



UNIVERSITAS INDONESIA



UNIVERSITÉ D'ARTOIS

**SIMULASI ALIRAN PENUMPANG BANDAR UDARA
MENGUNAKAN SOFTWARE QUEST UNTUK OPTIMASI
ALOKASI SUMBER DAYA**

TESIS

**FAHRUR ROZI
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**FAKULTAS TEKNIK
PROGRAM PASCASARJANA
UNIVERSITAS INDONESIA
JULI 2011**



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**Diajukan sebagai salah satu syarat untuk mendapatkan gelar Magister
Teknik**

**FAHRUR ROZI
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PROGRAM PASCASARJANA
UNIVERSITAS INDONESIA
JULI 2011**

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menggunakan *software* Quest untuk Optimasi
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Telah berhasil dipertahankan dihadapan dewan penguji dan diterima sebagai bagian persyaratan yang diperlukan untuk memperoleh gelar Master-2 Université d'Artois (Perancis) dan Magister Teknik Program Studi Manajemen Infrastruktur, Fakultas Teknik, Universitas Indonesia

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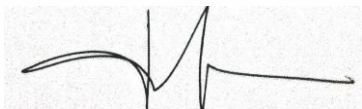
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Depok, 05 Juli 2011



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Depok, 05 July 2011



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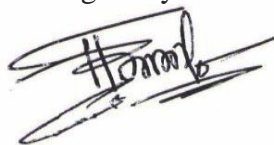
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ABSTRAK

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Judul : Simulasi Aliran Penumpang Bandar dengan menggunakan *software* Quest Udara untuk Optimasi Alokasi Sumber Daya

Laporan ini berfokus pada pemodelan aliran penumpang di Bandar Udara Internasional. Simulasi digunakan untuk mengembangkan model aliran penumpang untuk mendapatkan jumlah optimal dari sumber daya dan total waktu minimum penumpang di dalam sistem.

Aspek utama yang dipertimbangkan adalah kapasitas sistem, manajemen antrian dan peningkatan layanan penumpang dengan meminimalkan antrian. Ada tiga tahapan dalam penelitian ini: (i) mengembangkan model teoritis yang menggambarkan aliran penumpang, (ii) melaksanakan simulasi menggunakan perangkat lunak, dan (iii) mengoptimalkan alokasi sumber daya. Model teoritis yang diusulkan digambarkan menggunakan *Software Quest*; tahap optimasi dilakukan tanpa produk optimasi tertentu. Model yang sama kemudian diterapkan dan divalidasi menggunakan *software ARENA*. Produk *OPT-Quest* memberikan penugasan terbaik dari sumber daya sehingga untuk mengoptimalkan waktu tunggu total dan jumlah penumpang diproses.

Keywords: Simulasi, Bandara, Operasi Penumpang, Quest, Arena dan Pengambilan Keputusan

ABSTRACT

Name : Fahrur Rozi
Interest Program : Civil Engineering
Title : Airport Passenger Flow Simulation In Quest and Resource Allocation Optimization

Our internship focuses on modeling the flow of passengers through an international airport. Simulation is used to develop models flow of passengers in order to get optimum number of resource and minimum total time of passenger in the system.

Key aspects considered are system capacity, bottlenecks management and improving the customer service by minimizing the queue sizes. There are three stages in this research: (i) develop a theoretical model describing the flow of passengers, (ii) implement the simulation using well-known software products, and (iii) optimize the resource allocation. The proposed theoretical model was first implemented in Quest (by DELMIA); the optimization phase was carried out without a specific optimization product. The same model was afterword's implemented and validated in ARENA. The OPT-Quest product automatically provides the best assignment of resources so as to optimize the total waiting time and the number of processed passengers.

Keywords: Simulation, Airport, Passenger Operations, Quest, Arena and Decision Support Systems

TABLE OF CONTENTS

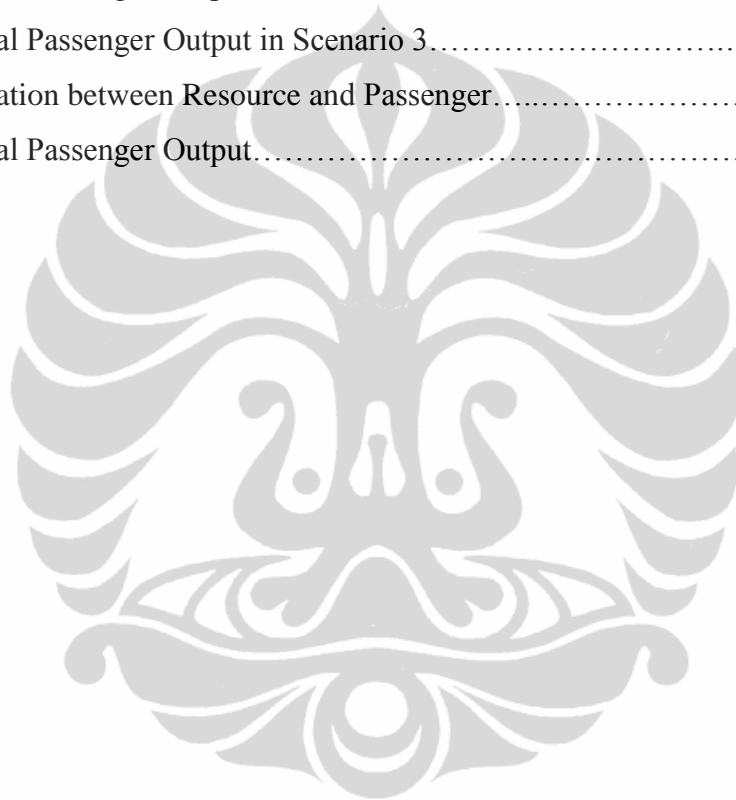
HALAMAN DEPAN	i
HALAMAN PERNYATAAN ORISINALITAS	ii
LEMBAR PENGESAHAN	iii
UCAPAN TERIMA KASIH	iv
HALAMAN PERSETUJUAN PUBLIKASI	v
ABSTRAK	vi
TABLE OF CONTENTS	vii
LIST OF FIGURES	viii
LIST OF TABLES	ix
CHAPTER 1 INTRODUCTION.....	1
1.1 Introduction.....	1
1.2 Problem Definition.....	1
1.3 Objectives.....	2
1.4 Systematic of Writing.....	2
CHAPTER II THEORY ANALYSIS.....	4
2.1 Airport Terminal Overview.....	4
2.2 Queuing Concept.....	5
2.3 Modeling and Simulation.....	5
2.4 Discrete Event Simulation.....	7
2.5 Modelisation in Quest Software.....	8
2.6 Modeling Using Arena Software.....	11
CHAPTER III RESEARCH METHODOLOGY.....	15
CHAPTER IV MODELISATION ANALYSIS.....	18
4.1 Description of Study Case.....	18
4.2 Data Collection.....	21
4.3 Simulation Model.....	22
4.4 Model With Arena Simulation.....	29
4.5 Simulation Analysis.....	29
CHAPTER V CONCLUSIONS.....	39
REFERENCES.....	41

LIST OF FIGURES

Figure 2.1 Discrete System Variable State.....	7
Figure 2.2 Continous Simulation.....	8
Figure 2.3 Quest Interface.....	9
Figure 2.4 3D Rought Cut Model.....	10
Figure 2.5 Arena Display.....	14
Figure 4.1 Passenger Type 1 IAT.....	22
Figure 4.2 Source of Passenger with Normal Distribution.....	23
Figure 4.3 Process Logic.....	25
Figure 4.4 Process Cycle of Security Airlines.....	26
Figure 4.5 Decision Point Have on Line ticket or Not?.....	27
Figure 4.6 Brake Process.....	28
Figure 4.7 Simulation Model Using ARENA.....	29
Figure 4.8 Graphic of Opt.Quest for ARENA.....	35
Figure 4.9 Composition Resource.....	36

LIST OF TABLES

Table 4.1 Type Passenger.....	18
Table 4.2 Schedule List of Agent.....	21
Table 4.3 Statistical Distribution For Each Agent.....	22
Table 4.4 Total Passenger Output in Scenario 1.....	31
Table 4.5 Total Passenger Output in Scenario 2.....	32
Table 4.6 Total Passenger Output in Scenario 3.....	32
Table 4.7 Relation between Resource and Passenger.....	32
Table 4.8 Total Passenger Output.....	34



CHAPTER I INTRODUCTION

1.1 Introduction

The Transport sector is one of many indicators to know economic growth and social development in one country. There are many type of transport that used to carry people, goods, and another item such as Air, Sea and Road. Airport is one type of infrastructure that consists of many complex systems that interconnected inside. There are two major systems in Airports such as Land side and Air side. Land side consist of parking area, security gates, ticketing counter, check in counter, passport agent, boarding area, etc. while in Air side area consist of Apron, runway, taxi way, and etc.

Airport management always continuously to improve their system to get customer satisfaction. Passenger as a customer in airport act as object in one of the phenomena waiting in the airport system. This phenomena usually occurs when the need be a service exceeds the available capacity for their implementation. This can be seen when passenger entry in the security gates, check in gates and another. Waiting can be applied mathematics and can be identified with a proces queuing in the simulation.

Processing passengers queuing in airport facilities will be interesting to be studied. Because both of the Airport management and passenger will be satisfied if there is minimum total time of passenger that will be take in the Airport system. Minimum total time is same meaning with minimum queue and minimum waiting time in the system, in the another side is get optimum agent resourced utilization. Interest with this case we will develop model of Passenger flow in the Airport.

In this paper we propose a simulation model in airport for investigating system performance (total number of passenger generate and minimum total time for the passenger enter the system).

1.2 Problems Definition

Based on the introduction background, some problems in the airport landside facilities can be describes as :

- a. How about the modeling of passenger flow in Airport.
- b. How about analysis queuing system in order to get minimum total time and get optimum output of passenger in Airport.

1.3 The Objectives

The objective of this paper is able to answer about the problem formulation with simulation software such as Quest and will be validating with Arena Software. There is three Objectives in this paper such as:

- a. Present the Model of Passenger flow in Airport .
- b. Run Simulation of the modeling passenger flow using Quest software and will be validation using ARENA software.
- c. Make Optimization of the model resource.
- d. Analysis between Software in Quest and Arena.

1.4 Systematic of the writing

This Paper will describes the analysis of passenger flow in the terminal airport in Land Side activity, from entrance to boarding to the aircraft. In particular this study develops one model and will be run the simulation using Quest and Arena Software.

We will developed the structured of this paper into six main sections such as:

- a. Chapter 1 : Introduction.

Introduction will define the reasons for the background of the issues, problem- problem definition, research objectives, and systematics writing.

- b. Chapter 2 : Provides Literature review.

In this section describe theory and literature review from book literature and journal about Simulation, modeling, discrete event simulation, Quest and Arena software.

Theory above that are used as guidance in solving problems.

- c. Chapter 3 : Methodological approach to solve the problem.

Methodological approach is used as frame work in order to get the objective.

d. Chapter 4 : Modeling Analysis

This section provides data collection need to simulation the model and present the architecture of proposed simulation model. This section also provide result of simulation using Quest Software and Arena Software. And try to optimized model using Opt.Quest for ARENA.

e. Chapter 5 : Conclusion.

This section provide solution and little review using Quest software and Arena software.



CHAPTER II THEORY ANALYSIS

2.1 Airport Terminal Overview

2.1.1 Passenger Activity

The passenger flow in the Airport terminal can be subdivided in three sub-processes: Departure, arrival, transfer. The departure process starts when passengers enter the terminal and finish when they exit from the structure. Departure process will follow some activity such as : Ticketing counter for buy ticket, Security Airport gates, Check in Agent for verify the passenger and get seat number, Passport Agent for verify passport in international terminal, and boarding area for waiting aircraft before departure.

Recent condition, passenger can buy ticket or make on line ticket using internet, this is one advantage for reduce queue in the airport terminal.

2.1.2 Passenger Airport Flow concept

One of the important elements in improving efficiency in the Airport services is managing the passenger flow. The passenger flow represents the ability of Airport management system to serve passenger quickly and efficiently throughout the system period. When the flow of the system operates properly, then the flow of passengers becomes smoother and all the processes involved can be resolved with minimum delay. A good passenger flow indicates that a passengers queuing can be reduced or minimized, while the inefficient passenger flow contribute to the problem of long and outstanding queue.

Passenger flow concept / phases before the flight for departing passengers essentially are three:

- a. The transit at the security controls in order to proceed to the boarding halls with their hand baggage
- b. The check-in operations at check-in desks, where the passenger delivers the baggage and receives the boarding pass,
- c. The boarding operations on the aircraft: the passenger must be show at the boarding gate of his flight with a boarding pass and a valid identity document.

2.2 Queuing Concept

In everyday life, it is seen that a number of people have to queue to get the desired service. If the arrival of people is frequent, they will have to wait for getting the services provided. Thus, the queuing system was introduced in order to facilitate the customer whereas eliminate congestion occurred during the period of service. The queue process or waiting lines in airport terminal are not only involve the lines of people, but also includes works such as baggage activity, aircraft seeking to land at busy airport runways. and anything else that associated with time delays.

Various studies have shown that the queuing theory is very useful in the Passenger flow in the Airport. Reference (1) has made a review of previous studies of the model to passenger and baggage flow in airport using a flexible simulation model[Lor]. Reference (2) has describe about reducing passenger boarding time in airplanes using simulation[Van02], Reference (3) has describe about Simulation of check in at airports[Paul01]. According to them, customer satisfaction can be improved by predicting and reducing the waiting time and rearrange the placement of staff or resource. Queuing theory have been widely employed in many areas of Airport passenger flow such as in check in area, passport control, security gate and baggage area.

2.3 Modeling and Simulation

Today simulation has become a very important thing, various research and several phenomena using the methode simulation as one technique to solve the problem, one problems can be solved by using the simulation is queuing problems has happened in the passenger flow in the airport.

A model is designed to capture certain behavioral aspects of the modeled system those that are of interest to the analyst/modeler in order to gain knowledge and insight into the system's behavior (Morris 1967).

Model can be used as simple describe of the system behavior, and can create from assumptions concerning the operation of the system. These assumptions are expressed in Mathematical, logical, and symbolic relationships between entities.

Modeling is the enterprise of devising a simplified representation of a complex system with the goal of providing predictions of the system's performance measures (metrics) of interest. [Alt07].

There is three type of model such as:

- a. A physical model is a simplified of physical object into different scale for example is prototype of airplane.
- b. A mathematical or analytical model is a set of equations or relations between mathematical variables for example is mathematical in linear function.
- c. A computer model is model that used program or software and can describe the system.

Simulation is a powerful tool for the evaluation and analysis of a new system designs, modifications to existing systems, and proposed changes to control systems and operating rules [Isk99]. Simulation involves the methodology to provide the information from the model by observing the flow of the model using a digital computer. There are many studies conducted previously on the use of simulation techniques as a tool in the analysis of passenger flow systems and queuing theory.

In the writer definition, Simulation is a tool that describes the imitation of the real world process or system over time. Simulation can be used as easy way to develop model, run model and evaluate model in specific time. There are several reasons why using simulation tools such as efficient time and can describe complex model, also can help to study and analysis for understanding the model that created. But there is some disadvantage using simulation such as : simulation result may be difficult to interpret because some simulation tools using some simulation language, also some simulation need to check or validate in order to get best result.

In this study, simulation was used to predict passenger travel times from one point to the other in the airport terminal, to determine expected occupancy levels at various locations

2.4 Discrete Event Simulation

Systems can be categorized as discrete or continuous. Few systems in practice are wholly discrete or continuous, but since one type of change predominates for most systems, it will usually be possible to classify a system as being either discrete or continuous. (Law and Kelton, 2000). A *discrete system* is one in which the state variable(s) change only at a discrete set of points in time. The passenger flow in airport is an example of a discrete system since the state variable, the number of passenger in the terminal changes only when a passenger arrives or when the service provided a passenger is completed. Figure 2.1 shows how the number of customers/passenger changes only at discrete points in time. [Pet03]

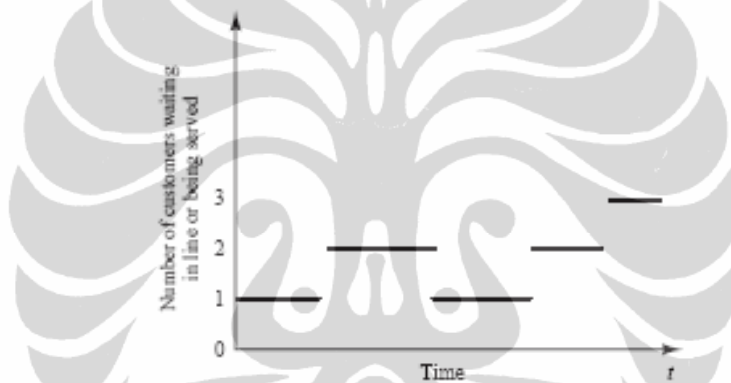


Figure. 2.1 : Discrete System variable State

(Source: The Multiple roles of Discrete Event Simulation in the workplace, Global journal engineering Educ. Vol.7, 2003)

The simulation of discrete event is often used to model systems characterized by complex processes, combined with infrastructure at limited capacity. The airports are therefore ideal places to work with simulations having these features. The software used for the case study of our study is Rockwell Arena and Quest DELMIA.

In the discrete-event system simulation. the modeling of systems in which the state variable changes only at a discrete set of points in time. The simulation models are analyzed by numerical rather than by analytical methods. *Analytical* methods employ the deductive reasoning of mathematics to solve the model. For example, differential calculus can be used to determine the minimum-cost policy

for some inventory models. *Numerical* methods employ computational procedures to solve mathematical models.

A *continuous system* is one in which the state variable(s) change continuously over time. An example is the head of water behind a dam. During and for some time after a rain storm, water flows into the lake behind the dam. Water is drawn from the dam for flood control and to make electricity. Evaporation also decreases the water level. Figure 2.2. shows how the state variable, head of water behind the dam, changes for this continuous system.

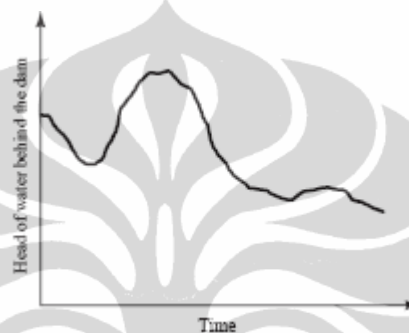


Figure 2.2 : Continuous Simulation

(Source: The Multiple roles of Discrete Event Simulation in the workplace, Global journal engineering Educ. Vol.7, 2003)

In the case of simulation models, which employ numerical methods, models are run, rather than solved; that is, an artificial history of the system is generated based on the model assumptions, and observations are collected to be analyzed and to estimate the true system performance measures. Since real world simulation models are rather large, and since the amount of data stored and manipulated is so vast, the runs are usually conducted with the aid of a computer. However, much insight can be obtained by simulating small models manually.

In summary, this paper is about discrete-event system simulation in which the models of interest are analyzed numerically, usually with the aid of a computer. In this case we used Quest and Arena software.

2.5 Modelisation in Quest Software

QUEST is Queuing Event Simulation Tool, simulation package is very powerful simulation tool that will to model and analyze complex systems. QUEST is designed for the construction of discrete event simulations that model the overall through and between work cells and is thus well suited to reviewing

the performance of production lines, Quest includes graphical model construction and run time animation. Quest presents a detailed and dimensionally accurate 3 dimensional animation of the system as part of its output. [Pet03]

Figure 2.3 below is illustrates Quest interface. The user interface is split into five general areas on the screen such as :

- 1) Models in the middle part of screen,
- 2) Menu at the top of screen,
- 3) The Menu Items
- 4) Action Buttons on the right of screen and
- 5) World Display Buttons at below of the screen.

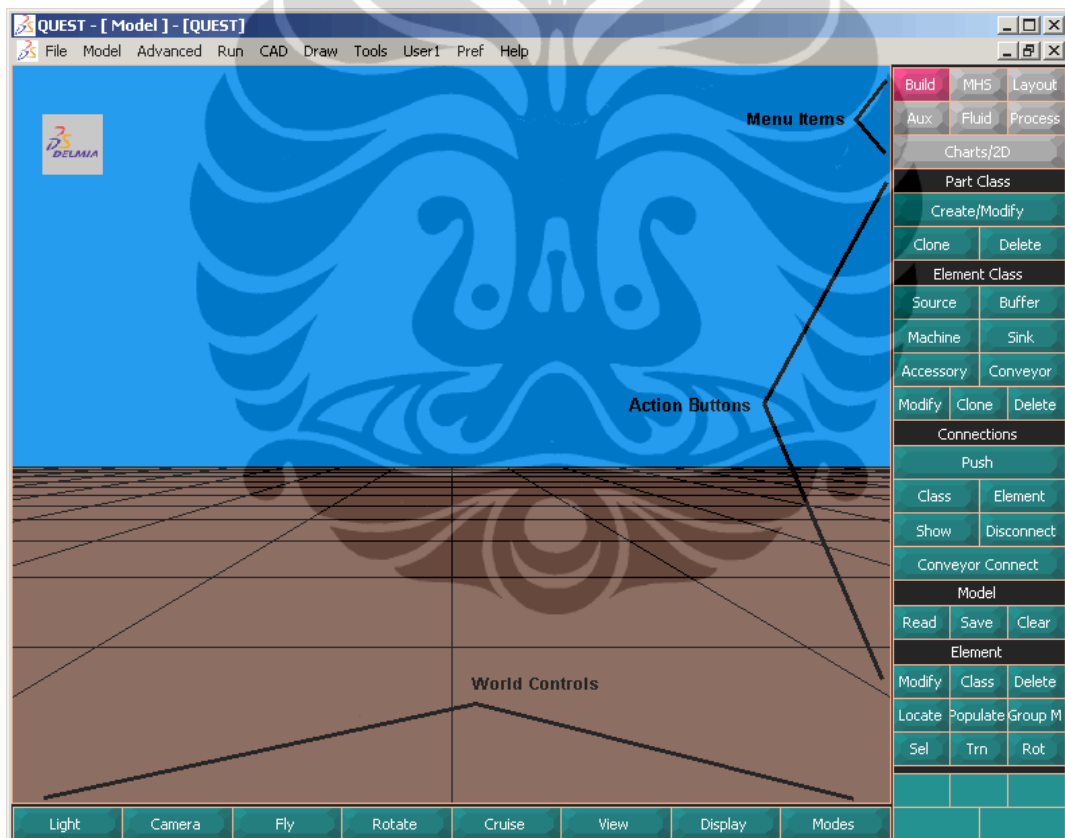


Figure 2.3: Quest Interface.
(Source : Quest Manual, DELMIA Corp.)

2.5.1 User Interface

Within the logical model there are a number of modeling entities such as elements, element classes, part, failures, shifts and so on. In this Simulation Model there are several elements and element classes. Figure 2.4. below shown the

elements Rough Cut Model. QUEST provides a powerful range of element classes that include: Accessories for geometries for improving the realism of the model, Buffer for storage of parts , Conveyor for continuous linear parts movement, Machine for processing of parts/assemblies, Part for creates part, tools and fixtures, Process for details of loading, unloading or part/assembly processing, Sink for removal of parts, Source for generation of parts.

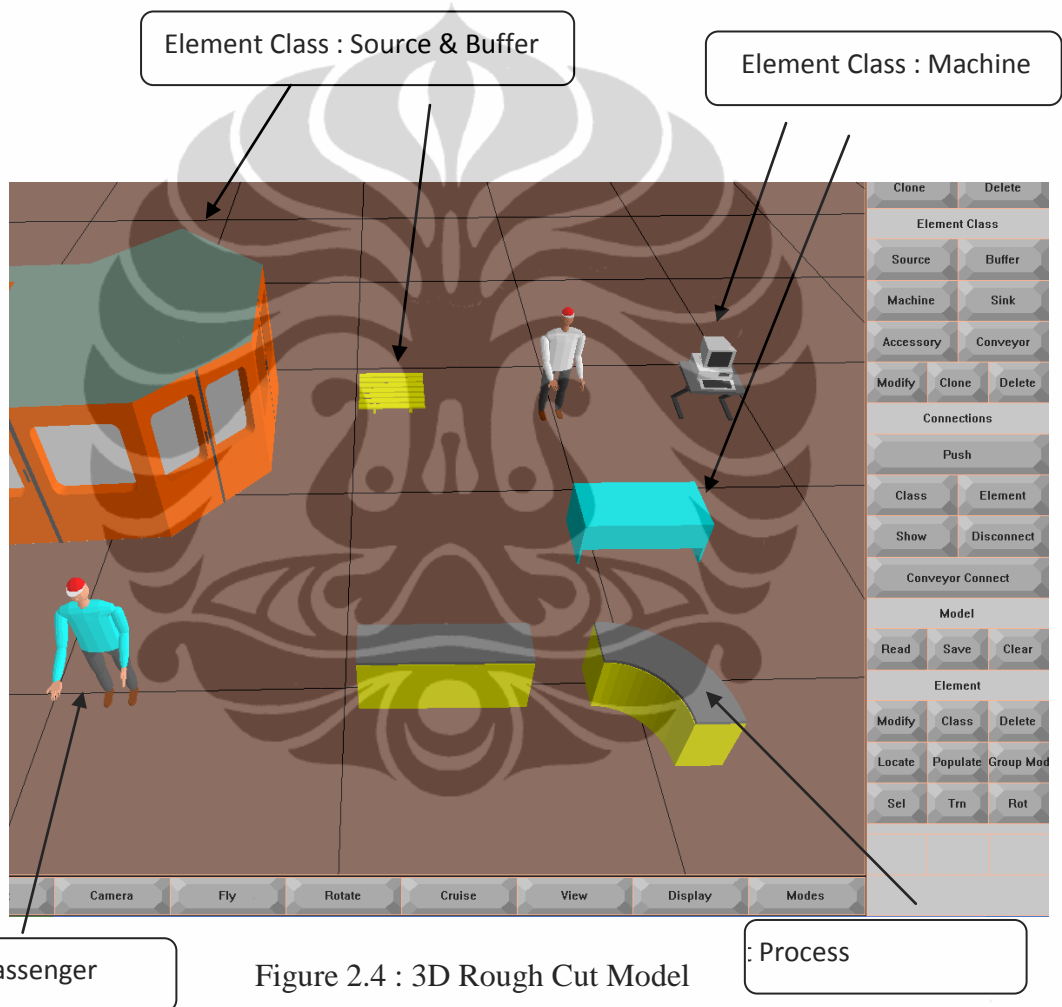


Figure 2.4 : 3D Rough Cut Model

QUEST’s user interface enables building and running of models. It is very powerful and allows quite complex model to be built without the need for programming. As an overview, the user interface is used to create model elements, describe their behavior, run the simulation, review the results and perform simulation experiments. [Mart97]

Each Element is created within an element class of similar elements (for example conveyors with the same characteristics as conveyor). Each element class has set of detailed data or parameter that controls the look (geometry) and behavioral characteristics. And then data is typed into dialog box or selected as an option.

One example of element class type is Parts, Parts are entities that flow through quest model. Part move from element to element in the model and are processed. In the airports system passenger describes as Parts that flow through machine (e.g. Check in Agent, Passport Agent, Security Agent, etc).

Routes for parts flow are created in two stages. First, possible parts flows are created by selecting “from” and “to” element. This is done quite simply through point-and click methods. Second, control rules are specified to govern part flow under various circumstances. Control rules may be selected from existing library and applied to either class or element levels.

Observing the simulation run can be done by click “Run”. While a QUEST simulation is running, the user has complete interactive control to zoom in and fly through to examine model behavior. This observation can be done with Virtual Reality devices such as stereo glasses, or full immersion devices. Realistic 3D simulation can be a very effective medium for communicating to observers from various disciplines. [Mart97]

To get the data result after running the simulation is done with “ Model Output”that will display in “ Single Run Output, Multiple Run Output, or Graph”. Performance statistics can be displayed or sent to file for use by other software packages (e.g., including in a report). There is a wide range of standard reports available and customized reports can be easily created.[Mart97]

2.6 Modeling Using Arena Software

In the simulation model using Arena software, it is important that begin with an understanding of some of vocabulary used in simulation, the following term will be used throughout the text: [Man10]

- a. *System* : A set of interrelated components that act together over time to achieve common objectives.

- b. *Parameters* : Model input that are unchanging properties of the system.
- c. *Variables* : Quantities that are properties of the system (as a whole) that change or are determined by the relationships among system components as it evolves through time.
- d. *System State* : Snapshot of the system at particular point in time characterized by the value of the variables that are necessary for determining the future evolution of the system from the present time.
- e. *Entity* : Object of interest in the system whose movement or operation within the system may cause events to occur.
- f. *Attribute* : property or variable associated with an entity.
- g. *Event* : Instantaneous occurrence or action that changes the state of the system at a particular point in time.
- h. *Activity* : Interval of time bounded by two events (start event and end event).
- i. *Resource* : limited quantity of items used (e.g., seized and released) by entities as they proceed through the system. A resource has a capacity that governs the total quantity of items that may be available. All the items in the resource are homogeneous, meaning that they are indistinguishable. If an entity attempts to seize a resource that does not have any units available, it may wait in a queue.
- j. *Queue* : Location that hold entities when their movement is constrained within the system.
- k. *Future Event List* : A list that contains the time-ordered sequence of events for the simulation.

Arena is a powerful simulation environment consists of modeling object templates, called *modules*, and transactions that move among them, called *entities*, has a *visual* front-end, built around SIMAN block-oriented language constructs and other facilities.

Arena modules are selected from template panels such as : Basic Process, Advanced Process, Advanced Transfer.

2.6.1 User Interface of Arena

The construction of simulation models with Arena, involves using modeling shapes, called *modules*, from the Basic Process panel. These modules are used as the building blocks in constructing a simulation model. There are two types of modules on a panel:[Jose09]

- a. *Flowchart modules*. The user places flowchart modules in the model window and connects them to form a flowchart, which describes the logic of model. The most common flowchart modules are: Create, Process, Decide, Dispose, Batch, Separate, Assign, and Record.
- b. *Data modules*. The user can edit these modules in the spreadsheet interface. These modules are not placed in the model window. The most common data modules are: Resource, Queue, Variable, Schedule, and Set.

A model is constructed in the model window flowchart view, which is the workspace of the model. From the Project bar, the user drags the flowchart modules needed into the model flowchart and connects the modules together. To edit a flowchart module, the user either double-clicks on the module shape and fills in the form, or edits its data in the spreadsheet.

The definition of a data module is carried out by clicking on the shape of then module in the Project bar to activate its spreadsheet. Then the user can edit the data of the module. Flowchart modules exist both in the model workspace and as a row in the spreadsheet.

Data modules exist only in spreadsheet view. Data modules can be added or deleted via the spreadsheet, while flowchart modules can only be added or deleted by placing the object or removing the object from the model workspace. Figure 2.5 below show Arena Display.

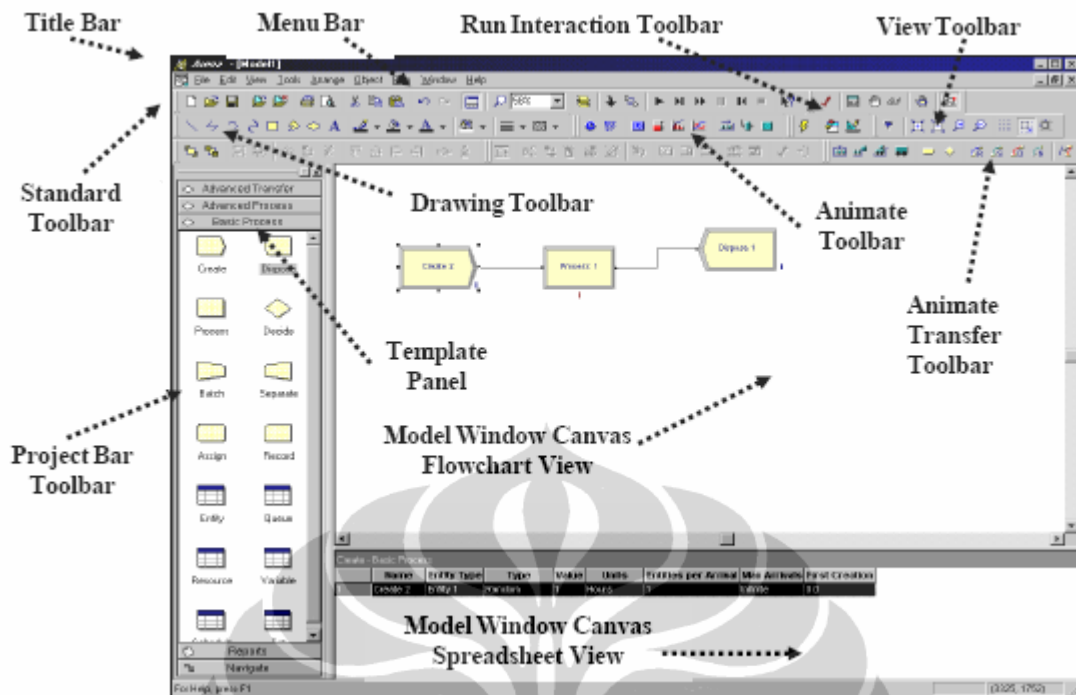


Figure 2.5 : Arena Display

To build a simulation model and to carry out simulation runs with Arena, a user performs the following steps: [Jose09]

- a. Construction of a basic model. Arena provides the model window flowchart view, which is a flowchart-style environment for building a model. The user selects and drags the flowchart module shapes into the model window and connects them to define process flow of the model.
- b. Adding data to the model parameters. The user adds actual data (e.g., processing times, resource demands, others) to the model. This is done by double-clicking on module icons and adding data.
- c. Performing a simulation run of the model. The user runs the simulation and examines the results.
- d. Analysis of the simulation results provided by the automatic reports of Arena. The user can expand the statistics.
- e. Modifying and enhancing the model according to the user needs.

CHAPTER III RESEARCH METHODOLOGY

In this chapter, the simulation methodology (The process of applying the simulation technique) issue will be described step by step to simulate real passenger flow in Airport using simulation tool. These papers include only necessary steps for the general simulation methodology. These generally accepted steps for a simulation study can be listed as describe with flow chart below:

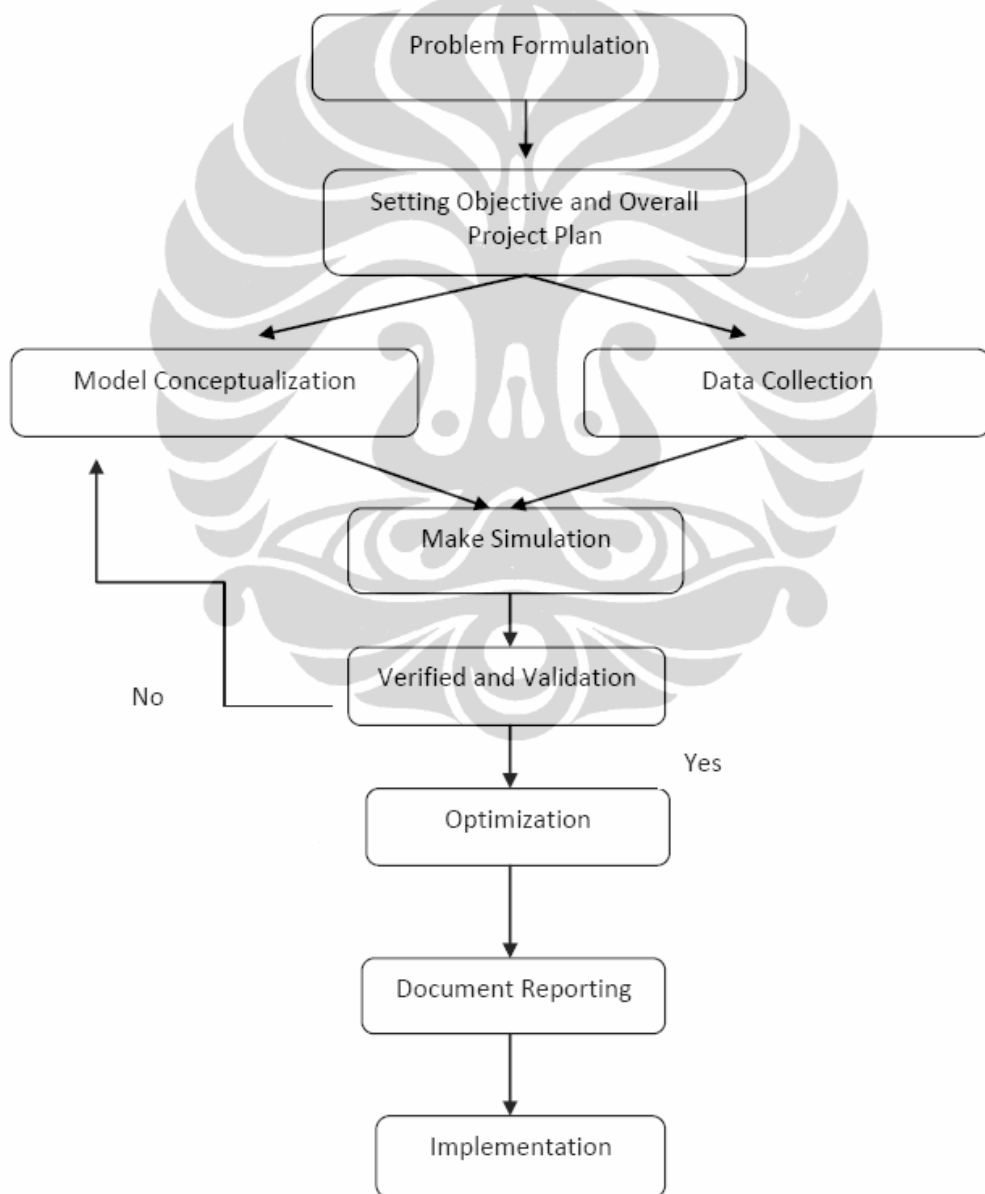


Diagram 3.1 : Flow Chart

a. Problem Formulation.

Problem Formulation can get by identifying the problem. Some literature review and read phenomena in airport today will help us to identify the problem.

b. Make Objective of the research.

Determine the objective and overall project plan.

c. Model Conceptual.

Formulate and develop a model. In this research we used simulation with Simulating modeling with program Quest and Arena, not analytical model by mathematical approach.[Alt07]

d. Data Collection.

Some data that is needed in order to create model passenger flow in Airport terminal such as:

- 1) The distributions of Inter Arrival time of Passenger.
- 2) The distribution data each in Each agent process such as Security gate, Ticketing Agent, Check in Agent, Passport Agent, etc.
- 3) Scheduling of Agent.

f. Make Simulation.

Simulation is running with Quest Software.

g. Verified model and Validation.

For Verified Model and validation is using another software, ARENA license.

h. Optimization.

In order to get best composition between each agent in Airport, it is need to make optimization using ARENA Licensed. Point value to Optimized is Minimum Total Time passenger in the system and Maximum Total Passenger Out from the system.

i. Document Reporting.

Document Reporting is created Pareto Diagram in order to know optimum composition between Agent/Resourced that influence with the Total

output passenger and total time passenger from entering terminal Airport until boarding gate.

j. Implementation.

The result analysis can be implemented by management of Airport with improve their capacity as suitable with condition of airport.



CHAPTER IV MODELISATION ANALYSIS

4.1 Description of Study Case

This research focus on the Airport in the Departure line. Airport describe is international Airport have 3 terminal. This study only focus in terminal 1 departure. Terminal 1 operates 16 hours all the day. Most Passengers who come to airport divided by three category. Type 1 passenger for passenger in general condition (Medium service type passenger), Type 2 Passenger for passenger who must buy ticket in Airport (Long service type passenger), Type 3 passenger for passenger business class/ passenger have on line ticket (short service passenger).

After survey to the Airport, This table below describe characteristic of each passenger, such as:

Table 4.1 :Type Passenger

NO	Type Passenger	Characteristic		
		Passenger Check-in	Passenger Check Baggage	Passenger on-line Ticket
1	Type 1	80%	85%	20%
2	Type 2	100% (must be check in /buy ticket at airport)	85%	0%
3	Type 3	0% (Businiss Class/online ticket)	85%	All Passenger

Passenger Type 1 is passenger that already buy ticket in ticketing agent (NOT in the Ticketing Agent in the Airport), and 80 % passenger type 1 must be take check in ticket in the check in counter in the airport terminal in other word there is 20 % of passenger that already done on line ticket before go to Airport. Only 85 % passenger type 1 have baggage that must give their baggage in baggage agent and 15 % another passenger carry their baggage in the cabin of Aircraft.

Passenger Type 2 is passenger that buy ticket in Airport ticketing agent, so the passenger must be go to check in counter to verified their ticket and get their seat number, only 85 % passenger type 2 have baggage that must give their

baggage in baggage agent and 15 % another passenger carry their baggage in the cabin of Aircraft.

Passenger type 3 is business class of passenger; their 100% have on line ticket and only 85% of passenger type 3 have baggage that must give their baggage in baggage agent.

There are several activity of passenger before flight departure such as:

- a. The Passenger arrives at terminal and check a ticket or must buy a ticket and than passenger have ticket enter to the airport gate and there is security airport to check their carrying goods via X-ray system in order to avoid dangerous good that enter to the aircraft.
- b. After check in security gate, passenger that is not have seat number must go to check in Agent to verified their ticket and get seat number (not on line ticket).
- c. After in check in counter, Passenger that has baggage has to go to baggage agent to take their baggage. Passenger that have not baggage directly to passport agent.
- d. Passenger in international airport has to go to Passport agent to verify their identity.
- e. After go to passport agent, passenger go to Boarding area for wait aircraft before flight departure.

The passenger activity start from security airport gate until boarding gate is based on the first in first out (FIFO) rule. Diagram 1 below shows the generalized model of passenger flow activity in airport .

Airport describe have two ticketing agent outside the airport to sell ticket for one airlines. Two agent in security gates that screening body and baggage each passenger before enter to the airport. Four check in agent with time schedule for work. Two agent baggages, two agent in passport control, and two security airline agent before enter the boarding area.

The four check in agent get one hour breaks each sift, which are staggered over the day such that the first break start 2 hours into the day. For the next 4 hours, three agent are working (one is on break). Then, 2 more hours with 4

agents, which completes the shift. This schedule check in agent will be describe with table 4.2 below for make simplified to understand.

Model activity flow of passenger in airport :

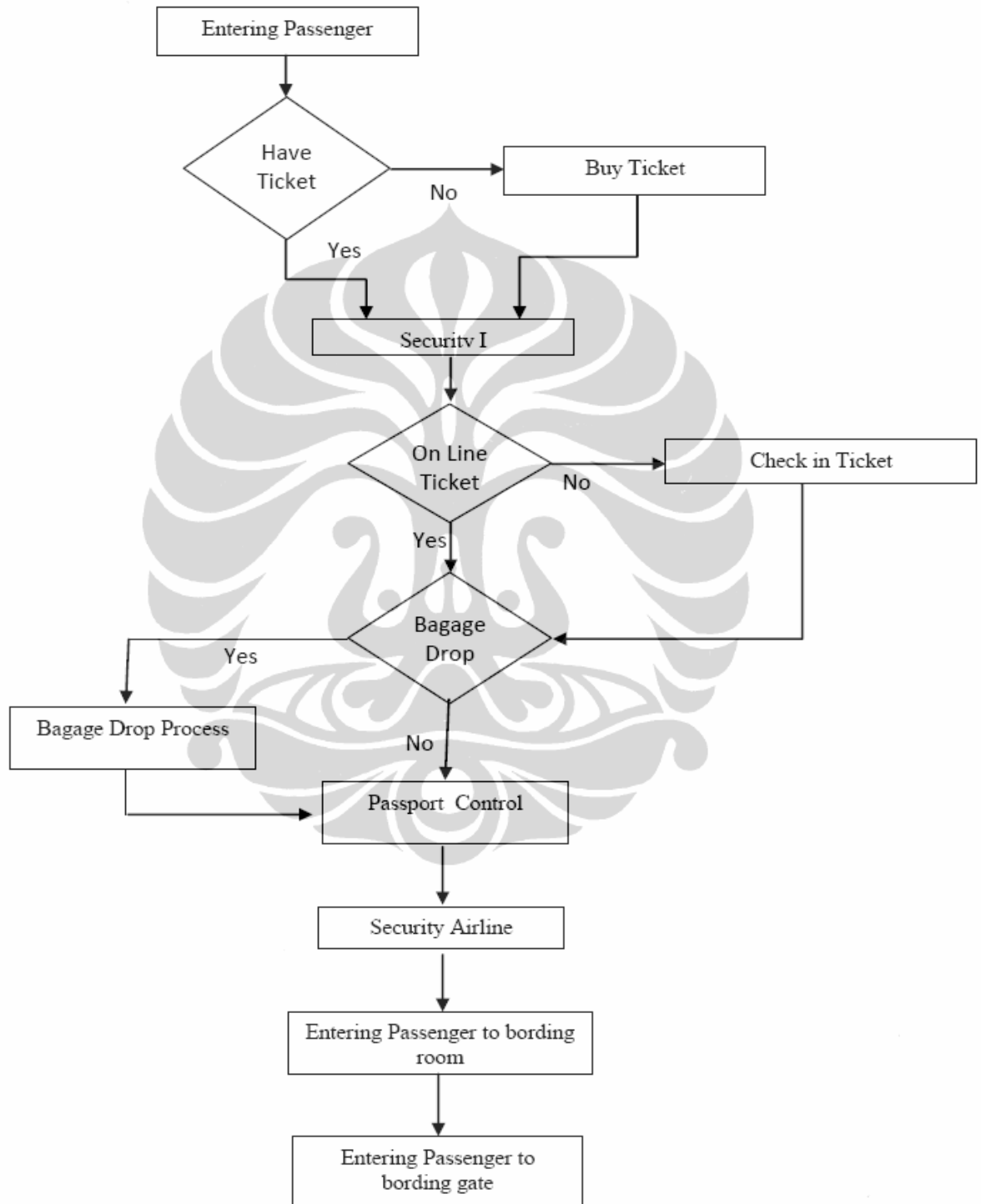


Diagram passenger Process activity in Airport

Schedule list for check in Agent as describe in table below:

Table 4.2 : Schedule List of Agent

Agent	HOURS															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I	√	√	√	√	√	×	√	√	√	√	√	√	√	×	√	√
II	√	√	√	√	×	√	√	√	√	√	√	√	×	√	√	√
III	√	√	√	×	√	√	√	√	√	√	√	×	√	√	√	√
IV	√	√	×	√	√	√	√	√	√	√	×	√	√	√	√	√

4.2 Data Collection

Data was collected in order to know complete characteristic for passenger flow in airport . The data required to develop the passenger flow are as follows:

- a. Passenger type 1, type 2, type 3 arrival times.
- b. Inter arrival times between passengers, Inter arrival time is the time between the arrival times of second passenger with second passenger.
- c. Service time at the security gates. Service time is the time taken at the beginning of the service until the end of the service for each passenger.
- d. Service time at the ticketing agent.
- e. Service time at the check in agent.
- f. Service time at the baggage agent
- g. Service time at the passport agent.
- h. Service time at the security airlines.
- i. The number of resource in airport. Resources is the agent check in, ticketing agent, baggage agent, passport agent, security agent.

The data collected are entered into input analyzer to determine the statistical distribution of the data as shown in figure 4.1 and the statistical distribution of the data as shown in table 4.3. This papers used Input Analyzer for Arena to allows user to enter raw data an obtain the statistical distribution for the data as needed.

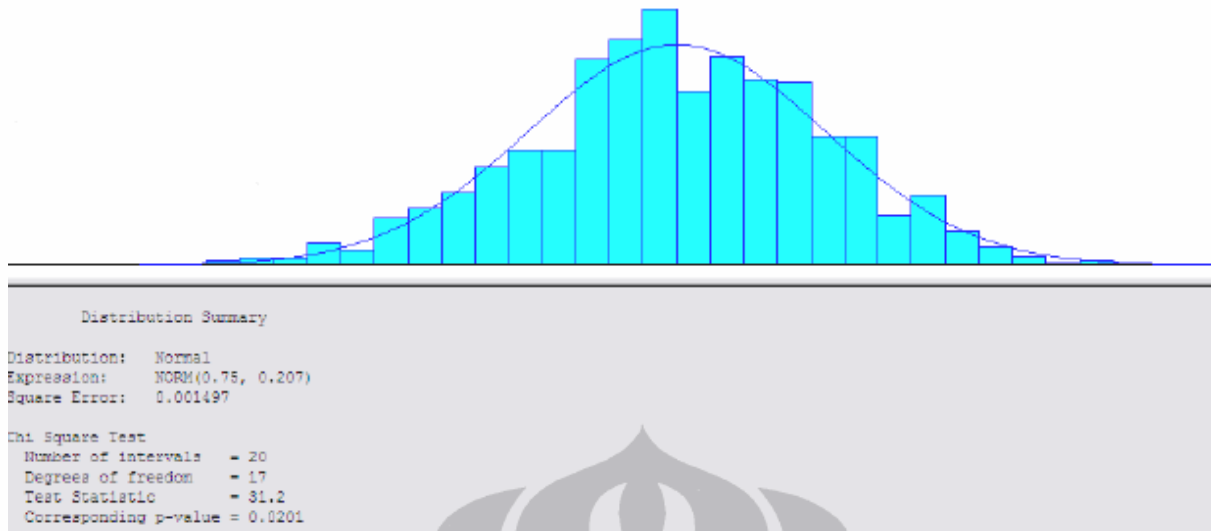


Figure 4.1: Passenger Type 1 Inter Arrival time Distribution.

Table 4.3 : Statistical Distribution For Each Agent.

Items	Distribution	Expression/Time (Min)
Passenger type 1 Inter Arrival Time	Normal	(0.75, 0.2)
Passenger type 2 Inter Arrival Time	Normal	(3.5, 0.5)
Passenger type 3 Inter Arrival Time	Normal	(10, 1)
Ticketing Agent	Triangular	(4, 5, 10)
Agent Security Gates	Triangular	(0.5, 1, 1.5)
Check in Agent	Triangular	(3, 4, 5)
Baggage Agent	Triangular	(0.5, 1, 1.5)
Passport Agent	Triangular	(0.5, 1, 1.5)
Agent Security Airlines	Triangular	(0.5, 1, 1.5)

4.3 Simulation Model

This section will discuss about the simulation process in the quest program, after determining the number of elements and lay-out, process is necessary in the

making of simulation, then we make characteristic of each element or the part of object that start from source of element class.

4.3.1 Create Source

In this simulation, there are three sources which have three different passenger categories, each category with the arrival of passengers using the normal distribution. To apply use the normal distribution of arrival of passengers on a Quest Program is to create the first element is called the Source. Sources in Quest are designed to produce part (passengers) for processing by the other elements in model. A source thus presents the point-of-entry of part into a model.

Source Characteristics of passengers may be modified by selecting the button that is needed, as an example to the characteristics of the selected passenger arrival is button of the IAT, the Inter Arrival Time, that is time difference between one with the other passenger in single category. As an example of the passengers in a single category has the characteristics of arrival with a normal distribution with a value of mean 0,75 and have deviation of 0.25 as seen in the figure 4.2 below:

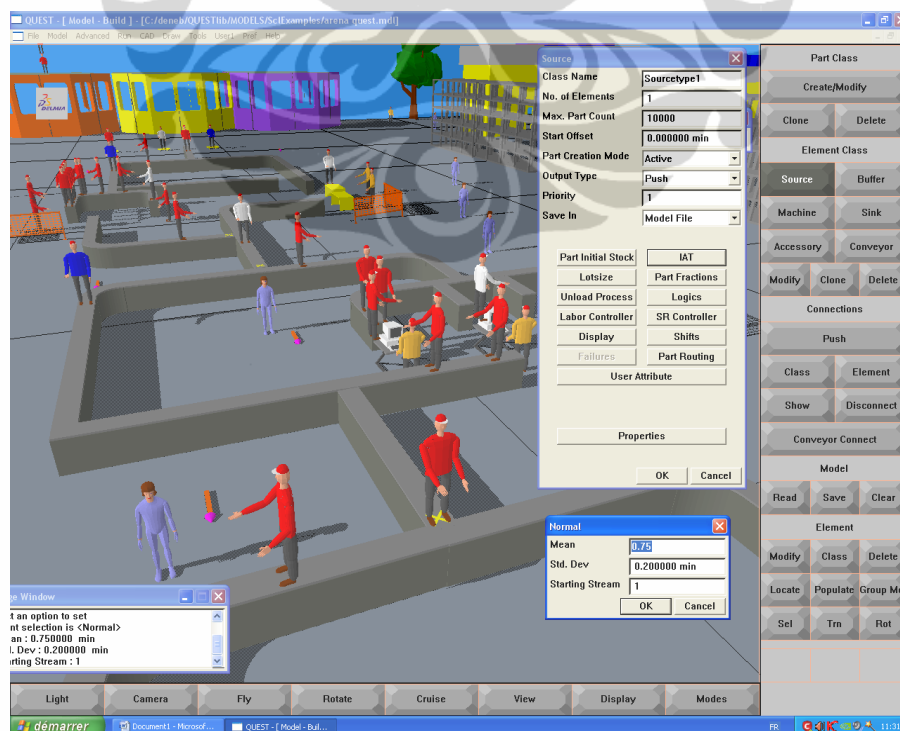


Figure 4.2 : Source of passengers with Normal Distribution

4.3.2 Create Part

Parts are the entities that are processed by element, like elements, parts have attributes and 3D CAD geometry but unlike elements, they do not have any logic. Passengers is describes as Part in this model, and we change the display with human.

Quest is discrete event simulator, therefore parts flowing through Quest are discrete in nature. In other words, each event, such as a part arrival, occurs at a discrete point time. [QuestMan1]

4.3.3 Create machine and Logic machine process

Machine are used to represent the system resources that are responsible for processing or carrying out work on part. Security agent, Ticketing Agent, Check in Agent, Passport Agent, Baggage agent is machine in our model.

Characteristics of Machine Elements may modified by selecting the button that has been available, in this case as an example is the Logic. The Logic Button allows you to further influence the behavior of the machine by changing the rules by which the machine operates. This control of behavior of a part inside the machine.

Process logics are initiated for all the element classes at the star of simulation and run all the time unless terminated through an SCL statement. **First Possible Process** : this logic sets that process of a machine whose process requierements are met first, and is the firstossible process among all the processes assigned to that machine, as shown in figure 4.3:

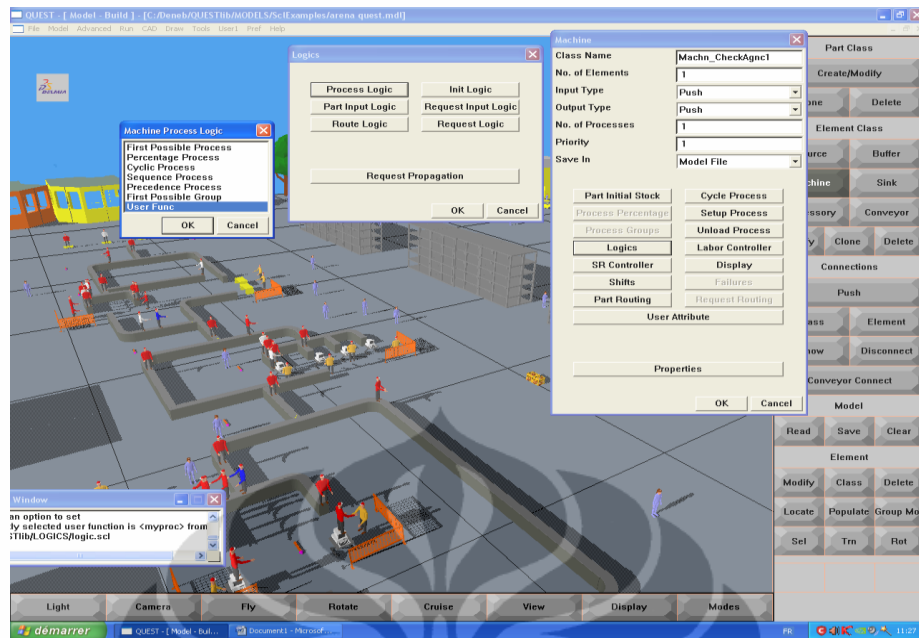
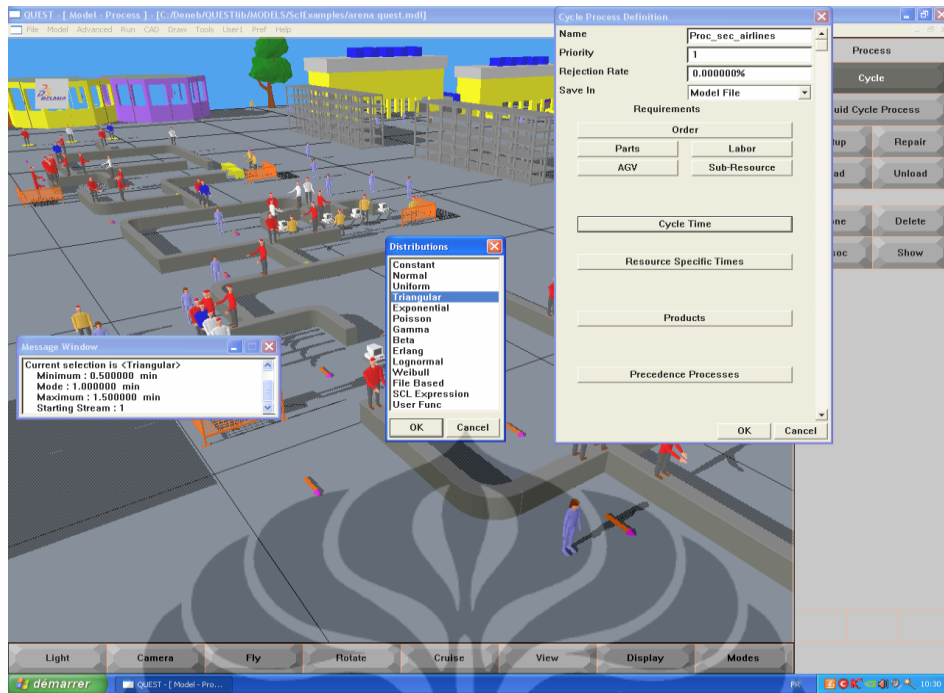


Figure 4.3 : Process Logic

4.3.4 Process Cycle

In passenger service on the Quest model contained in the Element class, where its characteristics can be modified to suit that has been given responsibility. As an example for this problem is the process of service on airline security agents, there are three categories in a triangular distribution. To enter the parameters of the triangle distribution into the Quest program is to select Model, Process on the Menu, and then select the Cycle Time, it will be shown a dialog box for the fitted value, as where in accordance with figure 4.4 :



Figur 4.4 : Process Cycle of Security Airlines.

4.3.5 Decision of On-line Ticket

The passenger aircraft have different characters and activity, passenger that have online ticket not need to go to check in counter, passenger that have bagage not need to go to bagage agent. Quest Simulation provide decision point in order to make model as proper to characteristic.

In this program there are four decision points, there are one decision point of have ticket or not, one decision point need additional help or not (this provide passenger to return to check in agent in order to change ticket or make clarification in wrong ticket or destination), a decision points of online ticket and a decision points have bagage or not.

Here is one example to determine the decision points of on-line ticket on a Quest Program.

”Select Model | Layout | Decpoint | conv. Choose Cnv_Dec_Pt”fromtheselectelem ent class” dialog box.in this dialog box we select Unloading button and choose the "Percentage" button then fitted the value of the percentage of each type of passenge, Figure 4.5 illustrates the percentage of each passenger.

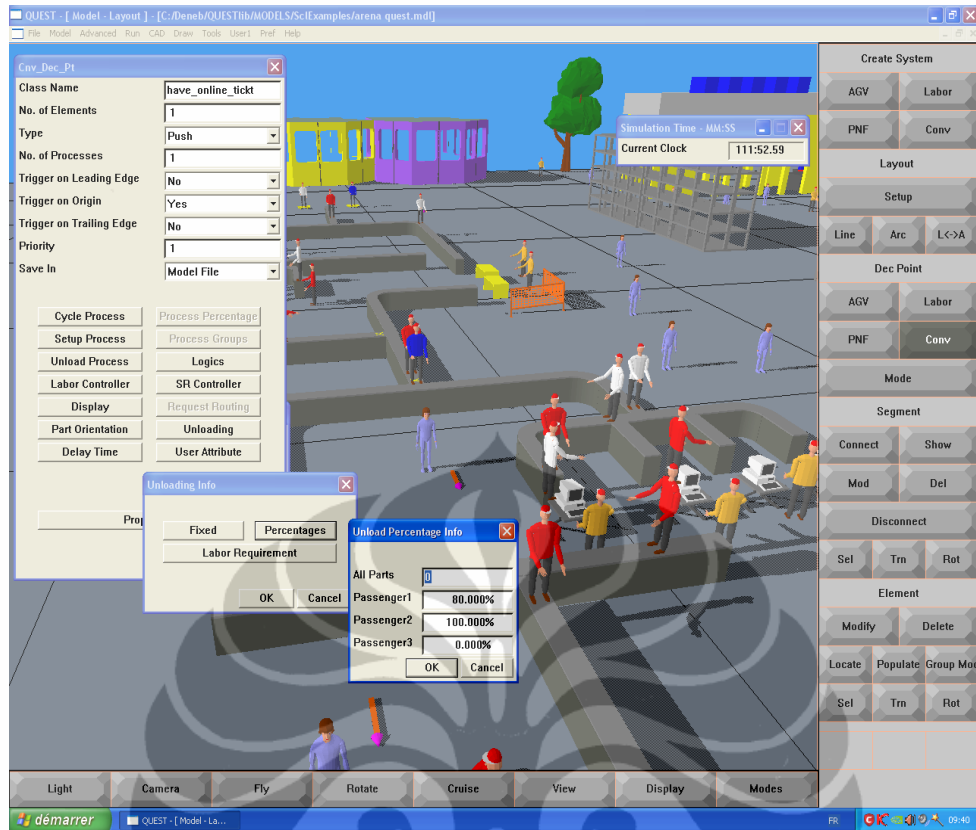


Figure 4.5 : Decision Point Have Online Ticket or Not ?

The process of other services to passengers is four ticket agents. The four ticket agents get one-hour breaks each shift, which are staggered over the day such that the first break starts 2 hours into the day. For the next 4 hours, three agents are working (one is on break). Then, 2 more hours with 4 working agents, which completes the shift.

Follows are simulating one 16 hour day, and collect statistics on agents and customers waiting service, and flowtime by customer type, in Quest Program. To begin with, define the breaks with the duration and other characteristics :

- a. Select **Model | Aux | Shifts | Shift Break**
- b. The Shift Break dialog box appears. Use the default name **Break_1** and enter a duration of 60 second.
- c. Create a second shift break. Accept the default name of **Break_2** and enter a duration of 60 second and repeat for the agent to 3rd and 4th.

- d. To define the daily schedule, select **Model | Aux | Shifts | Daily Schedule**
 - e. Accept the default name **Day_1** and enter a Start Time of **0:0** and End Time of **16:0**. This corresponds to a sixteen hour workday consisting of eight hours of actual work and one hour of breaks. Enter **2** in the No. Of Breaks.
 - f. Define the break states for Day_1. Select the **Breaks** button and enter the break names and break start times as shown. There is a break Break_1 scheduled after the second hour break. Break_2 scheduled after the eleventh hour, break time is adjusted to the table below.
- Figure 4.6 : illustrates The Agent IV Brake.

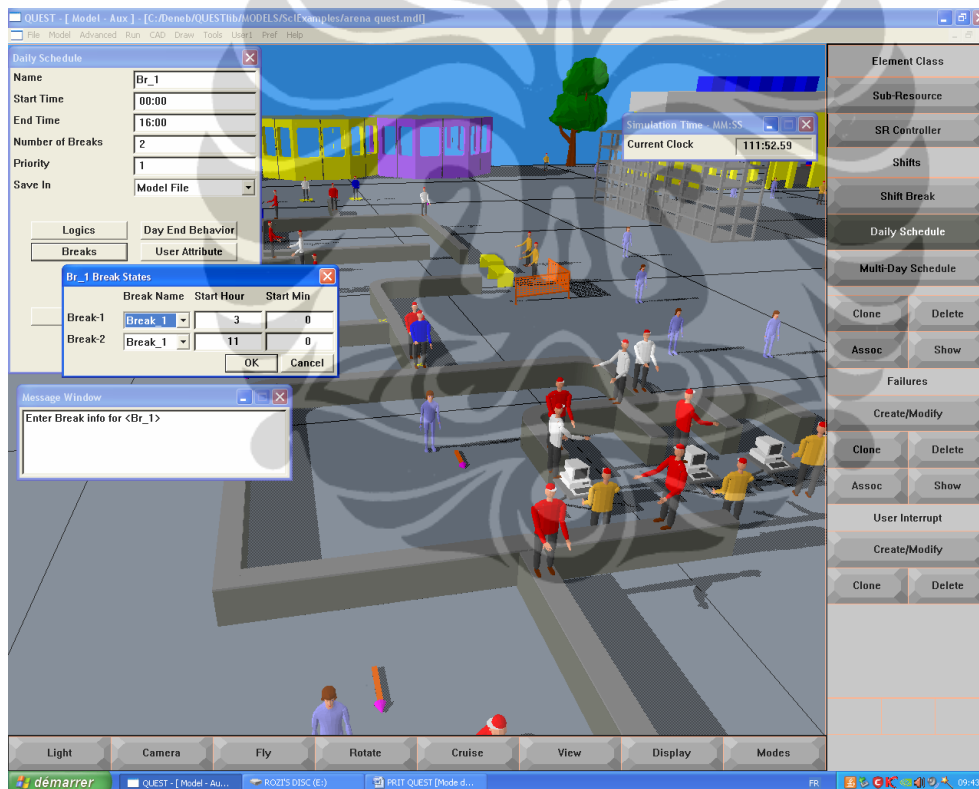


Figure 4.6 : Brake Process

4.3.6 Run The Simulation

The final step of this quest is to simulate the program in the following way:

- a. To run the model, Select **Run | Simulate | Simulation | Run**. The Run dialog box appears.

- b. Set the Run Time at **16** hours (960 minutes). The simulation will run to this time and terminate.
- c. When time 960 minutes is reached, the simulation will stop and the message window will prompt "Simulation Run Completed."

4.4 Model with Arena Simulation

After make model simulation in Quest, The passenger flow in airport system is studied in detail and modeled in a computer simulation program using Arena simulation package. Modeling using Arena is used to validation our model in quest, With Arena, the user can interactively build models by creating or inserting animation to the system collection data from developed simulation model and view the statistical reports output generate by SIMAN. Therefore, the analysis of the model can be done based on the reports generated. A snapshot observation of part of the subject area in figure 4.7 :

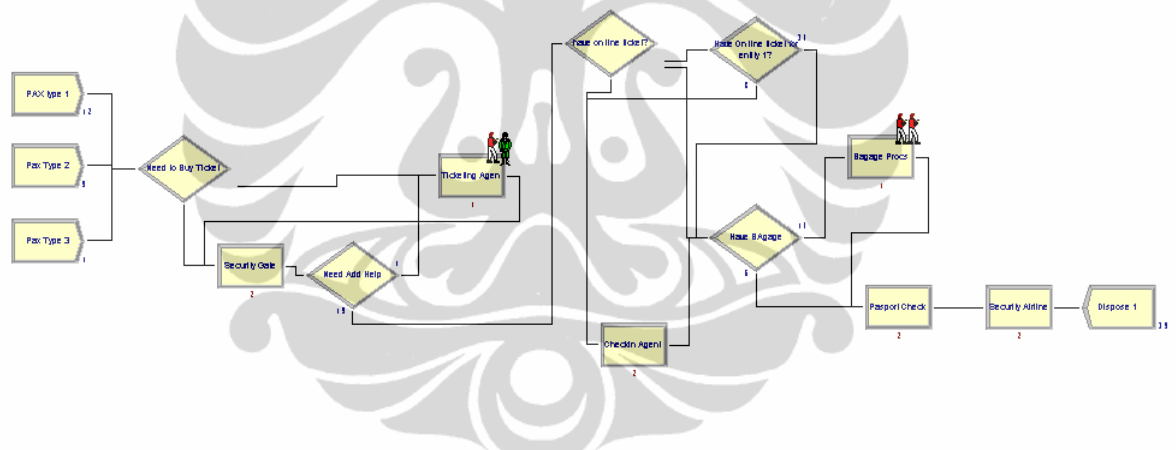


Figure 4.7: Simulation model using Arena.

4.5 Simulation Analysis

4.5.1 Using QUEST

In order to investigate the total time passenger in the system airport, the service time and number output of passenger flow in the Quest simulation. We will run the simulation . After complete running each simulation, a report on all the data pertaining to the run can be obtained using Quest's single run output. The report is broken down by element class (source, machines, buffer, conveyor, etc.), then by individual element (machines_1, buffer_1, conveyor_1, etc.).

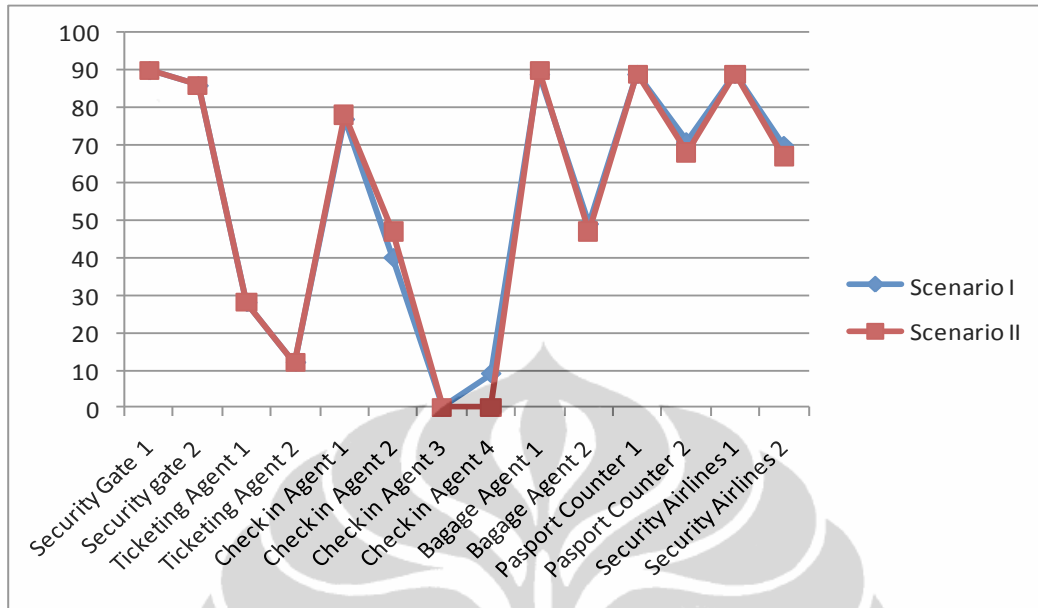
Based on report result simulation we make graphic of the utilization and average total time per passenger in the system, and number output of passenger create in the system. After utilization of each resource was identified, we make 3 scenarios in order to know what best composition for the resource configuration.

The objective value is to get minimize total time of passenger in the system airport. Its means each of the passenger have minimized queue in the each resource of the airport agent. While the constrain is number of the resource in the airport system such as : security gates, ticketing agent, check in agent, baggage agent, passport agent and security airlines.

Three scenario is describe below:

- a. Develop model with all resource is operating. It is means all resource is operate such as two security gates, two ticketing agent, two check in agent, two, baggage agent, two passport agent, two security airlines. Total resource is 14 agent. (Model composition)
- b. Develop model base on resource utilization result that achieved in scenario 1, we create the optimal composition resource agent. (Optimum composition)
- c. Develop model base on resource utilization result that achieved in scenario 2. We create model until reach critical point composition number of resourced agent. (To know critical point Composition)

Utilization will used to make analyzed each scenario. Utilization is the ratio of actual output to the potential output. Off all the machine (Agent Ticketing, check in Agent, Security Agent, passport counter) in this simulation it was found such as graphic 4.1.



Graphic 4.1: Graph of result Two Scenario

a. Scenario 1 :

Total resource agent operated is 14.

Total Passenger Created and Output in the System will be described as table 4.4 below:

Table 4.4: Total Passenger Output in Scenario 1

No.	Type Passenger	Number input	Number Output	Avg. Total time (Min)
1	Passenger Type 1	1277	1582 passenger	41.23 minute/ pax
2	Passenger Type 2	274		
3	Passenger Type 3	96		

b. Scenario 2 ;

Total resourced agent operated is 12. (reduce agent check in 3 and 4).

Total passenger created and output from the system will be described as table 4.5 :

Table 4.5 : Total Passenger Output in Scenario 2

No.	Type Passenger	Number input	Number Output	Avg. Total time (Min)
1	Passenger Type 1	1268	1552 passenger	53,15 minute/ pax
2	Passenger Type 2	277		
3	Passenger Type 3	97		

c. Scenario 3 ;

Total resource agent operated is 11. (reduce agent check in 1,3 and 4).

Total passenger created and output from the system will be described as table 4.6 below :

Table 4.6: Total Passenger Output in Scenario 3

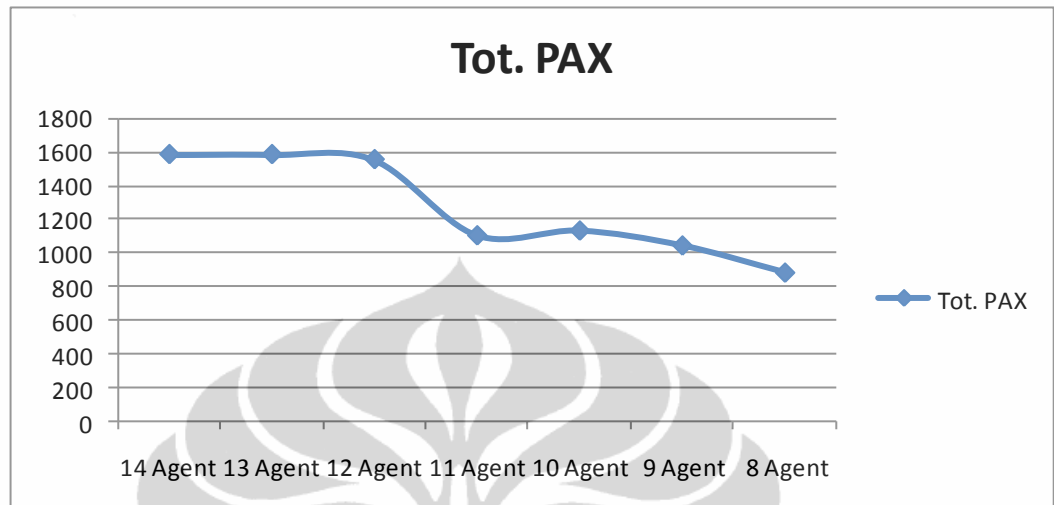
No.	Type Passenger	Number input	Number Output	Avg. Total time (Min)
1	Passenger Type 1	1292	1103 passenger	172 minute/ pax
2	Passenger Type 2	275		
3	Passenger Type 3	97		

The relation between each agent operated, output passenger and total time as describe in Table 4.7 below.

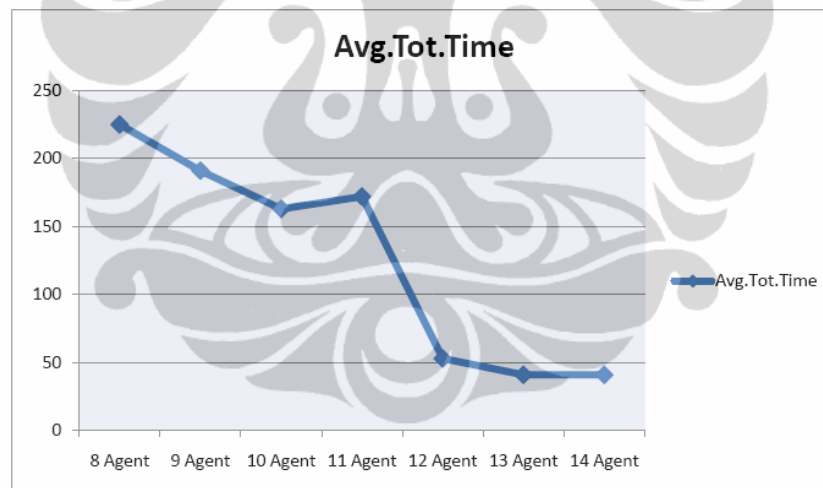
Table 4.7: Relation between Resource and Passenger

Total Resource	Avg. Total Time/Pax in Minute	Total Output Passenger	Resource OFF
14 Resourced Operated	41.23	1582	All operated
13 Resourced Operated	41.23	1582	Check in Agent 3
12 Resourced Operated	53.15	1552	Check in Agent 4
11 Resourced Operated	172	1103	Check in Agent 2
10 Resourced Operated	163	1131	Ticketing Agent 2
9 Resourced Operated	191	1043	Baggage Agent 2
8 Resourced Operated	225	883	Passport Control 2

Graphic 4.2 will describe the relationship between Resources operated with Total time and total passenger output.



Graphic 4.2: Graph of result the Scenario



Graphic 4.3: Graph of Avg Total Time

From graphic 4.2 and 4.3 we know that the critical resource agent is **12**, it means if the resource is reduced until 11 resource agent, it will significantly **increase total time**, queue and **reduce the passenger output** significantly.

4.5.2 Verification and Validation with Arena Simulation and Opt quest for Arena

Verification is the process of determining that a model implementation accurately represents developer's conceptual description and specifications. Validation is the process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended use of the model.[Dul07]

Validation in this research is used Arena software, Validation process compares the flow of passenger total time and output passenger from Quest result and compare result from Arena software. Total passenger output Created and average total time passenger in the system will be describe as table 4.8 below:

Table 4.8: Total Passenger Output

No.	Type Passenger	Number input	Number Output	Average Total Time/Pax in (Minute)
1	Passenger Type 1	1296	1584	40.75
2	Passenger Type 2	271		
3	Passenger Type 3	97		

If we compare the result between Quest and Arena, we get no significant result analysis. In Quest Software create Number Output passenger is 1582 with average time per passenger in the system is 41,23 minute. While in the Arena Software create Number output passenger is 1584 with average time per passenger in the system is 40,75 minute.

In order to get best composition between each resource agent like scenario 2 and 3, we use Opt.Quest for arena. Opt.Quest for Arena is the best choice for make optimization in resource and to get minimum time of passenger to the system.

The Figure 4.8 below describe the result of the Opt. Quest for ARENA.

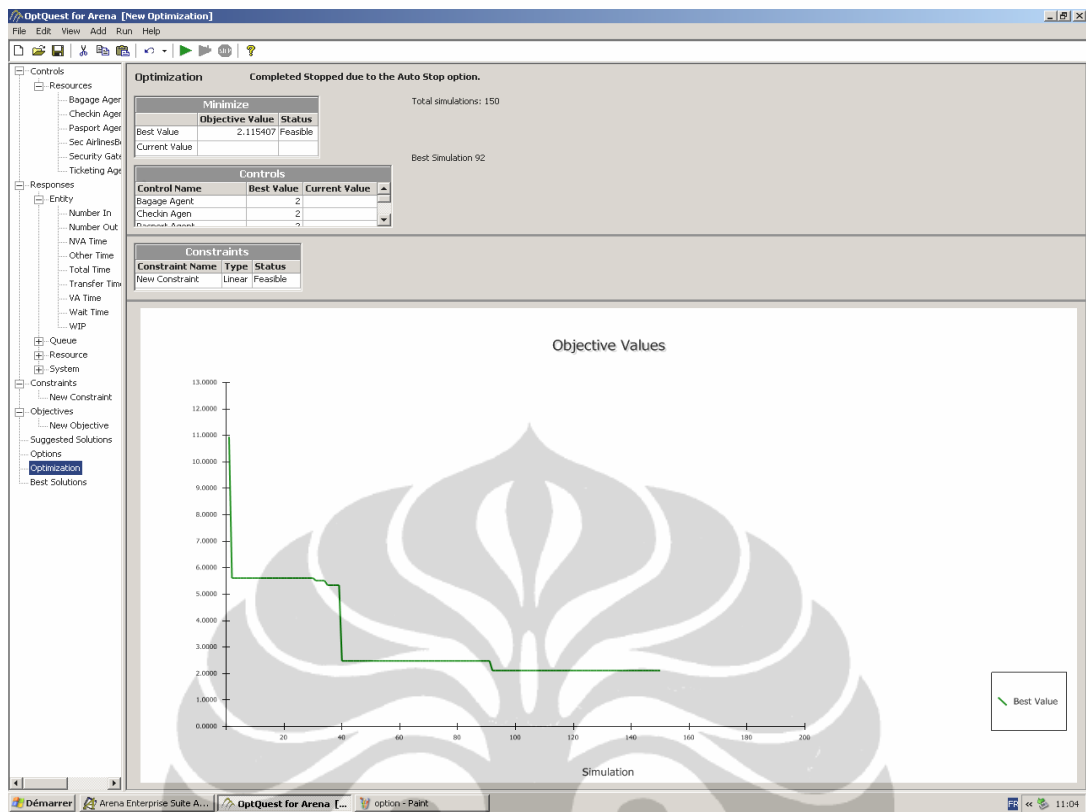


Figure 4.8 : Graph of Opt Quest for Arena

Running Opt Quest for Arena using the Attribute as describe :

a. Constrain :

Total ticketing agent + Security gates + Check in Agent + Baggage Agent + Passport Agent + Security Airlines are equal or less than 12. We used 12 because from the Graphic in Quest simulation 12 is the best composition in resource to get minimum total time passenger in the airport system and get optimum composition in resource.

b. Objective is to get minimum total time of passenger in the system.

Best Result of composition resource is described in figure 4.9 below:

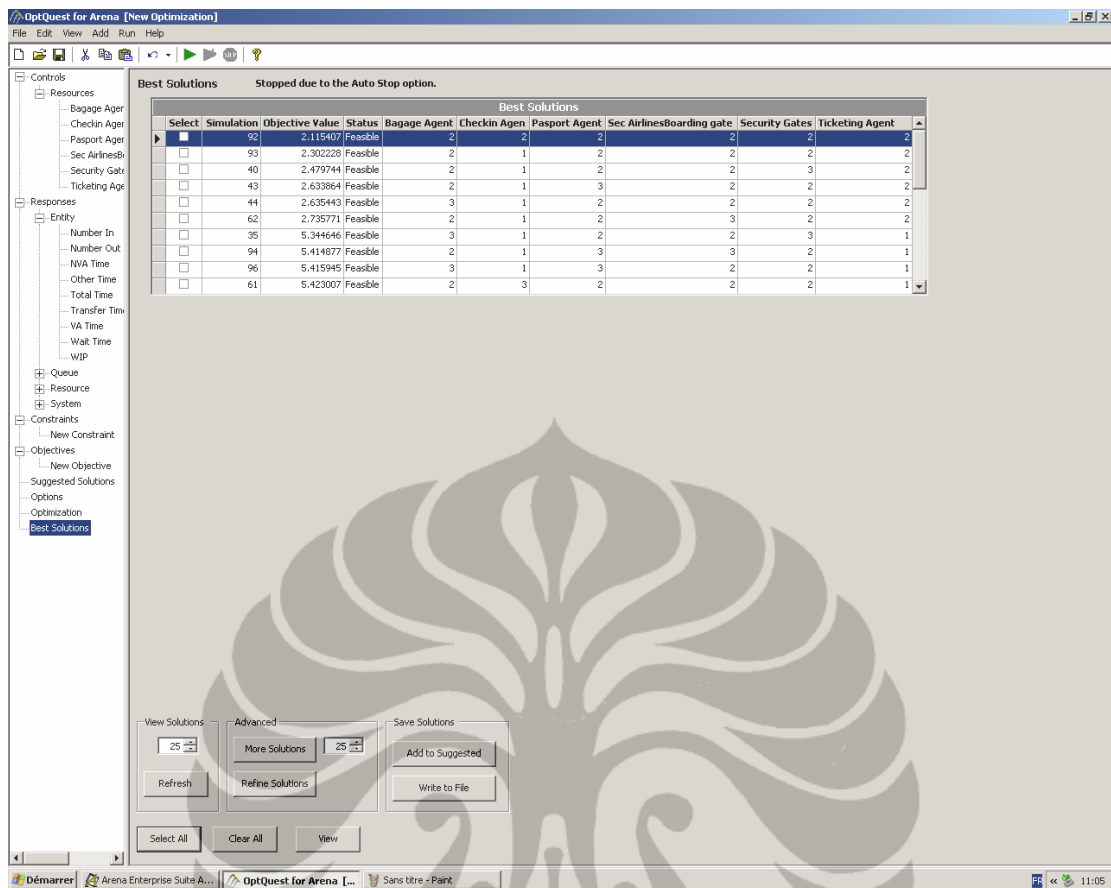


Figure 4.9: Ccomposition Resource

As the figure above we get the best solution for the Resource is 12 Agent with composition:

- 1) 2 Security Gate Agents.
- 2) 2 Ticketing Agents.
- 3) 2 Check in Agents.
- 4) 2 Baggage Agents.
- 5) 2 Passport Control.
- 6) 2 Security Airlines.

It means that Scenario 2 is approved, and there is same result between Arena and Quest.

4.5.3 Software analysis

4.5.3.1 Quest Analysis

Quest is suitable for make design in manufacturing or make layout for placement machine, design that related in manufacture process, etc. All feature provide by Delmia is feature analysis and display analysis for manufacture. But Delmia/Quest software give solution for user to create another feature using Basic Draw. We find some problem interface in this program such as : with the problem interface. Quest has a unique user interface where all of the menu items and action buttons are located on the right. The navigational controls are located at the bottom and are called “World Controls” in Quest.

This interface is very different from the Microsoft Windows interface and it is quite difficult to grasp at the beginning, it was difficult to learn and required numerous explanations. It was even more difficult to understand how to use the world controls. Reading the user manuals was helpful but not sufficient to operate the controls. After figuring out how to navigate the confusing interface, another problem the students faced was the complexity of the buttons layout. Once we click on a button in the user interface, a very generic type layout with many buttons in which one can alter the input variables will appear. As one is creating hundreds of parts and subparts it is extremely easy to miss or overlook one of the countless input variables. The overlooking of a single variable can result in problems ranging from simulation failure to inaccurate results which can be very frustrating. Another design problem encountered when using Quest happened when one exits the program. When a we exits Quest, it would prompt the user to confirm the exit. Unlike most commercial programs, to remind for save the data before exiting. There were many instances where part of work was lost as a result of exiting the program.

Quest have some advantage such as : The application of the Quest software could be very beneficial in teaching and manufacturing practice. Though this software is primarily prepared for manufacturing optimization, it has both design and manufacturing possibilities. If more features, such as CAD software for part design, were integrated directly into the program, the Quest software

would become even more powerful. Once the design and manufacturing can all be controlled under one program, Quest would be the ultimate engineering tool.

4.5.3.2 ARENA Analysis

Arena was designed to make creating simulation models an entirely graphical process. We can learn program by using student version that can be download easily in website. All system behaviors are represented by using the graphical modules, it is easily to make analysis of input data, process data and output data analysis. For system logic and queue selection rules, the user creates a flowchart of his system by placing the appropriate graphical modules on the Arena layout and directly connecting these modules. Non-animated modules from the Arena template that make up the majority of this flowchart can be freely interspersed with modules that contain animation.

All feature in Arena like windows interface, so it is easily for beginning to learn the program. Arena menu help will guide the user directly to solve the problem. Arena contains additional tools that are valuable for successfully conducting entire simulation projects. The Input Analyzer is useful for determining an appropriate distribution for input to an Arena model. The Input Analyzer allows the user to take raw data (e.g., inter arrival time for the passenger arrival or using historical data that provided) and fit it to a statistical distribution with information of error. This distribution then can be incorporated directly into the model. The Output Analyzer is used to display and analyze model data after the simulation run (or runs) has been performed. Graphical display options include plots, histograms, and more. Multiple replications can be displayed on a single chart or can be lumped together for display of the aggregate performance over multiple runs. The Output Analyzer also provides analysis features such as confidence intervals, one-way analysis of variance, and comparisons (of multiple systems). Both the Input and Output Analyzers are directly available on the Arena Tools menu.[Dav97]

To build 3 Dimension model using Arena is quite difficult than using Quest because of the feature of Arena is best for Graphical or flowchart Display.

CHAPTER V CONCLUSIONS

A Simulation model of the Airport terminal building is constructed and can be used to examine passenger flows. The passenger activity flow in the Airports follows as Discrete Event Simulation.

The main objective of this paper is to model and simulate the operation or the passenger flow in the airport. Which can be used to improve the operating performance and also improving the quality management of airport for give best service performance.

Based on our result model analysis, It is found that the critical number of resource agent is 12 agent. If there is 12 agent in the system total output passenger create is 1552 passenger during 16 hours airport operating and average total time from passenger enter the airport gate until the boarding gate is 53 minute.

The Graphic Pareto give the choice for management airport to choose suitable configuration of resource in order to improve passenger satisfying.

Using Opt.Quest for Arena can develop more number of resource capacity as provide in “ Control resource “ display. And simulate the system to get best configuration of each resource capacity.

There is no different significant result of number passenger created and average passenger total time in the system between using Quest software and Arena. It is means our model of passenger flow analysis in airport is valid.

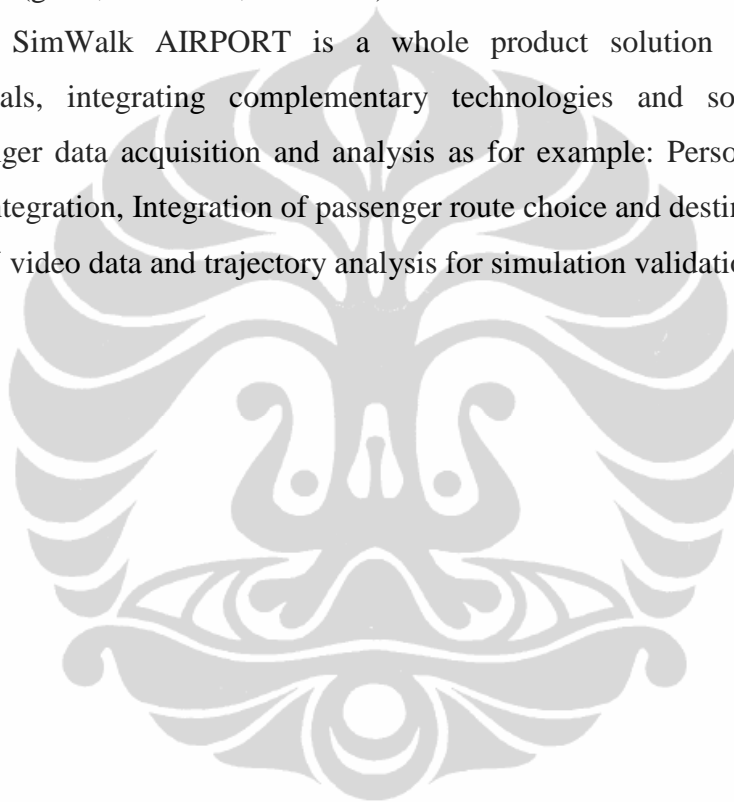
For additional information, there is Another Software Simulation that design specially for Airport process improvement for optimization like “SIMWALK Airport” software.

“SimWalk AIRPORT”, is software for specialised passenger simulation and analysis solution for airports, offers realistic modeling and evaluation of passenger operations in terminals. SimWalk AIRPORT

provides analysis of passenger capacities, operational layouts, congestions and queues as well as levels of service.

Realistic simulation of all airport passenger capacity issues regarding arrival and departure flows, check-ins, boarding gates, baggage claims, security check points, passport check points and commercial areas, Analysis of passenger bottlenecks, delays and high, densities in airport facilities, Capacity evaluation and feasibility testing of airport connection devices (gates, escalators, stairs etc.)

SimWalk AIRPORT is a whole product solution for airport terminals, integrating complementary technologies and software for passenger data acquisition and analysis as for example: Person counting data integration, Integration of passenger route choice and destination data, CCTV video data and trajectory analysis for simulation validation.



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