982).

2.3.4Simulation Software

There are a various number of simulation languages that are currently available at the moment. For the purpose of this project, only discrete event simulation language software will be mentioned.

- **Simio**

  Simio is a unique multi-paradigm modeling tool that combines the simplicity of objects with the flexibility of processes to provide a rapid modeling capability without requiring programming.Simio can be used to predict and improve the performance of dynamic complex systems in mining, healthcare, military, airports, supply chain, ports, manufacturing and other areas.

  Simio gives users the opportunity to:

  - Build models fast using Simio’sunique modeling framework based on intelligent objects.
  - Communicate results in 3D visualization.

(Simio simulation software. [Online]

http://www.simio.com/the-simio-simulation, accessed 2 May 2012)

- **Arena**

  Arena is a discrete event simulation and automation software. It consists of module templates, built around SIMAN language constructs and other facilities, and augmented by a visual front end, (Altiok and Melamed, 2001). Arena is fully compatible with windows software, like word processors and spreadsheets. Data can easily be transferred from the other software into arena, (Kelton et al 2002).

Arena is a Visio-compatible, flowcharting tool. The flowchart approach makes more sense to engineers who must be able to carefully document a process in order to accurately model it and analyze it. Arena's flowcharting methodology makes Arena:

- Easier to learn than other simulation tools
- Easier to validate, verify and debug
- Easier to communicate the intricacies of complex processes to others.

Arena's fundamental modeling components, called modules, are selected from template panels such as: Basic Process, Advanced Process and Advanced Transfer. The user can create experiments using modules from the selected panel. It has 60 modules and can model manufacturing operations and queuing systems.

Arena can be used to model changes in dynamic complex systems such as supply chain, logistics, manufacturing, service industry and distribution.

<u>Arena Technologies</u>

Arena Runtime feature allows analysts to perform what-if simulation analysis using an Arena model built by someone else. In runtime mode, an analyst can modify the characteristics of any object in the model, but cannot delete or add any objects in the model.

VB Automation. All Arena functions can be automated with Visual Basic Programming. Both thebuilding and the execution of Arena models can be fully automated through VB programming and theArena Object Model.

(Key advantages of Arena, [Online]

http:/www.actsolutions.it/File/Arena/Arena%20Simulation%20Key%20Advantages.pdf, accessed 3 May 2012)

- **GPSS**

  GPSS is a discrete event simulation language whereby models are developed with an editor and saved in text files. The modeler specifies the sequence of events, separated by lapses in time, which describe the manner in which objects flow through the system.

  A key feature of GPSS is the conceptual flexibility to model a wide range of different systems. Basic output data such queuing and service statistics are automatically provided without any further programming.

- **JSIM**

  JSIM is a discrete event simulator for the analysis of queuing network models. This simulation software supports several probability distributions for characterizing service and interval times, e.g. uniform and exponential distributions. Performance indices such as throughput, utilization, response times and queue lengths are evaluated.

- **ExtendSim**

  ExtendSim is a multi domain simulation software that can dynamically model continuous, discrete event, discrete rate, linear and non-linear models. It can be used to model systems in logistics and transportation, food industry, healthcare and chemical industry. It has building blocks that allow the user to build models rapidly and has the ability to adjust settings dynamically while the simulation is running.

  (ExtendSim software, [Online]
  http://www.extendsim.com/products_overview.html, accessed on 3 May 2012)

2.4 Data

As defined earlier (section 2.1 system), input and output data are the vital components in any system. Input data are what drive the system, and output data are what result from the system, (Chung, 2004).

2.4.1 Data Collection

One of the early steps in creating a simulation model is identifying the type of data required to support the model. Data collection can be time consuming, expensive and often frustrating, (Kelton et al, 2002).

Kelton (2002) suggested the following hints to keep in mind when deciding on the type and how much data to collect:

- Sensitivity Analysis: Sensitivity analysis can be used very early in a project to assess the impact of changes in data on the model results. It assists the user in understanding the type of data that is important and that is not.
- Cost: Since it may be expensive to collect data, using looser estimates of some data maybe a better alternative.
- "Garbage in, garbage out": As discussed earlier, the quality of data you put in the model is the same quality as you will get out from the model results.

2.4.1.2 Time study

Time studies are a requirement because they provide the most accurate if not exact amount of time that is spent on a process. Time standards can be determined by using estimates, historical records, and work measurement procedures, (Freivalds, 2009).

The time study analyst should ensure that the times taken are recorded accurately and honestly evaluate the performance of the operator. The minimum equipment needed to carry out a time study includes a stopwatch, time study board, time study forms and pocket calculator.

2.4.2 Probability Distributions

Should a decision be made to incorporate data values by fitting a probability distribution to them, a specific distribution maybe selected manually and use the input analyzer to provide numerical estimates of the appropriate parameters, or a number of distributions maybe put into the data and most appropriate one is selected, (Kelton, 2002).

Probability distributions fall into two main types: theoretical and empirical. The theoretical distributions such the exponential and gamma, generate samples on mathematical formulation. The empirical distributions simply divide the actual into groupings and calculate the proportion of values in each group, (Kelton 2002).

2.5 Conclusion Of Literature Review

After reviewing some of the methodologies that are currently available and are applicable to this project, Arena Rockwell Simulation software is the chosen software for this project. A full version is available at the University of Pretoria. All the simulation steps discussed will be followed when using arena. Time studies will be conducted by observing the processes and also historical time data will be used. The data from the time studies will be used in conjunction with arena using the input analyzer function to determine the probability distributions.

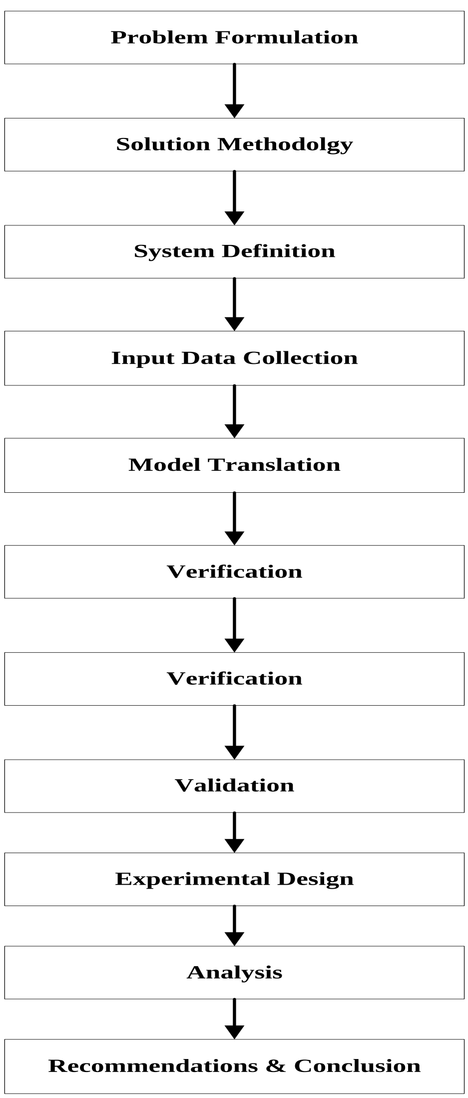
3. Model Conceptualization

A general approach will be followed in constructing the simulation model. The next section will discuss the steps involved in conducting a simulation study.

3.1 Conducting Simulation Studies

The following diagram illustrates the steps to be taken when conducting a simulation study. Some of the steps have already been completed in previous chapters of this project report.

Figure 2 Simulation steps



3.1.2 System Definition

System definition is the third step in conducting a simulation study. The work that needs to be carried out in systems definition includes; identifying system components to model and identifying input and output variables.

- **Identifying system components:** this stage requires the investigator to identify components of the system that need to be modeled. It does not necessarily mean that all components must be identified as there might be changes and new ideas might come up as modeling progresses.
- **Identifying input and output variables:**the investigator finds out the type of data that needs to be collected through asking questions, observing and looking at historical data. The input variables may be classified as:
    - System parameters such as the simulation run time
    - Number of vehicles required (Resources)
    - Time taken to deliver goods

  The output variables may be classified as:

    - Queue statistics
    - Time an entity spends in the system

3.1.2.1 Queuing Systems

A queuing system is described by its calling population, the nature of the arrivals and services, the system capacity, and the queuing discipline, (Banks, Carson and Nelson 1996).

When an entity arrives in the system, it might enter the system directly or wait in the queue depending on the availability of resources.

Figure 3 as illustrated by (Banks et al 1996) is a flow diagram that shows the arrival sequence of an entity.

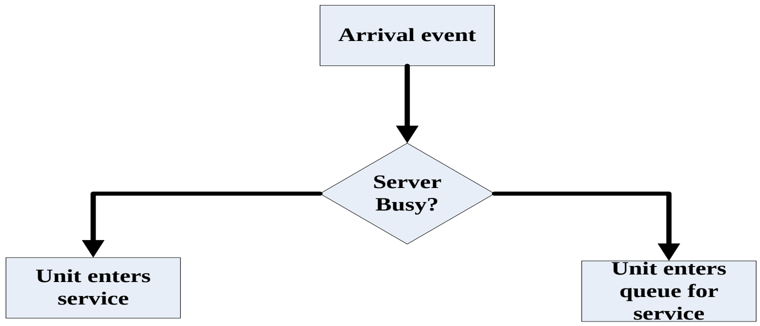
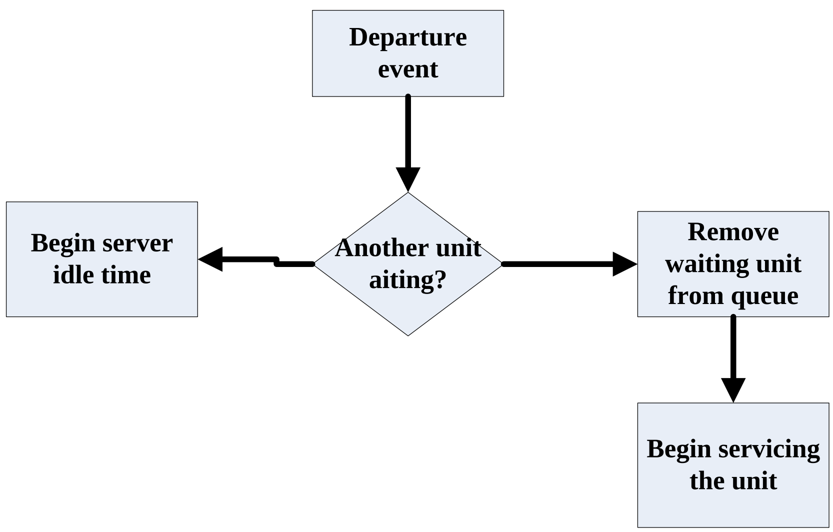


Figure 3 unit entering system flow diagram

Figure 4 as illustrated by (Banks et al 1996) is a flow diagram that shows the departure sequence of an entity.

Figure 4 Service Just completed flow diagram



3.1.3 Process Mapping

Before any successful data gathering was conducted, a process flow diagram depicting the current processes involved in the dispatching of goods was mapped. The process map enabled the observer in knowing the type of activities that the time studies would be conducted on.

The activities that take are discussed in detail below:

1) Cleared cargo is placed into area specific dispatch cage.

2) Dispatch coordinator signs acceptance for the number, condition and specific shipment transferred on the draw sheet including name, surname, date, time and any notations. The dispatch coordinator checks the following:
   - Condition of cargo
   - MAWB(Master Air Way Bill) number
   - HAWB(House Air Way Bill) number
   - Number of packages.

     The dispatch coordinator endorses any discrepancies and reports them to supervisor.
3) The dispatch coordinator then matches the delivery document with cargo. If document is not available, then email is sent to relevant import channel requesting delivery document by file number and client name.
4) Once all delivery documents are available, the dispatch load is prepared by consolidating the delivery documents with cargo again by checking: condition of cargo, MAWB number, HAWB number, number of packages.
5) Similar cargo checks and dispatch procedure to be followed when third party service providers collect cargo from dispatch cage.

   <u>Cargo pre check (During Off load)</u>

   1) At the time of capturing the load sheet and any short landed cargo and/or damages is captured onto the cargo wise delivery control system.
   2) The truck driver pre-checks the load in the presence of the dispatch coordinator by checking the following: MAWB number, HAWB number, customer name, file number as stated on the delivery documents.

      Once everything is achieved, cargo is loaded into the vehicle referring to loading guideline.
   3) Discrepancies: dispatch coordinator makes an endorsement on delivery schedule and a complete damage report is sent to the claims department.
   4) Driver will sort his delivery documents in the sequence of deliveries and hand them over to dispatch coordinator. Urgent goods will take first priority and loaded as first stop.

5) When loading is complete, a load sheet is printed. It is then checked against delivery document to see if all cargo has been captured by comparing file number.
6) Once satisfied, driver signs acceptance on deliver schedule. Driver takes one copy with him, and one copy is handed over to control room.
7) High value surveillance cargo is allocated seals and the number of each of the seals is recorded on the schedule. Security vehicles are allocated to escort the trucks.
8) Driver produces copy of signed load sheet at exit gate in order to be able to leave premises.
9) Dispatch coordinator emails pre advice to (selected clients) with the delivery destination including shipment details, any notation and the number of pieces.
10) Driver must ensure that he check the information on delivery documents not against cargo. If there is surveillance, cargo is re-sealed after each stop.
11) Driver must ensure that all delivery documents have been signed off in full, with company stamp. If there are any delays, driver must communicate with control room.
12) Upon completion, driver will proceed back to deport at the end of each day and return all delivery documents and keys to control room. The transport provider checks for any undelivered cargo, ensures that all PODs are signed and hands in POD and load sheet to administration office.
13) Administration office enters all PODs in POD register and load sheet is updated on cargo wise delivery control system.

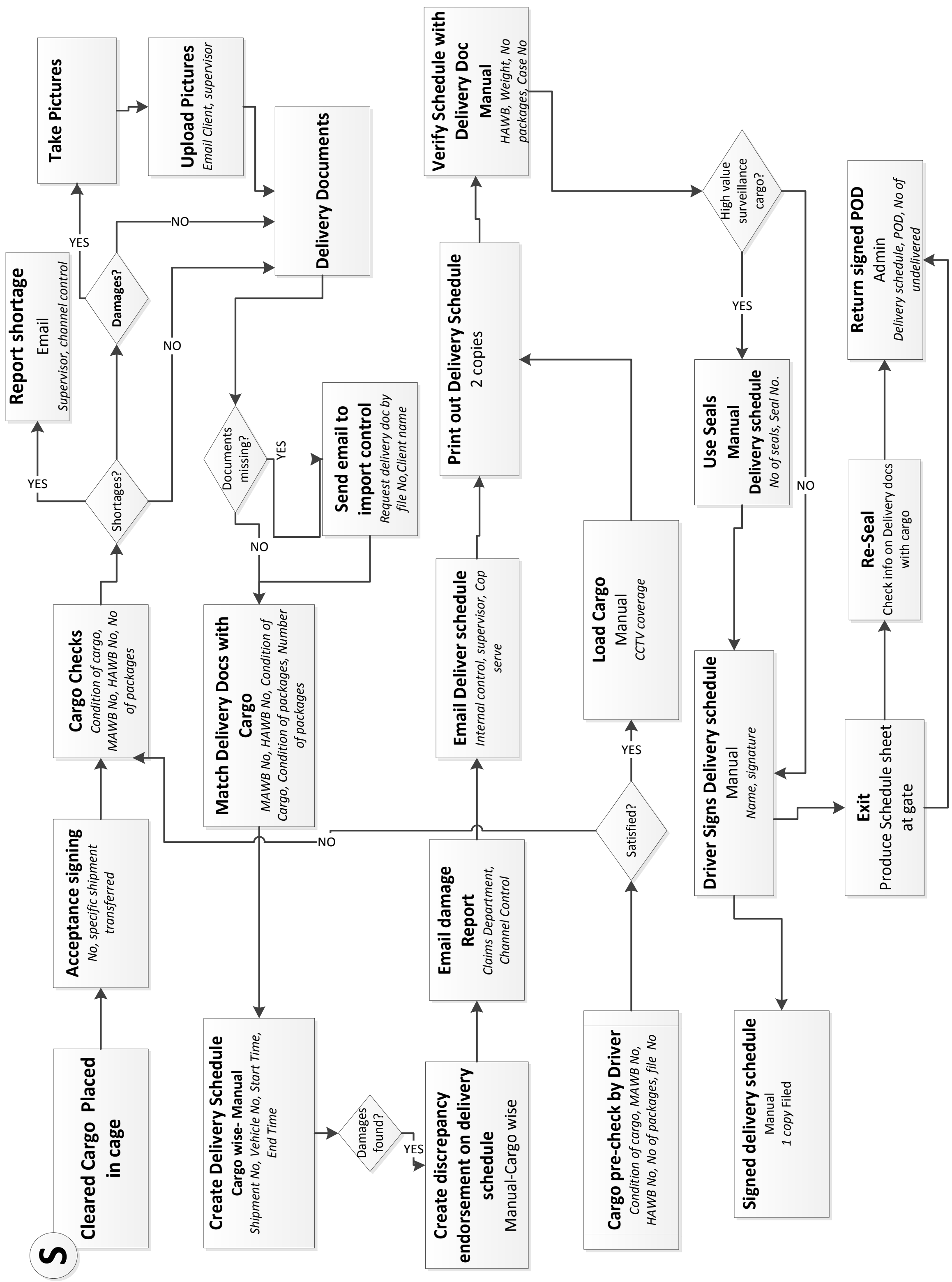


Figure 5 Dispatch Flow Diagram

3.2 Input Data Gathering

Before any desired results from a simulation model can be obtained, input data must first be defined and collected. The analyst must determine which areas are critical to the success or failure of the simulation model. The identified areas/activity of data collection are as follows:

- Truck sizes used at the warehouse
- Amount of cargo loaded onto a truck
- Number of employees (picking and dispatch)
- Loading times
- Picking times
- Number of pallet jacks and forklifts

The truck sizes will be used to determine the size of the cargo that is loaded onto it. This will in turn determine the loading time spent by each truck driver.

Depending on the size of the cargo, either a forklift or a pallet jack is used to move the cargo from the allocation area to the specific dispatch cage. The pallet jack is mostly used as most the cargo is of medium size.

3.2.1 Data analysis

Data was collected by observation, interviewing employees and accessing the company database. From figure 2, the processes that required data collection were identified. The average times are:

Process	**Time/Quantity**
Number of dispatch coordinator in cage	1 * two cages=2
Time cargo waits before being checked	1-2 hrs
Time for doing checks by dispatch coordinator	15 min
Time for doing checks by truck driver	20min
Creating delivery schedule	2min
Taking pictures	3min
Discrepancy report	2min
Collection of seals	3min
Truck turnaround time (delivery time)	2-3 hrs

Number of Working hours in a day	9hrs
Number of forklift used	1
Number of pallet jacks	4
Time picking cargo	15 min

Table 1 Input Data

3.3. Assumptions

Before building the simulation model, a few assumptions were taken into consideration.

- All workers are present
- No overtime
- All transporting(pallet jacks) are available
- No failure of forklifts, trucks or any other equipment.

4. Conceptual Model Design

Conceptual model translation is determining and addressing every aspect that will be needed in the model. The ‘pieces of the model’ identified for this model are as follows:

- **Entities**

  The entity identified is the cargo that moves from the allocation area up until it reaches the respective client. It will change status, affect the output performance of the system as it goes through all the processes.

- **Attributes**

  Attributes in the model will include the amount of time the entities spend in the system, defined TNOW

- **Variables**

  The variables in the model will be the recorded number of entities in the system and the number of entities that leave the system.

- **Resources**

  The identified resources are the dispatch coordinators, trucks and the truck drivers.

4.1 Simulation Model Description

4.2 Model Overview

The model developed in arena was based on the arrival of cargo in the dispatch cage going through all the physical checks and paper work done by the relevant resources up until it leaves the cage and delivered to the respective clients.

Each of the sevendispatch cages has its own process because of the different activity levels and the time spent in processing cargo. The simulation model for each cage is currently being simulated and for the purpose of this phase of the project, two of the cages will be illustrated.

Before the suggested simulation model can be discussed, the current as is simulation model at the company will be discussed first.

4.2.1 Cargo arrival

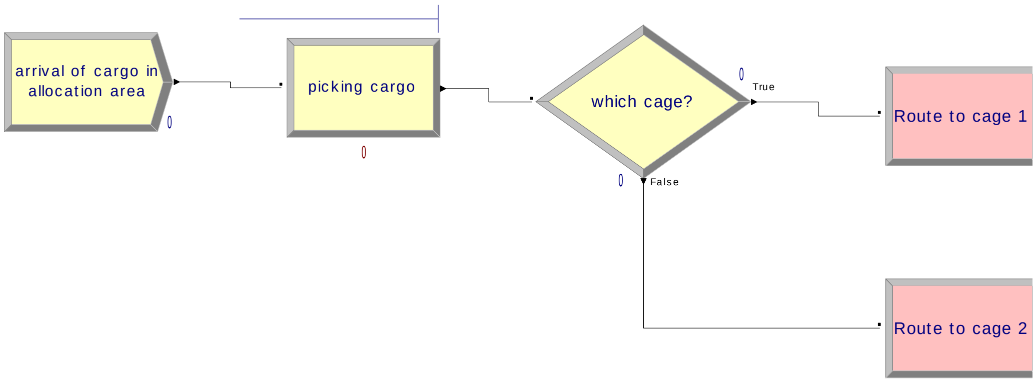


Figure 6 cargo arrival model

Cargo arrives in the allocations area every 2-4 hours. This is the area where the cargo is stored/kept before clearance from customs to dispatch the cargo is received. Once clearance is received, the allocations employee picks out the cargo from the various areas and takes it to the relevant cages. From observation it was determined that 60% of the cargo is sent to cage 1.Cargo is brought into the cage using pallet jacks, meaning that an entity is equivalent to a pallet. The assign module is used to record the number of pallets entering the system. A delay module was used to keep the cargo waiting in the cage until a significant amount of entities had entered and then they can be processed. A seize module is used to seize the dispatch coordinator who is the one that does the cargo checks. The cargo checks involve counting the number of boxes, checking the HAWB number to see if it corresponds with the runsheet (delivery document). Once the checks are complete, the dispatch coordinator is released. This is shown in figure 7 below.

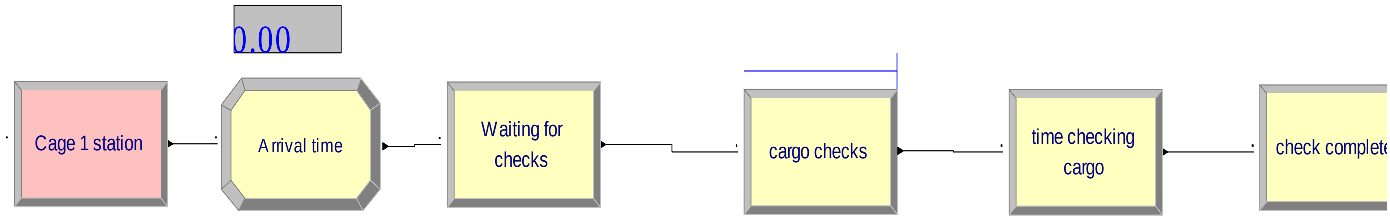


Figure 7 cargo checks

4.2.2 Data processing

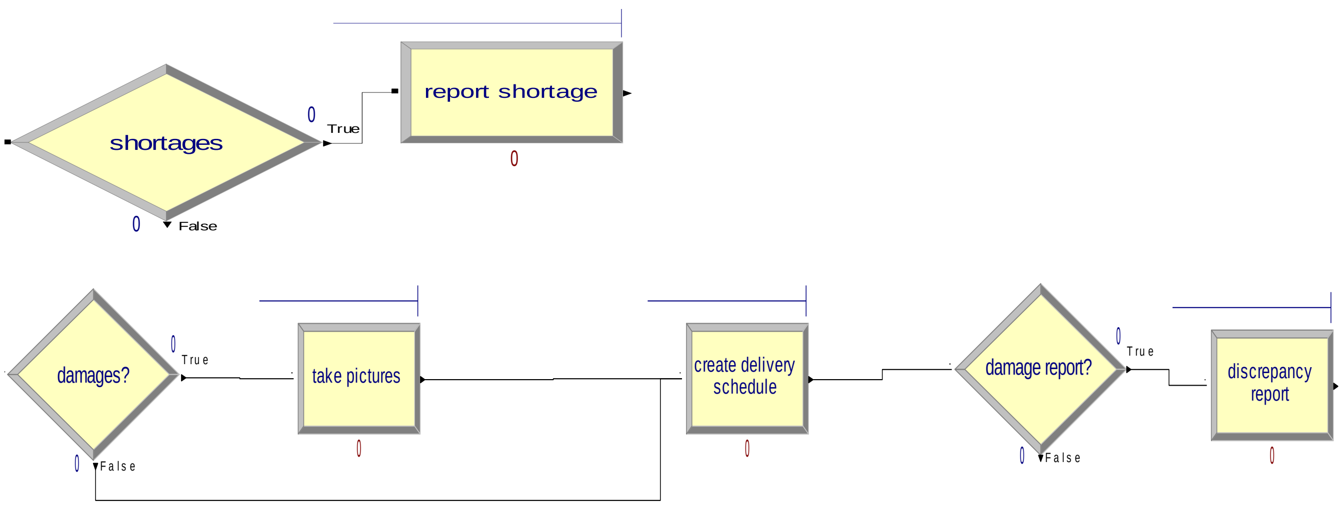


Figure 8 Data processing Model

Once the checks have been completed, the cargo is kept "waiting" whilst the dispatch coordinator reports any shortages, he does this by emailing/ calling his supervisors and the client. When the cargo is damaged, pictures are taken and the client is informed of this. The creation of the delivery schedule involves selecting an available truck in cargo wise, which is system software that is used and imputing all the information that is in the delivery document.

4.2.3 Batching Entities

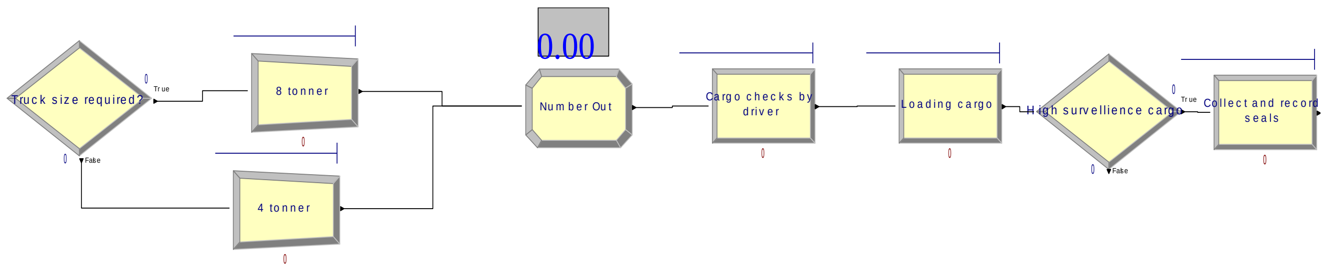


Figure 9 Batching Entities

The entities are then batched to determine the size of truck required. Most of the time the 8 tonner truck is allocated to the cages and during high peak seasons the bigger trucks are allocated. The van is used for urgent deliveries that are needed by the clients. The assign module is used to record the number of batched entities that come out and leave the premises.

4.2.4 Transporting Cargo

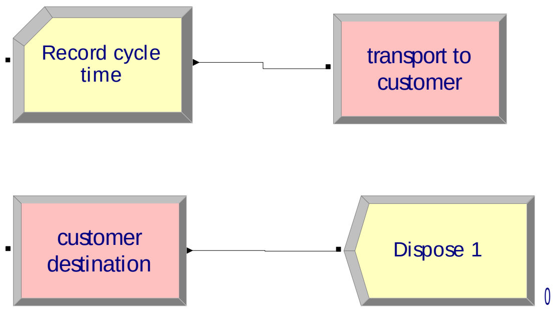


Figure 10 Transporting Cargo

The record module is used to record the amount of the time that the cargo spends in the cage. The route module was used to depict the movement of goods to the client. A route time of 2 hours was used because that is the average time that the dispatch coordinator puts in the cargo wise system. Should the truck return before the stipulated time has elapsed, it cannot be used because in the system it appears as if it has not returned yet.

4.3 Verification and Validation of AS-IS model

4.3.1 Verification

Verification is defined as the process of confirming that the designed simulation model performs in the way it was intended, according to the assumptions made. The comparison of the as-is simulation results with the real life system will ensure that the assumptions made are accurate. Any problems or bugs affecting the desired output results of the model need to be removed; this process is known as de-bugging.

4.3.1.1 Methods of Verification

One entity is allowed to enter the model. The entity is then followed every step of the way to ensure that the logic data is correct.

Counters and discrete change variables are also measures of entity flow. Verification is carried out by comparing the results of the output analyzer with the values shown through the counters or variables. The values should be more or less the same.

Animation is used as the visual representation of the activities in the model. The use of color, graphs and assigning pictures to the state of each resource (idle or busy), guarantees that the entity flow can be followed clearly.

4.3.2 Validation

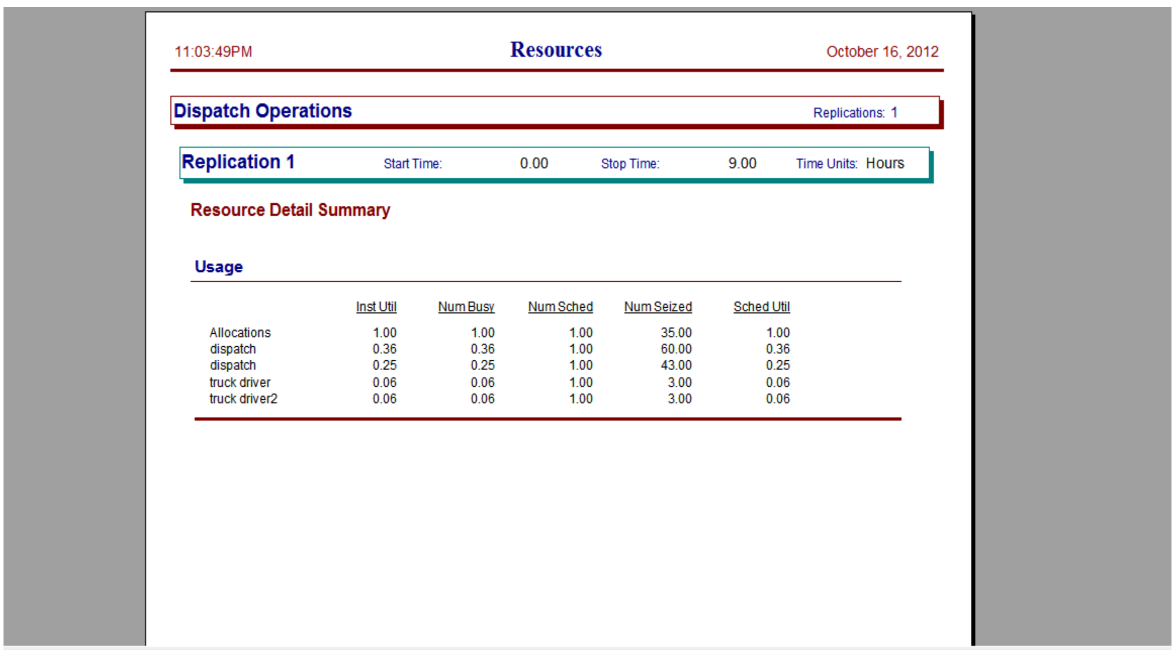
Validation is the task of making sure that the simulation model behaves the same as the physical system.

Validation does not mean that the model is exactly the same as the physical system. It means the model has been built sufficiently, representing the physical system to an acceptable degree of confidence in order to make changes on the physical system by testing them on the model first.

If comparison of results from the model output and real life system are similar, then validation is complete. Validation in this case was carried out by comparing the output to the real system. It showed that an average of two trucks leave the facility each day from the two cages analysed. After study of the real system, one or two trucks left the cages. Such a low number of trucks leaving the facility are attributed to the fact that data analysis and gathering was done during the off-peak season.

4.4 Current Model Simulation Results

The simulation model of the current process in the two cages produced the following results:



11:03:49PM **Resources** October 16, 2012

Dispatch Operations Replications: 1

Replication 1 Start Time: 0.00 Stop Time: 9.00 Time Units: Hours

Resource Detail Summary

Usage

	Inst Util	Num Busy	Num Sched	Num Seized	Sched Util
Allocations	1.00	1.00	1.00	35.00	1.00
dispatch	0.36	0.36	1.00	60.00	0.36
dispatch	0.25	0.25	1.00	43.00	0.25
truck driver	0.06	0.06	1.00	3.00	0.06
truck driver2	0.06	0.06	1.00	3.00	0.06

Figure 11 current resource utilization

The results above show that the allocations employee is over utilized. This causes a delay during the picking process hence delaying the overall movement of cargo in the entire dispatch process.

The results also show that the dispatch coordinators are relatively underutilized. The recorded cycle time is shorter in cage 2 than it is in cage 1.

4.5 Possible Simulation Model Scenarios

A number of possible scenarios of the simulation model need to be run in order to determine the most effective and optimal way of maximizing the use resources. Maximizing the resources will in turn help reduce the bottlenecks in the system.

- **Scenario 1**

  The first scenario that was run was to move the employee resources around. The current model results showed that there is long queue during the picking of the cargo to determine which cage it goes to. This is done by looking for the file number on each of the packages that correspond to the number on the runsheet. Since both dispatch coordinators and allocation employee receive the same email notification and runsheet once the cargo is cleared by customs, the dispatch coordinator can assist the allocations employee in picking cargo hence increasing the resource capacity at the picking area.

  After running this scenario, the waiting time of the entities at the picking process was reduced by almost half. This means as soon after picking, the dispatch coordinator can go back to his cage.

Table 1 Results comparison 1

	Current Model	Scenario1
Picking waiting time	1.65	0.62
Allocation employee utilization	1.00	0.50

- **Scenario 2**

  The dispatch coordinators currently work on the cage they are assigned to. This is causes the dispatch coordinator who is assigned to the cage with low activity to be idle most of the time. A possible solution to reduce the idle time would be to have the dispatch coordinator that is not working at the time move to the cage that is currently busy. So if there are two dispatch coordinators in a single cage, the time spent by the cargo in that cage would be greatly reduced and the utilization of each dispatch coordinator increased.

Table 2: Results Comparison

	Current Model	Scenario 2
Cycle time cage 1	6.4243	4.8067
Cycle time cage 2	5.2259	5.9522

When comparing the results of the cycle time from scenario 2 with those from the current results, it is evident that the alternative is a much better solution. The cycle time in cage 1 has reduced by 34%. The cycle time in cage 2 has increased by 12% which has minimal negative effect on the total cycle time.

5. Conclusions

Work turnaround time in any organization has proved to have a huge impact on the success of that organization. Eliminating unnecessary tasks or utilizing resources efficiently has shown to be of great importance.

The results in this report have shown that the current system at BPL is under achieving since resources are not being utilized efficiently. There is room for improvement and the current possible scenario that has been identified so far is to shift resources from cage to cage depending on how busy the cage is.

The various alternative designs have shown to be of prodigious assistance in determining the most effective usage of employees. The scenarios gave a conclusion that the employees should be moved around to reduce their idle time. The results have shown that by doing this, the amount of time that cargo spends in a cage before it is dispatch is greatly reduced.

In the picking process, by just adding the dispatch coordinator, the waiting time for cargo to be picked and taken to the cage is reduced by almost half.

So far the results that have been suggested will not cost the company anything but will instead increase their turnaround times and operational efficiencies.

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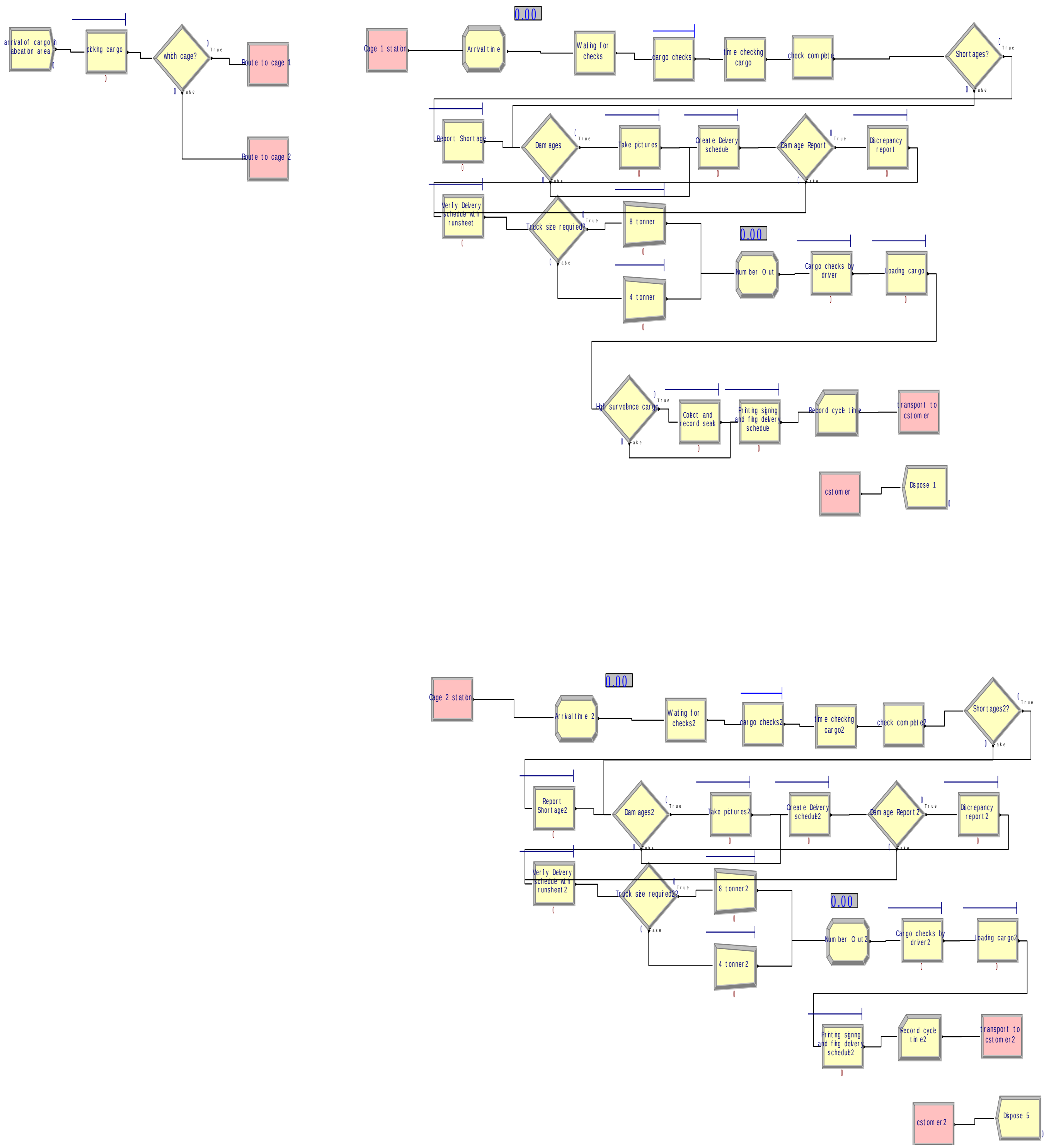
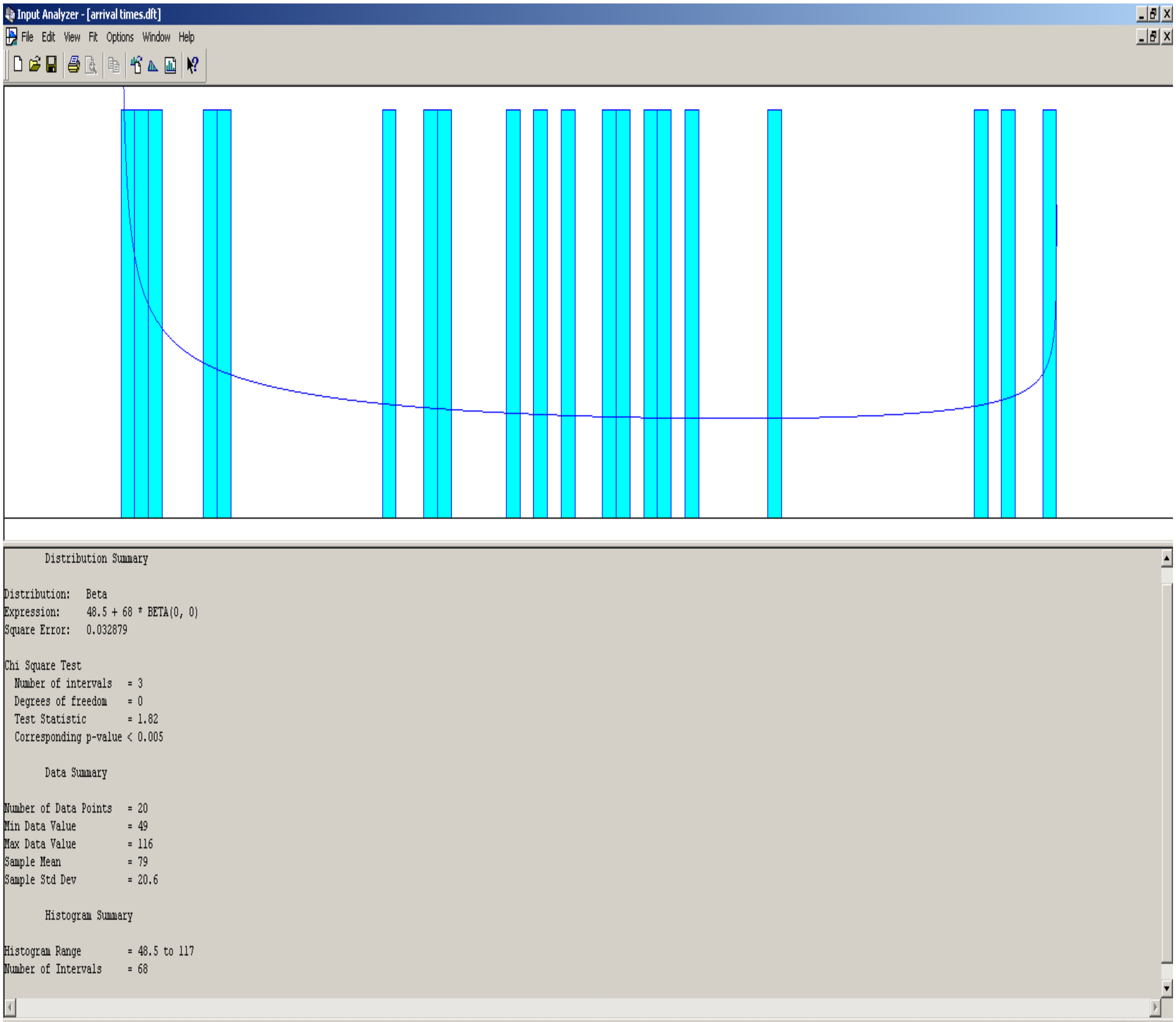
7. Appendix A

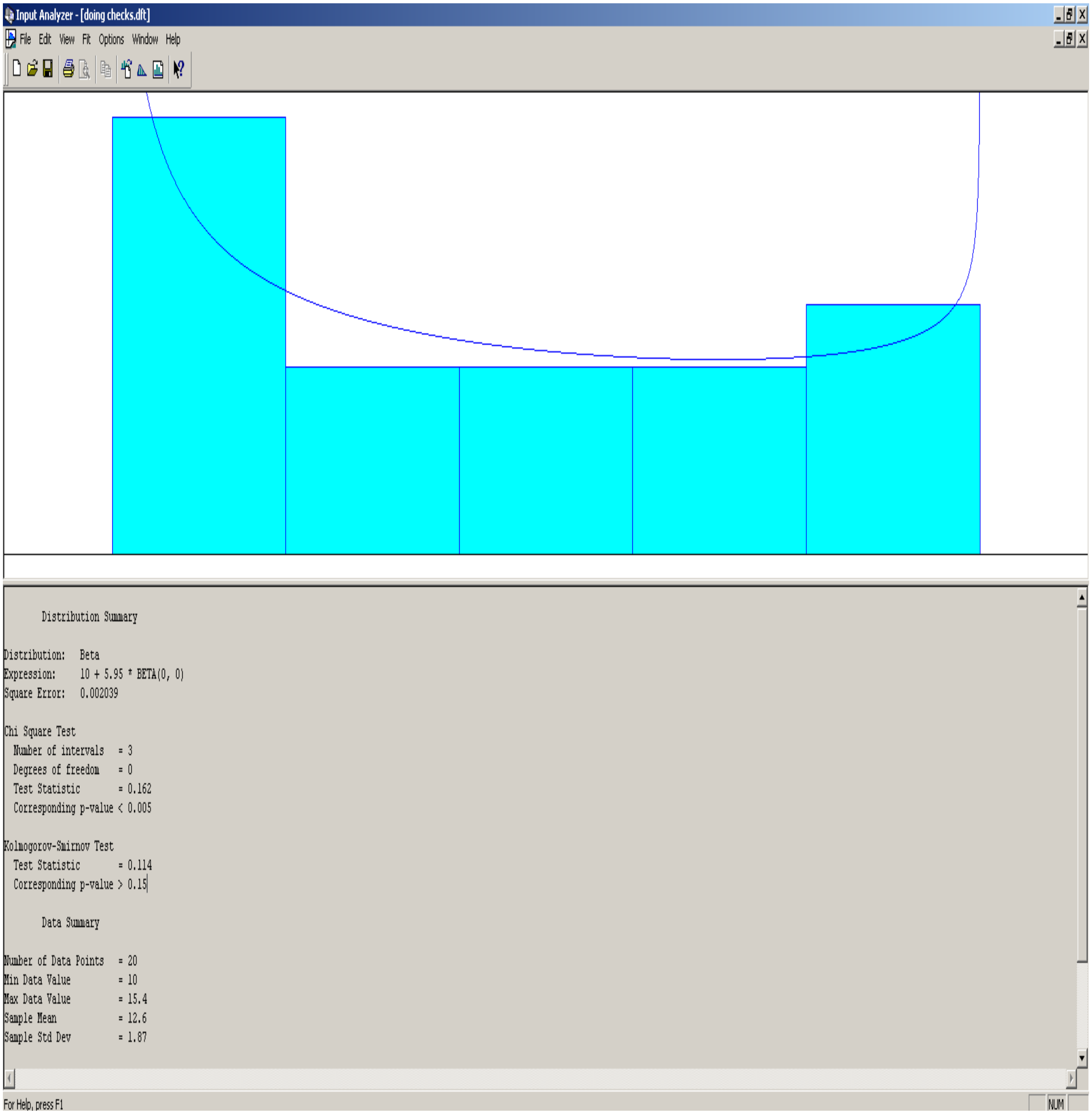
AS-IS Simulation model



7.2 Probability times

Arrival times




Input Analyzer - [doing checks.dft]
File Edit View Fit Options Window Help
Distribution Summary
Distribution: Beta
Expression: 10 + 5.95 * BETA(0, 0)
Square Error: 0.002039
Chi Square Test
Number of intervals = 3
Degrees of freedom = 0
Test Statistic = 0.162
Corresponding p-value < 0.005
Kolmogorov-Smirnov Test
Test Statistic = 0.114
Corresponding p-value > 0.15
Data Summary
Number of Data Points = 20
Min Data Value = 10
Max Data Value = 15.4
Sample Mean = 12.6
Sample Std Dev = 1.87
For Help, press F1
NUM

7.3 Simulation results

7.3.1 Resources AS IS

7.3.2 User defined AS –IS

7.3.3 Waiting time scenario 1

7.3.4 Cycle time scenario 2