IOSR Journal of Mathematics (IOSR-JM)
e-ISSN: 2278-5728, p-ISSN: 2319-765X. Volume 13, Issue 5 Ver. 1 (Sep. - Oct. 2017), PP 22-36
www.iosrjournals.org

Attenuation of Dawdle Time by utilizing Simulation and Multiphase Queuing System

*Roshli Aniyeri, Dr.C.Ratnam Nadar
Dept: of Mathematics, M.G.G.A.College mahe,
Dean Students Welfare, Noorul Islam University, Kanyakumari district,
Corresponding Author: Roshli Aniyeri

Abstract: *Dawdle period is a macro problem that almost everyone has to face, which causes a great squander of time for everyone. It is well known that all these linger line problems critically restrict the further development. The focus of this study is to deal with passengers queue issues of the International airport terminals of Kerala. Queuing theory is a mathematical approach to the study of waiting period in queues. The dissect of queuing theory that evaluates the effectiveness of implementation of multi-server queuing model .The Multi Server approach of modeling was adopted in this cram to develop a mathematical model to solve problem of queuing of air transport passengers at the International Airports in Kerala. The airport in the aviation industry of the country faces problems of many passengers queuing for boarding, departure with different arrival rate. The passengers average wait time for reaching the gate area measures system performance. This study compare the multiserver queuing system using Monte Carlo simulation in Airports in Kerala. The main aim of this paper is future behavior of Airports.*

Keywords: *Multi channel queueing model, Monte-Carlo simulation, probability distribution, queue length, system length and queue time and system time.*

Date of Submission: 14-08-2017 Date of acceptance: 00-00-0000

I. Introduction

Indian Aviation Industry is one of the fastest growing airline industries in the world. The history of Indian Aviation Industry started in December 1912 with its first domestic air route between Karachi and Delhi. The airport is the gateway of any country. A tree cannot make a forest, so says an adage. Thus the economy of a nation depends on some sector like the agricultural sector, the health sector, the works and housing sector and most importantly, the Airport, banking sector among others. All these sectors work together and integrate to make the life of a nation. A breakdown in any of these sectors will definitely have untold effects on the progress and success of the nation The airline industry is important for the global economy. Airports, in particular, hub airports are the backbone of air transportation. Transportation plays a vital role in the changing global economy, linking people and places, facilitating trade and tourism, and encouraging economics competition and specialization

The airport in the aviation industry of the country faces problems of many passengers queuing for boarding, departure with different arrival rate due to non availability of state of the art logistics management mechanisms for predicting the nature and service demands of travelers. The passengers average wait time for reaching the gate area measures system performance

Waiting lines or queues are omnipresent. It is formed when the number of customers arriving is greater than the number of customers being served during a period of time. Long waiting line or waiting time in public health is a notorious problem in most of the countries all over the world. This paper describes the use of queuing systems to decrease the waiting time of patients.

Queuing theory and simulation are analytical techniques that are increasingly being accepted as valuable tools. Queuing systems are quicker to use however, they do not have the flexibility of simulation technique. It describes the inter arrival time and service time of the passengers coming to the Airport with a suitable distribution. The primary inputs to these models are arrival and service patterns. These patterns are generally described by suitable random distribution. It is found that the inter arrival time of passengers follows the poisson distribution, and the service time follows Exponential distribution. Queuing theory can be used to predict some of the important parameters like total waiting time, average waiting time of passengers, average queue length. The queuing system predicted the average waiting time of passengers , average queue length, closer to the actual values.

Simulation is a emulation of reality that exists or is contemplated. Simulation is most effectively used as a stage in queuing analysis. The simulation is run for pasengers coming to Airport , the pertinent parameters like waiting time, service time, waiting time-service time ratio. Queuing Theory is mainly seen as a branch of applied probability theory. Its applications are in different fields.

In general, a queue is formed at a queuing system when either customers (human beings or physical entities) requiring service wait due to number of customers exceeds the number of service facilities, or service facilities do not work efficiently and take more time than prescribed to serve a customer.

The merging of queuing model and simulation technologies has seen a remarkable growth in recent years. The fruitful reason for the importance of simulation in queueing model is that many real world problems in operations research are too complex to be given tractable mathematical formulations. In such situations, resources can be listed in a series in the hope that at least one will give an adaptable solution.

Ultimately the striking goal in simulation and queueing model is to create a way to produce high quality solutions without any mathematical structures. It first requires that a model be developed and the model represents the behaviors of the process. Simulation can be used to predict the performance of an existing or planned system and to compare alternative solutions to a particular design problem . Simulation can be used to show the eventual real effects of alternative conditions and courses of action. It"s also used when the real system cannot be engaged, because it may not be accessible, or it may be dangerous or unacceptable to engage, or it is being designed but not yet to build, or it may simply not exist.

Monte Carlo simulation is a computerized mathematical technique. In this study need to generate random numbers to obtain random observations from probability distributions, and it's a sequence of numbers whose probability of occurrence is the same as that of any other number in the sequence. This study used random phenomena in waiting line model; the arrival rate and the service rate are usually probabilistic rather than deterministic.

Queuing theory and simulation are believed to work hand-in-glove to uncover and smooth out some of the rough spots in a productive. One of the important applications of simulation is the analysis of waiting line problems and its classified into Analogue model, Continuous model, discrete model. Simulation can be used as a pre-service test to try out new policies and decision rules for operating a system before running the risk of experimentation in the real system and it's the only 'remaining tool' when all other techniques become fail. It is the trial and error approach that produces different solutions in repeated trials. This means it gives only the optimum solution to the industrial problems. The simulation model does not produce answers by itself. The user has to provide all the constraints for the solutions which he wants to examine. Monte Carlo Simulation is now a much used scientific tool for problems that are analytically intractable and for which experimentation is too time consuming, costly or impractical.Random numbers are useful for a variety of purposes, such as generating data encryption keys, simulating and modeling complex phenomena and for selecting random samples from larger data sets. They have also been used aesthetically.

In this paper we analyze the multichannel queuing system through simulation. The purpose of this study is to review Queuing theory and its analysis based on the data from a Airportl Terminal.

Objective of the study

In most of the airports, the major problem is waiting of passengers in the queue for more deviation. This study analysis the queuing problem using alternative approach of the multiserver method in the international departure of passengers in International airports in Kerala. There are three International Airports in Kerala namely Trivandrum, Kochi, and Kozhikode .This study aims to study the existing queue pattern in these airports and to compare this with Simulation. Therefore the main objectives of this study are

- To study the congestion in the Airport terminal.
- To validate the data collected in the terminal
- To develop a queuing model for the system.
- To propose an simulation model and compare its efficiency levels with the existing model.

II. Literature Review

This literature review reveals various decision support techniques for the analysis of an airport. The motivation for this study is to determine an appropriate model to solve the queuing problem in International Airports in Kerala Numerous studies and work have been done on the subject of airport . One of the Study carried out a simulation study of the passenger check-in system at Ottawa International Airport. Later, investigated more in detail the check-in problem. They fixed their attention at the daily level and used simulation to determine: the minimal number of counters in order to meet a service level for each separate flight in term of waiting times. Next, they provided some integer programming formulations to minimize the total number of counters and the total number of counter hours under the realistic constraint that counters for one and the same flight should be adjacent. Another studied specifically the case of the kiosks, or automated self-service check-in machines, and analysis has been done for the improving of service quality of self-service kiosks, but also assisted the industry in developing a SUSS (Common-use self-service) standard that would enable airlines to share kiosks**.** Another analyzed transfer passengers' views on the quality of services at the terminal building, using data collected at Bandaranaike International Airport in Sri Lanka.In which Regression analysis was used to identify the transfer passenger facilities and services with the strongest effect on the overall perception of level of service

Another study about the check-in process of the airport terminal has been modeled and examined .The goal of their study was to determine delays and solutions to improve efficiency. A great number of security measures were adopted to avoid new terrorist actions in airport terminals. Without proper security measures, people could consider the air transportation system as unsafe and could refrain from traveling by aircraft.The state of art overview highlights different research works in modeling airport terminal operations. A simulation model to analyze passenger and baggage flow in an airport terminal, Another analyze the bottlenecks in the passengers flow and provide integral solutions for supporting future airport developments. There are also studies about the airport security; Another study baggage screening strategies using artificial intelligence techniques. Again another analyze the problems related to the design and analysis of security screening and inspection system. They introduces a new baggage-tracking system for improving airport security. In this paper the authors propose a simulation model of the airport of for investigating system performance under the effects of different scenarios characterized by different resources allocation and availability. Many researchers have faced issues concerning the optimization of an airport terminal The ***Nagoya University*** has conducted a simulation using the software Arena on departing flow passengers from the International Kansai airport in Japan, in order to reduce the number of passengers, because of long waiting times in peak periods and because of unavoidable delays, they lose their flights. NAIA, Abuja -Nnamdi Azikiwe International used the Death and Birth Rate approach to model to the waiting line at the airport and reported that more aircrafts are needed on daily basis both on the domestic and International routes for improved service. *This study is a continuation of this past work aimed at developing a queuing model using alternative approach of the Multi-Server method to facilitate the prediction, processing of passengers at the Airports in Kerala per operational period for effectiveness.* There are so many studies in the literature analyzing the problem of congestion in Airport terminal. **GUIZZI G(**2009) in his paper studied the analysis of passenger flow in the terminal airport, from entrance to boarding. In particular this study develops a simulation model. Based on the *Discrete Event theory***.** A related study can be found in **H. B. Thiagaraj(**2014),n his paper about the analytical approach and shows how to build a simulation procedure .This study is to measure the performance of an airport runway used only for arrivals, with different traffic mixes and operational variables. **Wasiq Ashfaq(**2006)n his paper studied analysis of the data at Birmingham Airport to provide effective and useful information about the dwell-time that passengers have between different points of their visit to the Airport The method he uses a Genetic Paradigm which is able to process that data using a compact and robust simulation model, so that the time spent by the visitors to the airport can be extracted from the raw data produced by the sensors. **Cynthia Barnhart(**2003)in his paper studied several important areas of operations research applications in the air transport industry. **Houda Mehri (2008)** in his paper studied solving of waiting lines models in the airport using queuing theory model and linear programming. The model about airport for passengers on a level with reservation is the multiple-channel queuing model with Poisson Arrival and Exponential Service Times (M/M/S).Total expected costs are studied, total costs is the sum of the cost of providing service plus the cost of waiting time. **Díaz Esteban Pedroj (2008)** in his paper Check in process at Lisbon Airport used two methods are implemented, event based simulations and collaborative design.

III. Methodology

Data collection and sampling

There may be many possible extensions to this study. Therefore the data quality is crucial and important for this study. A better and larger set of data should be obtained from international Airport in Kerala. Furthermore, an airport performance is crucial for applying this technique. Thus, to determine more appropriate airport performance variables like arrival of passengers and services in terminals using the different definitions and derivations of the variables. By using the key variables selected from the proposed methodologies, this paper reviews a queuing model for multiple servers. The average queue length can be estimated simply from raw data collected through the questionnaires, the number of passengers waiting in a queue in each minute. Then compare this average with that of simulation model.

In order to compare the deviations,

- The data was collected directly from three Airports in kerala,India for a period of one week by using the predetermined questionnaire .
- The observations were made for the number of passengers in a queue, their arrival-time and departure-time without distracting the employees
- The whole procedure of the service unit each day was observed and recorded using a time-watch during the same time period for each day. In these Airport Terminals there was no balk or renege.

IV. Data Analysis

The following assumptions were made for the analysis of the data.
(i)The waiting line has two or more identical servers
(ii)The arrivals follow a poison probability distribution with a mean arrivals rate of **λ**
(iii) The service times follow an exponential probability distribution
The mean service rate, "***μ***" is the same for each server
(iv)The arrivals wait in a single line and then move to the first open server for service in orderly manner
(v) The queue discipline is first-come-first serve (FCFS)
(vi)As the traffic intensity **ρ = λ /c*μ*** gets closer to one, there is a very rapid increase in the measures of congestion, **Lq** (expected number of passengers in the queue) and **Wq** (expected time a passenger in the system) gets closer to one.
The Multi Server approach of modeling was adopted in this study to develop a mathematical model to solve problem of queuing of air transport passengers at the International Airports in Kerala. The elementary probability theory to predict average waiting time, average queue length, distribution of queue length etc on the basis of 'Arrival pattern of passengers' to the resource, Service pattern of the passengers.

Components of Queue Models

Queues are not an unfamiliar phenomenon and to define it requires specification of the characteristics which describes the system such as the arrival pattern, the service pattern, the queue discipline and the queue capacity Adedayo (2006) observed that there are many queuing models that can be formulated. According to them it is essential that the appropriate queuing model is used to analyze problems under study.

The arrival pattern: This may be the arrival of an entity at a service point. This process involves a degree of uncertainty concerning the exact arrival times and the number of entities arriving. And to describe this process there are some important attributes such as the sources of the arrivals, the size of each arrivals, the grouping of such an arrival and the inter-arrival times.

***The service pattern*:** This may be any kind of service operation which processes the arriving entities. The major features which must be specified are the number of servers and the duration of the service.

The queue discipline: This defines the rules of how the arrivals behave before service occurs.

***The queue capacity*:** The queue capacity may be finite or infinite.

Queuing Model of International Airports in Kerala

The system of operation at International airport terminals in Kerala can be model as a queuing process. There are three international Airports in Kerala I have to collect data from three international Airports in Kerala by questionnaire form for this research and compare it. An attempt is made in this study to find solution to the queue of airport terminal congestion in Kerala The problem can be modeled as a multi-server queue problem with no system limit, arrival can be from a theoretically infinite source and the service is on first-come-first-serve priority rule. Thus T has the exponential distribution with mean 1 /λ if the inter arrival time are independent and have the same exponential distribution then the arrival follows the Poisson distribution. So in airport terminal the arrival of passengers are independent. Therfore the arrival follows the Poisson distribution and service rate are exponentially distributed. There are s parallel service channels and a passengers can go to any of the free counter for his service ,where the service time is identical and have the same probability density function s(t) with mean service rate μ per unit of time per busy server. Thus, overall service rate when there are n units in the system is given by:

$$P_0 = \frac{1}{\sum_{n=0}^{s-1} \frac{1}{n!}\left(\frac{\lambda}{\mu}\right)^n + \frac{1}{s!\left(1-\frac{\lambda}{s\mu}\right)}\left(\frac{\lambda}{\mu}\right)^s}$$

Characteristics of the Model

Expected number of passengers' in the queue or queue length (L_q). this model has a total of s servers ,the expected queue length is given by

$$L_q = E(N_q) = E(N-s) = \sum_{n=s}^{\infty}(n-s)P_n = \sum_{x=0}^{\infty} x P_{x+s} \quad \textit{putting} \quad x = n-s$$

Thus we have

$$L_q = \sum_{x=0}^{\infty} \frac{x}{s!s^x}\left(\frac{\lambda}{\mu}\right)^{s+x} P_0 \quad = \frac{1}{s!}\left(\frac{\lambda}{\mu}\right)^s P_0 \sum_{x=1}^{\infty} x\left(\frac{\lambda}{s\mu}\right)^x$$

it follows that

$$L_q = \frac{1}{s!}\left(\frac{\lambda}{\mu}\right)^s P_0 \frac{\lambda}{\mu s} \frac{1}{\left(1-\frac{\lambda}{\mu s}\right)^2}$$

Using the fact that

$$\sum_{x=1}^{\infty} x\left(\frac{\lambda}{s\mu}\right)^x = \frac{\lambda}{\mu s}\sum_{x=1}^{\infty} x\left(\frac{\lambda}{\mu s}\right)^{x-1} = \frac{\lambda}{\mu s}\left[1-\frac{\lambda}{s\mu}\right]^{-2}$$

Hence we deduce that

$$L_q = \frac{1}{s\,s!}\frac{\left(\frac{\lambda}{\mu}\right)^{s+1}}{\left(1-\frac{\lambda}{\mu s}\right)^2} P_0$$

Average or expected number of passengers' in the system (L_s)

By little's formula we have

$$L_s = L_q + \frac{\lambda}{\mu} = \frac{1}{s\,s!}\frac{\left(\frac{\lambda}{\mu}\right)^{s+1}}{\left(1-\frac{\lambda}{\mu s}\right)^2} P_0 + \frac{\lambda}{\mu}$$

where $L_s = E[N] = \sum_{n=0}^{\infty} n P_n$

Average waiting time of a passenger in the system (W_s) By Little's formula

$$W_s = \frac{L_s}{\lambda} = \frac{1}{\lambda} * \frac{1}{s\,s!}\frac{\left(\frac{\lambda}{\mu}\right)^{s+1}}{\left(1-\frac{\lambda}{\mu s}\right)^2} P_0 + \frac{1}{\mu}$$

i.e $$W_s = \frac{1}{\mu} + \frac{1}{\mu}\frac{1}{s\,s!}\frac{\left(\frac{\lambda}{\mu}\right)^{s}}{\left(1-\frac{\lambda}{\mu s}\right)^2} P_0$$

The average waiting time of a passenger in the queue (W_q)

By Little's formula $$W_q = \frac{L_q}{\lambda} = \frac{1}{\lambda}\frac{1}{s\,s!}\frac{\left(\frac{\lambda}{\mu}\right)^{s+1}}{\left(1-\frac{\lambda}{\mu s}\right)^2} P_0$$

$$W_q = \frac{1}{\mu}\frac{1}{s\,s!}\frac{\left(\frac{\lambda}{\mu}\right)^{s}}{\left(1-\frac{\lambda}{\mu s}\right)^2} P_0$$

The probability that an arrival has to wait for service

The arrival has to wait for service if and only if $T_s > 0$ where T_s denote the waiting time of a passenger in the system ,i.e if and only if there are s or more passengers' in the system .Thus the required probability is equal to

$$P(T_s > 0) = P(N \geq s) = \sum_{n=s}^{\infty} P_n = \sum_{n=s}^{\infty} \frac{1}{s!\,s^{n-s}} \left(\frac{\lambda}{\mu}\right)^n P_0 = \frac{1}{s!}\left(\frac{\lambda}{\mu}\right)^n P_0 \sum_{n=s}^{\infty} \left(\frac{\lambda}{\mu s}\right)^{n-s}$$

i.e $$P(T_s > 0) = P(N \geq s) = \frac{\left(\frac{\lambda}{\mu}\right)^s P_0}{s!\left(1 - \frac{\lambda}{s\mu}\right)}$$

The probability that an arrival enters the servise without waiting

$$1 - P(T_s > 0) = 1 - \frac{\left(\frac{\lambda}{\mu}\right)^s P_0}{s!\left(1 - \frac{\lambda}{s\mu}\right)}$$

The mean waiting time in the queue for those who need to wait :

$$E[T_q | T_s > 0] = \frac{E[T_q]}{P[T_s > 0]} = \frac{W_q}{P[T_s > 0]}$$

Substituting the values of W_q and $P[T_s > 0]$ in the above equation we get

$$E[T_q | T_s > 0] = \frac{1}{\mu} \frac{1}{s\,s!} \frac{\left(\frac{\lambda}{\mu}\right)^s}{\left(1 - \frac{\lambda}{\mu s}\right)^2} P_0 \times \frac{s!\left(1 - \frac{\lambda}{\mu s}\right)}{\left(\frac{\lambda}{\mu}\right)^s P_0}$$

Simplifying we get

$$E[T_q | T_s > 0] = \frac{1}{\mu s\left(1 - \frac{\lambda}{\mu s}\right)} = \frac{1}{\mu s - \lambda}$$

The average or expected number of passengers' in non empty queues (L_n)

If N denote s the number of passengers' in the system and N_q denote the number of passengers' in the queue ,then L_n is the conditional expectation defined by

$$L_n = E[N_q \mid N_q \geq 1] = \frac{E[N_q]}{P[N \geq s]} = \frac{L_q}{P[N \geq s]}$$

Since there are s servers , substituting the values of L_q and $P[N \geq s]$ we get

$$L_n = \frac{1}{s\,s!} \frac{\left(\frac{\lambda}{\mu}\right)^{s+1}}{\left(1 - \frac{\lambda}{\mu s}\right)^2} P_0 \times \frac{s!\left(1 - \frac{\lambda}{\mu s}\right)}{\left(\frac{\lambda}{s\mu}\right)^s P_0} = \frac{\left(\frac{\lambda}{s\mu}\right)}{1 - \frac{\lambda}{s\mu}}$$

Now appling the above multiserver queuing formula from the data collected from the three airports in Kerala.(Appendix below reference)

Data Collection at International Airports in Kerala

Data Collection at Kozhikode:The path related to passengers departing from Terminal 1 consists of two floors: on the ground floor we have the check-in desks, and on the first floor, assessable by escalators, the security control facilities immigration, security and customs and some shops and food services are located. On the other side of the ground floor besides the path related to arriving passengers there are the ticket office, the two currency exchange offices, several car rentals, and so forth. simulation studies require an exact description of processes and representative data. Therefore correct data is essential to get valid and valuable results about bottlenecks and to define relevant scenarios

Data Collection at Kochi :The country's first green field airport in the public private partnership model has integrated some unique and standout features in to its terminal design that marks the biggest expansion programme since the airport turned operational in 1999. The present international terminal with a built-up space of 4.75 lakh sq.ft has a peak hour capacity to handle only 1,200 passengers each on the arrival and departure sides. The terminal's elevation has been modelled along the State's traditional and aesthetically-rich temple architecture. It would be a multi-level terminal complex with the ground level to feature arrivals, and departures in the first level

Data Analysis Trivandrum: The path related to passengers departing from Terminal 1 consists of two floors: on the ground floor we have the check-in desks, and on the first floor, assessable by escalators, the security control facilities immigration, security and customs and some shops and food services are located. On the other side of the ground floor besides the path related to arriving passengers there are the ticket office, the two currency exchange offices, several car rentals, and so forth. simulation studies require an exact description of processes and representative data. Therefore correct data is essential to get valid and valuable results about bottlenecks and to define relevant scenarios

V. **D**ata **Analysis And Computation At International Airports In Kerala**

The most problematic phase of this study has been that on data acquisition. Sampling took place in the passenger terminal Karipur International airport. After a thorough inspection airport it same out that passenger traffic peaks during Wednesday Therefore the focus data collection phase was on three days: Monday, Wednesday and Friday. Data was grouped in the spreadsheets that show some information such as basis information flight (the airline and destination), time of departure, time of opening and closing its check-in and finally the flight code. This information is important because from the flight code it is possible to know the type of the aircraft used for that flight and then the total number of aircraft available seats. . In order to carry out a correct analysis of collected data it was necessary to make an appropriate data stratification for highlighting some key aspects. By observation the following data was collect at exactly 7**.00am** to **1.00Pm** on daily basis. **Table** shows the arrival, inter-arrival, service for a certain group of random Passengers that used the facilities in Airport Terminal as at the time of observation and data collection

Sampling took place in the passenger terminal Kochi International airport. After a thorough inspection airport it same out that passenger traffic peaks during Midnight. Data was grouped in the spreadsheets that show some information such as basis information flight (the airline and destination), time of departure, time of opening and closing its check-in and finally the flight code. This information is important because from the flight code it is possible to know the type of the aircraft used for that flight and then the total number of aircraft available seats. . In order to carry out a correct analysis of collected data it was necessary to make an appropriate data stratification for highlighting some key aspects. By observation the following data was collect at exactly 7**.00am** to **5.00Pm** on daily basis. **Table** shows the arrival, inter-arrival, service for a certain group of random Passengers that used the facilities in Airport Terminal as at the time of observation and data collection

Sampling took place in the passenger terminal Trivandrum International airport. After a thorough inspection airport it same out that passenger traffic peaks during Midnight. Data was grouped in the spreadsheets that show some information such as basis information flight (the airline and destination), time of departure, time of opening and closing its check-in and finally the flight code. This information is important because from the flight code it is possible to know the type of the aircraft used for that flight and then the total number of aircraft available seats. . In order to carry out a correct analysis of collected data it was necessary to make an appropriate data stratification for highlighting some key aspects. By observation the following data was collect at exactly 12**.00AM** to **2.00AM** on daily basis. **Table** shows the arrival, inter-arrival, service for a certain group of random Passengers that used the facilities in Airport Terminal as at the time of observation and data collection

Table .1 Data Analysis of Karipur International Airport

Dubai				
	Baggage	Immigration	Customs	Security
P_o	0.01475	0.03774	0.16667	0.17266
L_q	5.16465	1.52847	4.16675	2.17074
W_q	10.3293	4.58541	16.66667	6.51222
Saudi				
	Baggage	Immigration	Customs	Security
P_o	0.01475	0.0008029	0.06667	0.044944
L_q	5.1647	2.5125	5.71695	3.51125
W_q	10.3294	2.513	22.87	17.56
Dubai				
	Baggage	Immigration	Customs	Security
P_o	0.0598	0.00812	0.09091	0.0562
L_q	3.027	12.2020	3.788	2.5
W_q	9.081	12.2020	11.364	12.5
Saudi				
	Baggage	Immigration	Customs	Security
P_o	0.9091	0.009140	0.14285	0.0747
L_q	3.788	1.265	1.928	1.7033
W_q	11.364	2.53	7.712	6.813
Sharjah				
	Baggage	Immigration	Customs	Security
P_o	0.053697	0.00585	0.052632	0.0641
L_q	14.4	7.13451	7.673454	2.14
W_q	57.6	35.40699	38.36727	6.4298

Interpretation of results for queuing model 1

The interpretation of the Airport terminal Analysis of karipur International Airport From above table that the probability for servers to be busy in dubai flight- baggage screening is 0.1475 i.e. 14.75%. The average number of passengers waiting in a queue is Lq = 5.16465 passengers per minutes. The waiting time in a queue per server is Wq = 10.33 minutes. because from the flight code it is possible to know the type of the aircraft used for that flight and then the total number of aircraft available seats. . In order to carry out a correct analysis of collected data it was necessary to make an appropriate data stratification for highlighting some key aspects.

Table-2 Data Analysis of Kochi International Airport

Colombo				
	Baggage	Immigration	Customs	Security
P_o	0.04889	0.5769	0.09677	0.05101
L_q	5.133	6.8560	4.03208	5.0756
W_q	40.24	11.112	12.09624	36.56
Abudhabi				
	Baggage	Immigration	Customs	Security
P_o	0.1091	0.00895	0.04348	0.05394
L_q	7.2758	6.87446	9.6453	4.99051
W_q	43.5211	42.6100	57.8700	32.66
Dubai				
	Baggage	Immigration	Customs	Security
P_o	0.04708	0.02548	0.07527	0.03450
L_q	5.194	5.970	9.29047	5.61
W_q	41.552	42.310	65.033	30.05
Riyadh				
	Baggage	Immigration	Customs	Security
P_o	0.01473	0.10470	0.16271	0.0756
L_q	6.498	6.499	2.20336	3.3356
W_q	29.24	24.177	17.62688	13.3424
Dubai				
	Baggage	Immigration	Customs	Security
P_o	0.03439	0.1652	0.14286	0.05125
L_q	5.6184	6.39	1.9286	4.562
W_q	32.1602	45.287	19.286	22.81

Table-3 Data Analysis of Trivandrum International Airport

Saudi				
	Baggage	Immigration	Customs	Security
Po	0.0345	0.0000928	0.1659	0.125
Lq	2.5557	4.60767	3.455	2.382
Wq	10.288	5.148	24.185	21.438
Dubai				
	Baggage	Immigration	Customs	Security
Po	0.0556	0.000210	0.0526	0.04773
Lq	21.476	18.168	7.6736	8.634
Wq	106.6	18.168	38.36	42.220
Doha				
	Baggage	Immigration	Customs	Security
Po	0.148	0.0000374	0.090909	0.10345
Lq	5.165	6.8346	3.7878	3.156
Wq	10.33	6.12	34.0902	25.258
Abudhabi				
	Baggage	Immigration	Customs	Security
Po	0.0471	0.000113	0.07359	0.07692
Lq	5.13	7.18289	5.03141	4.747
Wq	40.24	7.18289	11.0692	33.23
Dubai				
	Baggage	Immigration	Customs	Security
Po	0.12987	0.000036	0.013243	0.1111
Lq	2.2165	2.247	3.580	2.84
Wq	6.6495	2.247	7.55434	28.4

Now we analyses the Airport terminals using simulation in queueing system. In this paper we analyze the multichannel queuing system through simulation. The purpose of this study is to review Queuing theory and its analysis based on the data from a Airport The passengers arrival and service time probability distribution as follows:

Arrival distribution

SL. N	Inter Arrival Time(min)	No. of Passengers	Probability	Cum. Probability	Tag Random Numbers
1	1-2	30	0.375	0.375	000-374
2	2-3	20	0.250	0.625	375-624
3	3-4	10	0.125	0.750	625- 749
4	4-5	20	0.250	1.00	750-999
		80			

Service distribution

SL. N	Inter serviceTime(min)	No. of Passengers	Probability	Cum. Probability	Tag Random Numbers
1	1-2	30	0.171	0.171	000-170
2	2-3	15	0.085	0.256	171-255
3	3-4	20	0.114	0.370	256-369
4	4-5	20	0.114	0.484	370-483
5	5-6	19	0.108	0.592	484-591
6	6-7	20	0.114	0.706	592-705
7	7-8	12	0.068	0.774	706-773
8	8-9	13	0.074	0.848	774-847
9	9-10	27	0.153	1.00	848-999

The aim of studying queuing system simulation is trying to find the arrival events are separated by the 'inter-arrival time' and the departure events are specified by the service time in the facility. The fact that these events occur at discrete point is known as "Discrete – event Simulation.

The following table gives the detailed simulation of multichannel queuing model with 2 servers.

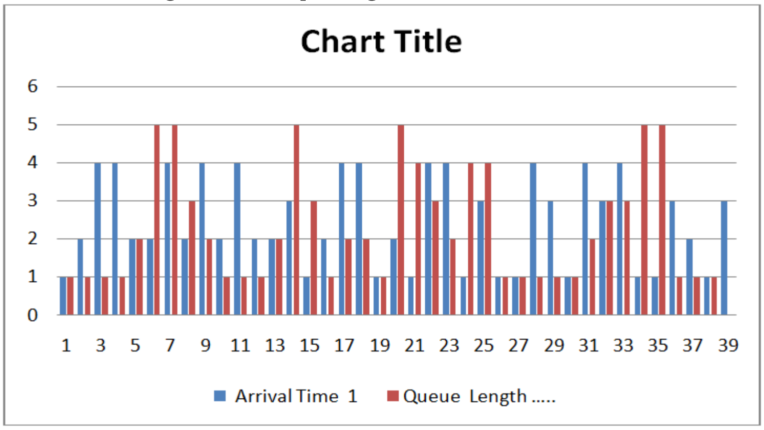
SL No.	Random No	Inter(min) Arrival Time	Random No	Inter (min) service time	*Clock arrival* time	Service I Begins	End
1	333	1	88	1	7.01	7.01	7.02
2	289	1	80	1	7.02	…….	…….
3	408	2	169	1	7.04	7.04	7.05
4	899	4	220	2	7.08	7.08	7.1
5	870	4	722	7	7.12	………	……..
6	393	2	107	1	7.14	……..	……..
7	419	2	165	1	7.16	7.2	7.21
8	809	4	148	1	7.2	……	……
9	386	2	454	4	7.22	7.22	7.26
10	915	4	950	9	7.26	…….	……..
11	407	2	256	3	7.28	7.32	7.35
12	822	4	88	1	7.32	7.35	7.36
13	618	2	239	2	7.34	……	……
14	437	2	191	2	7.36	7.36	7.38
15	671	3	237	2	7.39	…..	....
16	107	1	761	7	7.4	7.4	7.47
17	525	2	64	1	7.42	…..	…….
18	824	4	938	9	7.46	7.46	7.55
19	848	4	927	9	7.47	7.47	7.56
20	249	1	311	3	7.48	…….	……
21	402	2	582	5	7.5	……	….
22	293	1	840	8	7.51	7.51	7.59
23	845	4	871	9	7.55	……	…….
24	814	4	849	9	7.59	……	……..
25	214	1	57	1	8	8.08	8.09
26	649	3	905	9	8.03	…	….
27	64	1	513	5	8.04	8.08	8.13
28	310	1	704	6	8.05	8.14	8.2
29	821	4	321	3	8.09	8.18	8.21
30	684	3	756	7	8.12	8.19	826
31	315	1	530	5	8.13	……	……
32	926	4	817	8	8.17	…..	…..
33	696	3	879	9	8.2	8.27	8.36
34	933	4	145	1	8.24	…..	……
35	214	1	144	1	8.25	……	…..
36	141	1	371	4	8.26	838	8.42
37	627	3	126	1	8.29	…..	…..
38	553	2	221	2	8.31	….	….
39	327	1	204	2	8.32	8.42	8.44
40	607	3	334	3	8.35	8.45	8.48
		95		165			

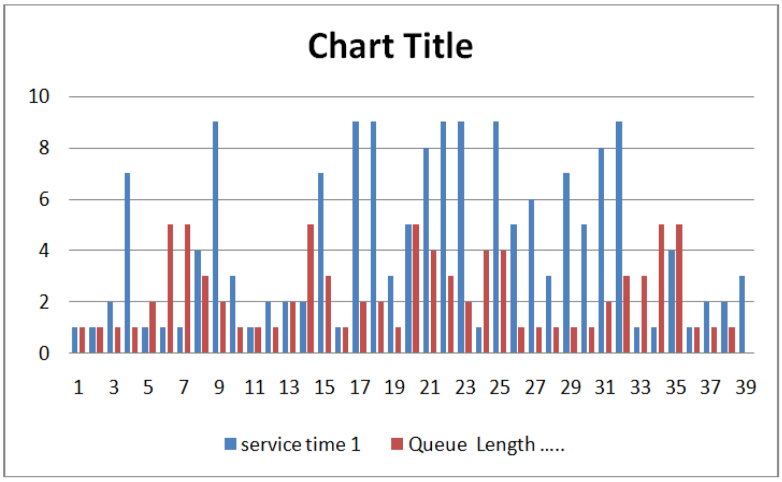
SL No.	ServiceII Begins	End	Customer Waiting time	Waiting time Service I	Server II	Queue Length
1	…….	……..	1			…..
2	7.03	7.04		1		1
3	………	……..			3	1
4	………	…..		2		1
5	7.12	7.19	5	3		1
6	7.19	7.2	4		8	2
7	……	………	1			5
8	7.21	7.22		10		5
9	………	……….			1	3
10	7.26	7.35	4	1		2
11	……..	……….	3		4	1
12	……….	……….	1	8		1
13	7.35	7.37				1
14	………	………	1			2
15	7.4	7.42				5
16	……	…….	4		3	3
17	7.46	7.47		2		1
18	……..	…….			4	2
19	………	…….	6	1		2
20	7.54	7.57	2	8		1
21	7.52	7.57			7	5
22	……	…….			5	4

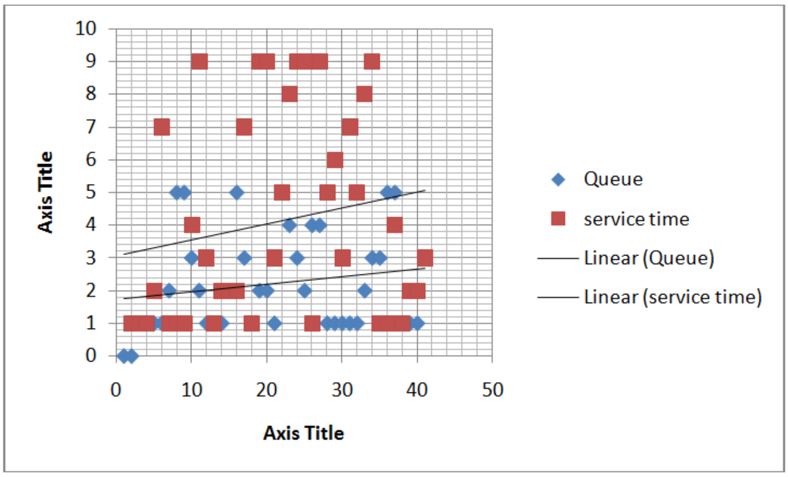
23	7.55	8.04		5		3
24	7.59	8.08	8		2	2
25	……….	……..	5		5	4
26	8.08	8.17	4	9		4
27	…….	…….	9			1
28	…….	…….	9	1		1
29	…….	…….	7	1		1
30	…….	……..	8	2		1
31	8.21	8.26	9	3		1
32	8.26	8.34	7		4	2
33	……..	…….	13			3
34	8.37	8.38	13	1		3
35	8.38	8.39			3	5
36	…….	……….	10			5
37	8.39	8.4	9	2		1
38	8.4	8.42	10			1
39	……	……	10	1		1
40	…..	…….	163	61	49	88

1. Average queue length = 88/40 = 2.2
2. Average waiting time of a passengers = 163 / 40 = 4.075
3. Average service time = 165 /40 = 4.125
4. Time the customer spend in the system = 4.075 + 4.125 = 8.2
5. Average Arrival time = 95 /40 = 2.375

This reviews a queuing model for multiple servers. The main idea of this study is to measure the expected queue length in each server. The second idea is to gives a view of queuing process and running the simulation experiments to obtain the required statistical results. This method infers that the multichannel queuing model is better model, since there is no waiting time for customers and hence there is no queue length. So this model is costlier than the single channel queuing model.



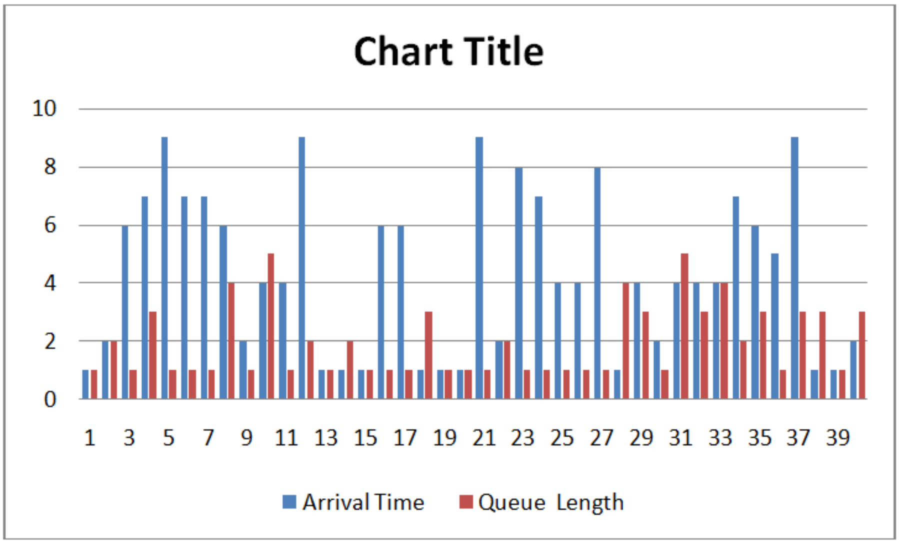


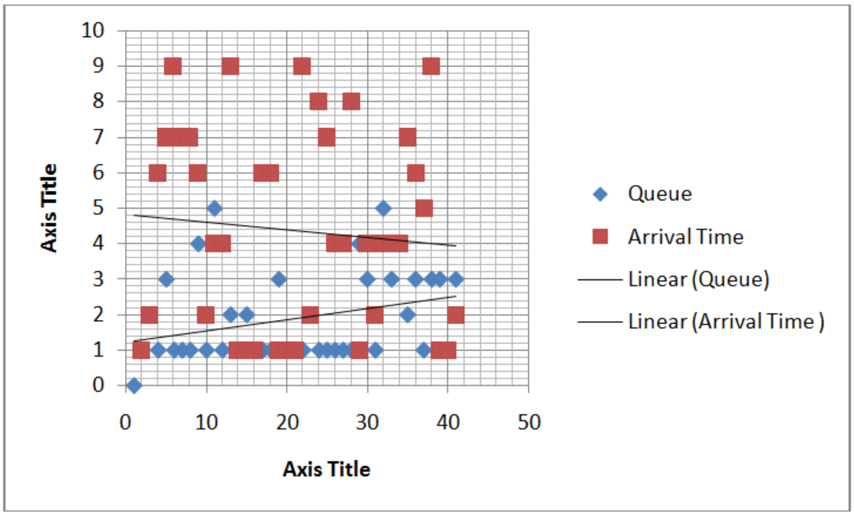


SL No.	Random No	Inter(min) Arrival Time	Random No	service time (min)		*Clock arrival* time	Begins	Service I End
1	210	1	98	3		8.01	8.01	8.04
2	347	2	620	5		8.03	....	....
3	741	6	315	4		8.09	8.09	8.13
4	822	7	379	4		8.16	....	....
5	896	9	657	5		8.25	8.25	8.3
6	824	7	430	5		8.32	....	....
7	767	7	726	5		8.39	8.39	8.44
8	749	6	581	5		8.45	....	....
9	318	2	52	2		8.47	8.5	8.52
10	529	4	265	4		8.51	....	....
11	547	4	757	6		8.55	8.56	9.02
12	901	9	361	5		9.04	....	....
13	128	1	902	8		9.05	9.09	9.17
14	64	1	582	5		9.06	....	....
15	107	1	911	8		9.07	9.22	9.3
16	721	6	861	7		9.13	9.3	9.37
17	709	6	653	5		9.19	9.37	9.42
18	133	1	584	5		9.2	....	....
19	171	1	263	4		9.21	9.47	9.51
20	192	1	698	5		9.22	9.51	9.56
21	925	9	717	5		9.31	9.56	10.01
22	439	2	906	8		9.33	....	....
23	885	8	658	5		9.41	....	....
24	830	7	425	4		9.48	....	....
25	511	4	918	8		9.52	10.18	10.26
26	551	4	638	5		9.56	10.26	10.31
27	861	8	148	4		10.04	10.31	10.35
28	338	1	540	5		10.05	....	....
29	612	4	566	5		10.09	....	....
30	264	2	805	7		10.11	10.45	10.52
31	492	4	61	2		10.15	10.52	10.54
32	565	4	48	2		10.19	....	....
33	547	4	205	4		10.23	....	....
34	769	7	133	3		10.3	....	....
35	729	6	317	4		10.36	....	....
36	627	5	77	3		10.41	11.07	11.1
37	917	9	33	1		10.5	11.1	11.12
38	3	1	120	3		10.51	....	....
39	188	1	21	1		10.52	11.15	11.16
40	259	2	171	4		10.54	....	....

	ServiceII		Customer	Waiting time		
SL	Begins	End	Waiting time			Queue
No.				Service I	Server II	Length
1	……..	……..		1		1
2	8.04	8.09	1		4	2
3	……..	……..		5		1
4	8.16	8.2			7	3
5	……..	……..		12		1
6	8.32	8.37			12	1
7	……..	……..		9		1
8	8.45	8.5			8	4
9	……..	……..	3	6		1
10	8.52	8.56	1		2	5
11	……..	……..	1	4		1
12	9.04	9.09			8	2
13	……..	……..	4	6		1
14	9.17	9.22	11		8	2
15	……..	……..	15	5		1
16	……..	……..	17			1
17	……..	……..	18			1
18	9.42	9.47	22		20	3
19	……..	……..	26			1
20	……..	……..	29			1
21	……..	……..	25			1
22	10.01	10.09	28		14	2
23	10.09	10.14	28			1
24	10.14	10.18	26			1
25	……..	……..	26	17		1
26	……..	……..	30			1
27	……..	……..	27			1
28	10.35	10.4	30		17	4
29	10.4	10.45	31			3
30	……..	……..	34	10		1
31	……..	……..	37			5
32	10.54	10.56	35		9	3
33	10.56	11	33			4
34	11	11.03	30			2
35	11.03	11.07	27			3
36	……..	……..	26	13		1
37	……..	……..	20			3
38	11.12	11.15	21		5	3
39	……..	……..	23	3		1
40	11.16	11.2	22		1	3
			707	91	115	78

Comparison of Arrival with queue length





VI. Results And Discussion

A number of studies have performed passenger queue simulations in airport terminals for the purpose of analyzing current and future levels of service. Traditionally these studies have focused on the mandatory processing facilities such as check-in, security, immigration, airside boarding lounge and the boarding gates themselves through the application of queueing theory..

The queue problem at international Airports in Kerala was modeled as a Multi-Server queuing problem. Theoretically, arrival is from infinite source and the service pattern is on First-Come-First-Server (FCFS). One week data of departures of passengers at International Airports in Kerala is considered. See Table 1,2,3, Adebayo, (2008) stated that the closer the traffic intensity it to zero the more efficient the operations of the service facilities.. According to Satty (1961), if $\lambda > 1$, the number of passengers would be infinite. In the International Airport Karipur in peak hrs the average no of customers in the queue is more than 20per minute and in the non peak hrs the it is more than 10per minute. In the International Airport Karipur in peak hrs the average no of customers waiting in the queue is more than 45per minute and in the non peak hrs the it is more than 28per minute. In the International Airport Kochi in peak hrs the average no of customers in the queue is more than 25per minute and in the non peak hrs the it is more than 15per minute. In the International Airport Kochi in peak hrs the average no of customers waiting in the queue is more than 1 1/2 hour and in the non peak hrs the it is more than one hr. In the International Airport Trivandrumin peak hrs the average no of customers in the queue is more than 25per minute and in the non peak hrs the it is more than 10per minute. In the International

Airport Trivandrum in peak hrs the average no of customers waiting in the queue is more than 1and1/2hours and in the non peak hrs the it is more than 50 minute(below table). This shows that that during weekdays prime hours there is heavy passengers in terminals.

VII. Conclusion

In the case of Dubai Airlines ,passengers take more time for baggage than other activities when compared to other air services. This may be due to their liberalism in baggage restriction.

This study has been done by observing the passengers arrival time, waiting time in the queue, different behavior of passengers in the queue like jockeying and service time in Airport terminals in Kerala. This Study was made the information for one week duration in all the three Airport during weekdays peak and non peak hrs.. Generally, arrivals do not occur at fixed regular intervals of times but tend to be clustered for a duration of a week. The Poisson distribution involves the probability of occurrence of an arrival are random and independent of all other operating conditions. The inter arrival rate (i.e., the number of arrivals per unit of time) λ is calculated by considering arrival time of the customers to that of the number of customers Service time is the time required for completion of a service i.e., it is the time interval between beginning of a service from Airport and its completion.

This reviews a queuing model for multiple servers. The main idea of this study is to measure the expected queue length in each server. The second idea is to gives a view of queuing process and running the simulation experiments to obtain the required statistical results So this model is costlier than the single channel queuing model. The overall scope of future research is to balance the cost of waiting with the cost of adding more resources by using the programming languages and to simplify the design of simulation programs.

In this study the researcher has calculated mean service time μ of passengers by considering different service time of passengers. Based upon the tabulation and taking one day as a standard, the researcher inferred that during prime hours there is heavy passengers in terminals, which implies that the utilization factor is 1.With the increasing number of customers' coming to Airport terminal, there must be trained employees serving at each service unit.. Increasing more than sufficient number of servers may not be the solution to increase the efficiency of the server by each service unit

Reference

[1]. A. Nuhu Ademoh and Anosike, Esther Nneka-Queuing Modelling of Air Transport Passengers of Nnamdi Azikiwe International Airport Abuja, Nigeria Using Multi Server Approach Middle-East Journal of Scientific Research 21 (12): 2326-2338, 2014 DOI: 10.5829/idosi.mejsr.2014.21.12.21807
[2]. Brunetta, L. (2004) 'Passenger and baggage flow in an airport terminal: a flexible simulation model', Journal of Air Traffic
[3]. Canadalino, T.J. (xxxx) 'Designing optimal aviation baggage screening strategies using simulated annealing', Journal of Computers and Operation Research, 19 September, pp.1753–1767
[4]. C.Barnhart, (2003) 'Applications of operations research in the air transport industry transportation science', INFORMS, November, Vol. 37, No. 4, pp.368–391.
[5]. Chang, H-L. and Yang, C-H. (2008) Science Direct Tourism Management, Vol. 29, pp.980–993.
[6]. De Barros, Somasundaraswaran and Wirasinghe (2007) 'Evaluation of level of service for transfer passengers at airports', Journal of Air Transport Management, Vol. 13, No. 5, pp.293–298,DOI: 10.1016/j.jairtraman.2007.04.004.
[7]. Esteban, D. and Pedro, J. (2008) 'Check-in process at Lisbon Airport', Event-based Simulations and Collaborative Design.
[8]. Guizzi, G., Murino, T. and Romano, E. (xxxx) 'A discrete event simulation to model passengerflow in the airport terminal MMACTEE'09 Proceedings of the 11th WSEAS international conference on Mathematical methods and computational techniques in electrical engineering page 427-434
[9]. Mehri, H., Djemel, T. and Kammoun, H. (2008) 'Solving of waiting lines models in the airport using queuing theory model and linear programming the practice case'. 11 Mar 2008 HAL Id: hal-00263072
[10]. Olapiriyakul, S. and Das, S. (2007) 'Design and analysis of a two-stage security screening and inspection system', Journal of Air Transport Management, Vol. 13, No. 2, pp.67–74.
[11]. Oyatoye, E.O. (2011) 'Application of queuing theory to port congestion problem in Nigeria'. European Journal of Business and Management vol-3 No. 8 -2011
[12]. Sun Olapiriyakul, Design and analysis of a two-stage security screening and inspection systemJournal of Air Transport Management Volume 13, Issue 2, March 2007, Pages 67–74
[13]. Thiagaraj, H.B. (2014) 'A queueing model for airport capacity and delay analysis', Applied Mathematical Sciences, Vol. 8, No. 72, pp.3561–3575.
[14]. Van der Sluis, E. and Van Dijk, N.M. (2006) 'Check-in computation and optimization by simulation and IP in combination', European Journal of Operational Research, June,Vol. 171, No. 3, pp.1152–1168
[15]. Vasumathi (2010) 'Application of simulation technique in queuing model for ATM facility', International Journal of Applied Engineering Research, Vol. 1, No. 3, Dindigu.pp 469- 482 Code : EIJAER2015.
[16]. W. Ashfaq, (2006) Analysis of passenger movement at Birmingham International Airport. Proceedings of IEEE World Conference on Computational Intelligence (IEEE Congress on Evolutionary Computation), pp. 1339-1345
[17]. Yfantis, E.A. (1997) 'An intelligent baggage-tracking system for airport security', Engineering Applications of Artificial Intelligence, December, Vol. 10, No. 6, pp.603–606
[18]. Yuheng, C., Nsakanda, A.L and Pressman, I. (2003) 'A simulation study of the passenger check-in system at the Ottawa International Airport', Proceedings, Summer Computer Simulation Conference, Montréal, QC, pp.573–579.

Roshli Aniyeri. "Attenuation of Dawdle Time by utilizing Simulation and Multiphase Queuing System." IOSR Journal of Mathematics (IOSR-JM), vol. 13, no. 5, 2017, pp. 22–36.