MODELLING HUMAN QUEUING AT KUANTAN CINEMA

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MODELLING HUMAN QUEUING AT KUANTAN CINEMA

SESSION 2016/2017

ABDUL QADIR JAILANI BIN MUCHTAR

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MODELLING HUMAN QUEUING AT KUANTAN CINEMA

ABDUL QADIR JAILANI BIN MUCHTAR

A thesis submitted in fulfillment of the requirements for the award of the degree of Bachelor of Science Computer (Software Engineering) with Hons.

Faculty of Computer Systems & Software Engineering
UNIVERSITI MALAYSIA PAHANG

DECEMBER, 2016

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ABSTRACT

This thesis presents a comparison between types of queue system simulation by using Discrete Event Simulation (DES). In our literature review we identified a gap in comparing the applicability of this type of queue system. Hence, we focused our research on reactive and different level of detail of proactive of human behavior in service system.The aim of our thesis is first to identify the possible queuing type's model, second is to develop different queuing types using discrete event simulation and lastly to compare the developed queuing type models based on waiting times and no. of customer served. To reach that we investigate both similarities and differences between model results performance and the similarities and differences in model difficulty performance.The comparison of the simulation is reach by using scenario method. We conduct three scenarios in same environment and DES method, the different is we use the different type of queue system in the simulation. In the first scenario(cinema ticket service) we use single queue line and multi service or counter, second scenario we still use single queue line and multi service but we reduce two counter services, and lastly third scenario we use multi queue line and multi service.The result from the experiment reveals that both single line and multi-line suitable for that kind of environment. In addition, multi-line and multi-service is more suitable in this environment for achieving the shorter waiting time to serve the customer in counter ticket cinema.

ABSTRAK

Tesis ini membentangkan perbandingan antara jenis simulasi sistem baris gilir dengan menggunakan Discrete Event Simulation (DES). Dalam kajian literatur kami telah mengenal pasti jurang dalam membandingkan kesesuaian jenis sistem beratur. Oleh itu, kami memberi tumpuan penyelidikan pada tahap reaktif dan berbeza terperinci daripada proaktif tingkah laku manusia dalam sistem perkhidmatan. Tujuan tesis kami adalah yang pertama untuk mengenal pasti model jenis giliran itu, kedua adalah untuk membangunkan jenis giliran yang berbeza dengan menggunakan Discrete Event Simualtion (DES) dan akhir sekali untuk membandingkan model jenis beratur dibangunkan berdasarkan masa menunggu dan bilangan pelanggan yang dilayan. Untuk mencapai menyiasat kita kedua-dua persamaan dan perbezaan antara prestasi keputusan model dan persamaan dan perbezaan dalam prestasi model kesukaran. Perbandingan simulasi adalah mencapai dengan menggunakan kaedah senario. Kami menjalankan tiga senario dalam persekitaran yang sama dan kaedah DES, yang berbeza adalah kita menggunakan jenis yang berbeza daripada sistem beratur dalam penyelakuan. Dalam (perkhidmatan pawagam tiket) senario pertama kita menggunakan garis barisan tunggal dan perkhidmatan berbilang atau kaunter, senario kedua, kami masih menggunakan talian barisan tunggal dan perkhidmatan multi tetapi kita mengurangkan dua perkhidmatan kaunter, dan Senario ketiga akhir sekali kita menggunakan garis barisan pelbagai dan perkhidmatan pelbagai .Hasil daripada eksperimen menunjukkan bahawa kedua-dua baris dan berbilang talian sesuai untuk apa yang alam sekitar. Di samping itu, berbilang talian dan pelbagai perkhidmatan adalah lebih sesuai dalam persekitaran ini untuk mencapai masa menunggu yang lebih pendek untuk berkhidmat kepada pelanggan di pawagam tiket kaunter.

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LIST OF SYMBOLS

SYMBOLS	TITLE
%	Percent
A	Area
k	Density
k_c	Critical density / Decisive density
k_j	Jam density / Jam denseness
km/h	Kilometer per hour
L	Distance of road
m	Fixed point
min	Minutes
n	Vehicles
p.m	Post meridiem (after midday)
Q	Max flow
q	Flow
sec	Seconds
s	Spacing
t_1	Inverse average spacing
t_t	Overall travel time
v	Speed
w	Wave speed
x	Inverse average headway

LIST OF ABBREVIATION/ACCRONYM

ABBREVIATION	TITLE
2D	Two Dimensional Objects
3D	Three Dimensional Objects
ABS	Agent-Based Simulation
CAD	Computer-Aided Design
CDPD	Cellular Digital Packet Data
DES	Discrete Event Simulation
GM	General Motor
IDE	Integrated Development Environment
LOC	Line of Codes
OD	Origin-Destination
ODE	Ordinary Differential Equation
UMP	University Malaysia Pahang
MMI	Multilane-Multiple Intersection
S1	Scenario 1
S2	Scenario 2
S3	Scenario 3
VR	Virtual Reality

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter will talk about background and motivation, research aim and objective and scope project. The organization of the thesis will also be concluded in this chapter.

1.2 BACKGROUND AND MOTIVATION

The evolvement of information has brought about an expanding number of complex frameworks in the cutting edge world. In Operation Research (OR), recreation has turned into a favoured device for examining complex framework (Kelton et al.2007) when a logical demonstrate difficult to utilize. Recreation can mirror true issues by demonstrating a framework's conduct over a set timeframe (Banks 2000). Recreation is viewed as a choice bolster instrument which has given answers for issues in industry since the mid-1960s (Shannon 1975).

Queueing is a study of mathematical of analysing the congestions and delay of waiting in line. As a technique of managing process queueing examines every expect of waiting line that have to be served, including the arrival process, number of service that should be operation, service process, number of system, number of customer, and arrival and service patterns. Waiting in lines is part of everyday life. Real-life application of queueing theory had been implementing in various process such as, people shopping, paid bill, withdrawing or making deposit at ATM machine, and so on. For this research case study we will focus on queueing in cinema Kuantan.

As discussed in the literature review (chapter 2), modelling human queuing using DES method show some positive reaction to the approaches. But there are appear several questions that arise here:

- Queuing line in cinema during peak hour
- Modelling, analyse, and understand process of human behaviour and workflow of the queuing system.
- Identify the suitable queuing pattern to produce shortest waiting time in line cinema Kuantan Pahang.

Solving the problem statement will bring us to identify the best simulation method in modelling human behaviour. The choice of an inappropriate simulation technique could lead to an ineffective modelling process (Owen et al. 2008).

This thesis explains research work on modelling human queuing system using DES (Discrete Event Simulation). This study is to investigate the different solution of queuing problem at Kuantan cinema to apply in real-life as a result reducing waiting time for customer to get service.

1.3 RESEARCH AIM AND OBJECTIVE

This study is to investigate the different solution for queuing problem at Kuantan cinema. The idea is to provide better service by reducing the waiting time. In order to accomplish this aim, several measurable objectives must be achieved:

1. To identify the possible queuing types model
2. To develop different queuing types using discrete event simulation
3. To compare the developed queuing type models based on waiting times and no. of customer served.

As stated in the research methodology (Chapter 3), to achieve the research aim and objectives, five case studies from the service sector have been identified.

1.4 SCOPE OF PROJECT

The scope of this research is as follow:

1. Finding the potential alternatives to get the best method to optimizing performance.
2. Determine the impact of uncertainty and variability on the system performance.
3. Implement the “what-if” scenarios to evaluate proposed process changes
4. Visualize results with 2D and 3D animation.

1.5 ORGANIZATION OF THESIS

The thesis about an investigation of Kuantan Traffic Flow using DES consists of:

This thesis consists of several chapters. On this chapter (Chapter 1) explained about detail or introduction to the project by defining research problem statement, objective and project scope.

Chapter two presented the literature review of earlier face of study on the queuing theory and modelling human behaviour to pick the suitable method that can be apply in the cinema Kuantan Pahang.

In chapter three, the methodology was introduced in order to achieve the objectives on this research.

.

Chapter four present the implementation phase. From the methodology that we choose to solve case study implement it in the real situation

Chapter five defines a general end of the proposal. Next, the key of contribution and recreation in this research is granted. Lastly, the section comes up with future work around there.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will explore about research studies by other researchers on modelling human queuing at Kuantan cinema. Queues are normally found in all the system that human involve and where there exist one or more shared assets. Any framework where the client demand a service it will might be thought to be a queues system

Queuing system can also be called as system of flow. Another client enters the queue system and joins the line. During the implementation, a waiting line is created in a system because the arrival time of every client is not something that we can calculate or predict, and the time usually will not be the same for each person because each people have their own problem.

2.2 HUMAN QUEUEING SYSTEM

Research into human conduct showing is all around recorded internationally and examined in an assortment of utilization ranges. Reproduction gives off an impression of being the favoured decision as a displaying and mimicking apparatus for examining human conduct (ProModel 2010). This is on the grounds that the assorted qualities of human practices is all the more precisely delineated by the utilization of reproduction (ProModel 2010). definitions of the flow, stable, breakdown, and jam density in terms of traffic flow (Fred, 2016):

Ferber and Drogoul (1991) allude to receptive conduct as reaction sort conduct. Kendall et al. (1998) concur that receptive conduct can incorporate reactions to the adjustments in nature. Halpin and Wagner (2003) attest that: "responsive conduct might be seen as an arrangement of response examples that decide how the framework responds to occasions". To abridge, environment can be the variable to the responsive conduct of a man

2.3 TYPES OF QUEUEING

Queuing system can be single or multiple lines it depend on the service that they give and the size of the area. In a single-line queue, there is term like "short" line to beat another client everybody has an almost equivalent waiting time. They are served without preference or without lucky things by picking the speediest line. This is the reason why single line for fair in term of waiting time. Other than fairness, individual wait times in a single-line queue can be fundamentally lower than wait times of people in a multiple-line system. When you have five services and only one line, every individual is served on a first come, initially served premise. The subsequent speed of waiting time in queue and service time will be improve 30 percent compared to other queuing methodology

The benefit of using a solitary line when different servers are available is the client can be serving similarly. That is, the client is not rebuffed by picking the moderate line but instead is served taken after first-come, initially served hypothesis that when the general population start things out get administration and individuals come last get the last administration. The single-line strategy can make individuals all the more fulfilling with the reasonableness of the administration. What's more, a solitary line, different server framework is a superior methodology as far as holding up time and similarly benefits time than the same framework yet have a line for each of the server.

The multiple-line setup is fitting when particular servers are utilized or when space considerations make a single line badly arranged. For example, in a supermarket some registers are other paths for clients with a little number of things

to reduce waiting time for each queue. Utilizing express lines lessens the sitting tight time for clients making littler buys. Creates flexibility, the client has more confortable in a multiple-line queue since they get the opportunity to choose the line in which they want to stand. Giving they're not of the moving nature, having the ability to pick can make a client more satisfied in light of the fact that they've chose where they need to be and aren't feeling compelled to remain in a single line. At the point when there is one line, serpentine or straight, long or short, a client can feel caught by considered being helpless before one and only holding up choice. Different lines keep up the deception where there is more administration accessible and, in this manner, worth the waiting

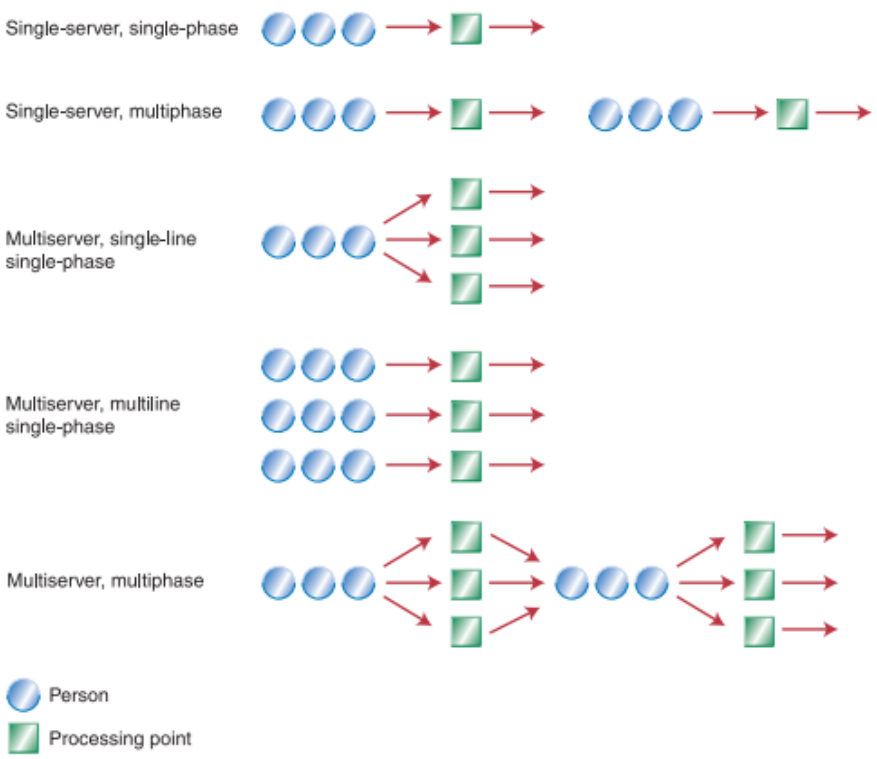

Figure 2.1: Single-Line and Multiple-Line model

2.4 QUEUEING MODELLING

Modelling is a technique for produce a solution to the problems, in which the system under study is change by a basic object that portrays the real system and/or its conduct and is known as a model. The easiest model waiting line model includes a single server, single-line, single-phase system. The presumptions are made when we show this environment:.

1. The customers are understanding (no balking, reneging, or moving) and originate from a population that can be viewed as unbounded.
2. Customer entries are depicted by a Poisson distribution with a mean arrival rate of λ (lambda). This means the time between progressive customer landings takes after an exponential distribution with a normal of 1/ λ.
3. The customer service rate is portrayed by a Poisson distribution with a mean service rate of μ (mu). This implies the service time for one client takes after an exponential distribution with a normal of 1/ μ.
4. First come first served is a rule for the waiting line.

Utilizing these assumptions, we can calculate the working qualities of waiting line system utilizing the accompanying formulas:

λ = mean arrival rate of customers (average number of customers arriving per unit of time)

μ = mean service rate (average number of customers that can be served per unit of time)

p = $\frac{\lambda}{\mu}$ = the average utilization of the system

L = $\frac{\lambda}{\mu-\lambda}$ = the average number of customers in the service system

L_Q = pL = the average number of customers waiting in line

W = $\frac{1}{\mu-\lambda}$ = the average time spent waiting in the system, including service

W_Q = pW = the average time spent waiting in line

P_n = (1 - p)p^n the probability that n customers are in the service system at a given time

Note: The service rate must be greater than the arrival rate, that is, $\mu > \lambda$. If $\mu \leq \lambda$, the waiting line would eventually grow infinitely large. Before using the formulas, check to be sure that $\mu > \lambda$.

In the single-line, multi-server, single-stage model, customers frame a single line and are served by the main server accessible. The model expect that there are s identical servers, the service time distribution for every server is exponential, and the mean service time is 1/. Utilizing these presumptions, we can portray the working attributes with the following formulas:

s = the number of servers in the system

p = $\frac{\lambda}{s\mu}$ the average utilization of the system

$P_0 = [\sum_{n=0}^{s=1} \frac{(\lambda/\mu)^n}{n!} + \frac{(\lambda/\mu)^s}{s!} (\frac{1}{1-p})]^{-1}$ = the probability that no customers are in the system

$L_Q = \frac{P_0(\lambda/\mu)^s p}{s!(1-p)^2}$ = the average number of customers waiting in line

$W_Q = \frac{L_Q}{\lambda}$ = the average time spent waiting in line

L = λW = the average number of customers in the service system

$P_n \begin{cases} \frac{(\lambda/\mu)^n}{n!} P_0 & for\ n \leq s \\ \frac{(\lambda/\mu)^n}{s!s^{n-s}} P_0 & for\ n > s \end{cases}$ = The probability n customers are in system at a given time

Note: The total service rate must be greater than the arrival rate, that is, $s\mu > \lambda$. If $s\mu \leq \lambda$, the waiting line would eventually grow infinitely large. Before using the formulas, check to be sure that $s\mu > \lambda$.

Simulation is used when do investigations on a real system would be impossible or unsuitable: for example, as a result of the high cost of prototyping and testing, or because the system easy to be damage and will not be support extensive tests, or because of the system cannot perform in real environment. We have to recognize physical and mathematical modelling. A case of a physical model is a scale duplicate of a plane in a wind tunnel.

Simulations are an uncommon class of computer based mathematical models whose conduct directed by equations and algorithms, normally information, and represented to by some kind of PC customer interface. These models mirror the behaviour of some real-world system and create theoretical outputs in view of differing info information. This permits the simulation customer to evaluate at complex conduct and situations on an extensive variety of condition significantly more rapidly and modestly than with physical systems.

One of the initial phases in building up a recreation model is making the determination for that model. A few terms are frequently utilized, for example, model formalism, metaphysics, and scientific classification. In the past the utilization of a taxonomical premise has been the standard technique for characterizing the recreation approach and for looking at option reproduction approaches. The motivation behind scientific classifications, ontologies, and formalism is to permit the reproduction designer to better portray the framework and along these lines model it. As indicated by Merriam-Webster, scientific categorization is the investigation of the general standards of experimental grouping, and is particularly the methodical arrangement of things as per their assumed characteristic connections. What's more, cosmology is worried with the nature and relations of being. It is a specific hypothesis about the way of being or the sorts of things that have presence.

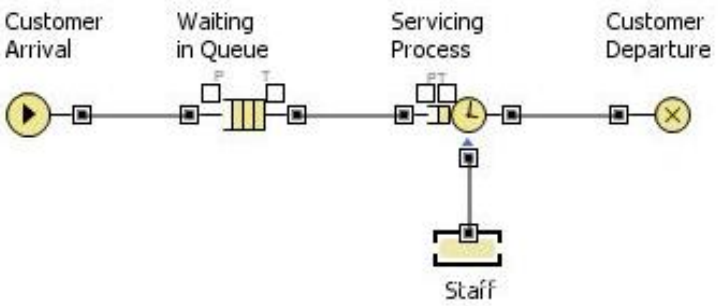

Figure 2.2: General process of queuing system.

2.5 SIMULATION

On the off chance that we allude to Borshchev and Filippov (2004) about the meaning of simulation, where they express that a reproduction model is "an arrangement of principles (i.e. conditions, flowcharts, state machines, cell automata) that characterize how the framework being displayed will change in future given in the present state." From these definitions, it can be abridge that a recreation model is produced from a numerical model that has been electronic to ensure the explored framework will be enhanced in term of comprehension. simulation models can be masterminded into three measurements estimations as showed up in Table 2.1, while Figure 2.3 demonstrates the relationship between the systematic and the reproduction models concerning this present reality issue.

Class of Simulation Models	Definition
Static vs. Dynamic	A static simulation model is a representation of a system at a particular time i.e. Monte Carlo models. A dynamic simulation model is a representation of a system that evolves over time i.e. manufacturing model
Deterministic vs. Stochastic	A deterministic model is a simulation model that does not contain any probabilistic components i.e. all patients arrived at the scheduled appointment time in a hospital. A stochastic model is a simulation model that operates by having at least some random components i.e. simulation of a bank involves random inter-arrival times and random service times.
Continuous vs. Discrete	A continuous model is one in which the state variable(s) change continuously over time i.e. the flow of water into the lake behind a dam. A discrete model is one in which the state variable(s) change only at discrete set of points in time i.e. the check in services at an airport.

Table 2.1: Class of Simulation Models

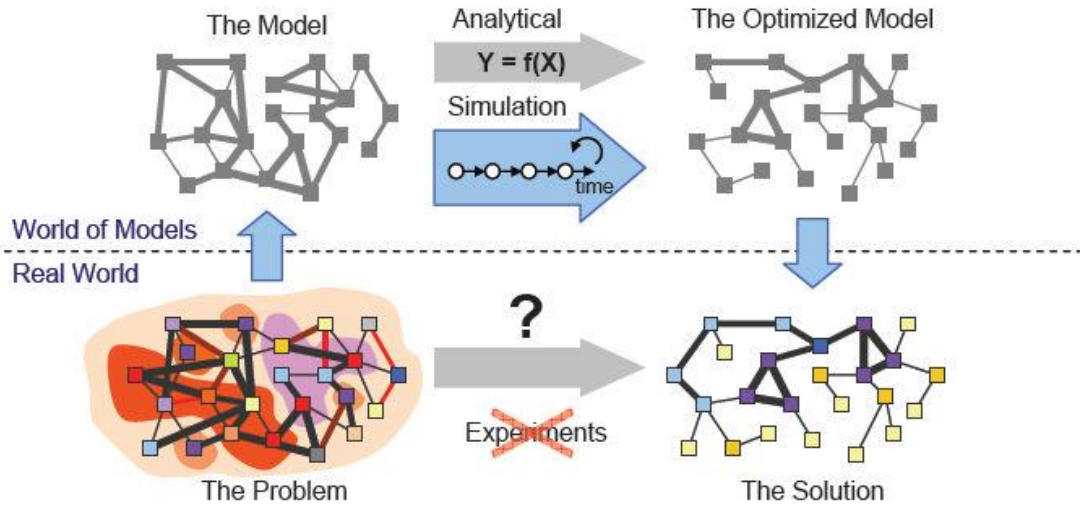

Figure 2.3: Analytical (static) and simulation (dynamic) modelling (Borshchevand Filippov 2004)

2.5.1 TYPE OF SIMULATION

There are three major methodologies used to create dynamic business recreation models: System Dynamics (SD), Process- centric ("Discrete Event", DE) modelling, and Agent Based modelling (AB). The initial two were produced in the 1950s and 1960s and both utilize a system level (top-down) perspective of things. The agent based approach, a later improvement, is a base up methodology where the modeller concentrates on the conduct of the individual articles.

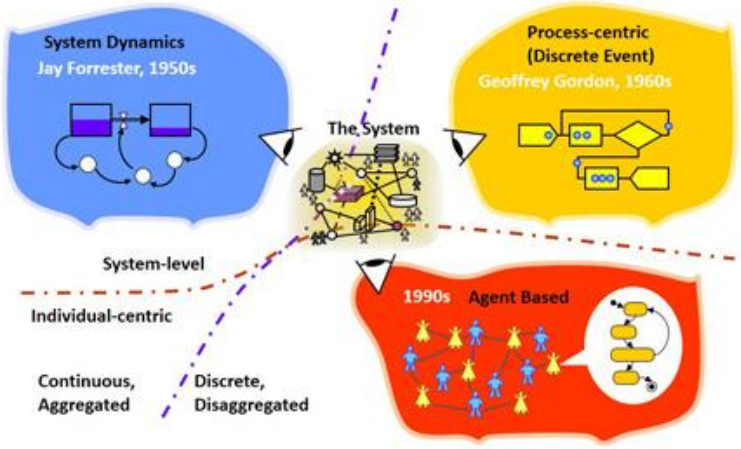

Figure 2.4: Type of Simulation.

2.5.2 AGENT BASED MODELLING (ABM)

One of type of simulation is Agent Based Modelling (ABM). Agent Based Simulation (ABS) is another worldview among simulation methods and has been utilized for various applications in the most recent couple of years. Although the fact that you can locate various different meanings of Agent Based Modelling (ABM) in the writing, from the perspective of practical applications operator based demonstrating can be characterized as a basically decentralized, individual-driven (instead of framework level) way to deal with model outline. At the point when outlining an agent based model the agent can be assets, product, people, project , etc.

Identify they reaction or behaviour, places them in a specific situation and deploy the simulation. Result will be validating as an interaction of many individual behaviour. AnyLogic underpins Agent Based modelling (and in addition Discrete Event and System Dynamics Modelling) and permits you to productively consolidate it with other demonstrating approaches

The configuration of ABS depends on counterfeit consciousness utilizing the idea of mechanical autonomy and multi-operator frameworks (MAS) (Macal and North 2005). A MAS comprises of various specialists which interface with each other in the same environment (Wooldridge 2002); to get their requirements each of the operator has turned out with their own methodology.

2.5.3 SYSTEM DYNAMIC

System Dynamic Simulation (SDS) is a conventional simulation technique which was produced in the mid - 1950s (Sterman 2000). Jay Forrester, the author of SDS, characterized it as "the investigation of data criticism normal for mechanical movement to show how authoritative structure, intensification (in strategies) and time delay (in choice and activity) associate to impact the achievement of big business" (Forrester 1958). System Dynamic is a methodology release for understanding dynamic characteristic in complex system. If this level of abstraction

is suitable for your issue, SD might be the right strategy to utilize. However if singular points of interest are important, you can simply re-conceptualize all or a portion of your model utilizing Agent Based or Discrete Event strategies while never leaving the AnyLogic environment.

. "System dynamics is a point of view and set of reasonable apparatuses that empower us to comprehend the structure and flow of complex system. System dynamics is additionally a thorough demonstrating strategy that empowers us to fabricate formal PC simulation of complex system and use them to plan more powerful approaches and associations. Together, these devices permit us to make administration pilot training programs micro worlds where space and time can be compacted and hindered so we can encounter the long haul symptoms of choices, pace learning, build up our comprehension of complex frameworks, and configuration structures and methodologies for more noteworthy accomplishment." From John Sterman, "Business Dynamics: Systems Thinking and Modeling for a Complex World"

2.5.4 DISCRETE EVENT SIMULATION

DES is one of the better referred to simulation sorts as it has been utilized following the 1950s (Robinson 1994; Hollocks 2004). DES is a dynamic, stochastic and discrete simulation strategy (Banks et al. 2005). In DES, simulation time assumes a critical part (dynamic model) and DES is a stochastic model as it comprises of irregular information segments. What's more, DES is discrete on the grounds that it displays a framework in which the condition of substances in the framework changes at a discrete time (Carson 2003).

The extraordinary majority part of procedures we see on the world comprise of consistent changes. Be that as it may, when we attempt to dissect these procedures it regularly bodes well to isolate a consistent procedure into discrete parts to improve the investigation. Discrete Event Modelling techniques approximate continuous real world procedures with non-nonstop occasions that you characterize.

In discrete event modelling the development of a train from point A to point B would be demonstrated with two occasions, to be specific a departure event and a landing event. The real development of the train would be demonstrated as a period delay (interim) between the departure and entry event. This doesn't mean however that you can't demonstrate the train as moving. In this research the best and the suitable methodology that will be used for modelling human queue at Kuantan cinema is Discrete Event Simulation.

2.6 DISCRETE EVENT SIMULATION IN QUEUING MODEL

Early days in the 1950 and 1960, the evolution in traffic simulation has been extraordinary. It is linked to transformation of technology and devices of programming. This is because during this 50-year period, the exploration in traffic and transportation has moving forward. Thus, simulation is an instrument for professionals and specialists in all fields of the profession from now an everyday.

Author	Research Title	Queuing Model	Software
L.M. Kisiel, , A. Jones-Bitton, A.L. Greer	Agent-based models to identify and evaluate dog population management strategies	Agent-based models	AnyLogic
Shady S. Atallah, Miguel I. Gómez, Jon M. Conrad, And Jan P. Nyrop	A Plant-Level, Spatial, Bioeconomic Model Of Plant Disease Diffusion And Control: Grapevine Leafroll Disease	Agent-based models	AnyLogic(XJ Technologies)
Mihir Paithane	The Effect of Cellular Interactions on Cancer Cell Growth Using Evolutionary Game Theory	Agent-based models	AnyLogic

E. Zankoul, H. Khoury, R. Awwad	Evaluation of Agent-Based and Discrete-Event Simulation for Modeling Construction Earthmoving Operations	Agent-based and Discrete-Event simulation models	AnyLogic

Table 2.2 Other Research about Simulation Model

2.7 CONCLUSION

In conclusion, DES is being chosen as the most suitable methodology or analysis approach to develop modelling human queue simulation. This is because queue simulation can conduct significantly to various programs that using DES. It can be observed from the study of DES that the module target require more reasonable and descriptions that are precise are more suitable for this research. Other than that, to model a queuing system, DES was the most appropriate and often used because it is originally based on queuing theory.

. Chapter 3 will introduces more about methodology of DES simulation on traffic flow.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

In this chapter, the exploration system utilized for each of the contextual analyses is quickly talked about in the accompanying grouping: contextual investigation portrayal, calculated model improvement, model usage, check and acceptance, experimentation and result examination. The conclusion that can be made as a consequence of utilizing this exploration technique is examined toward the end of the part.

3.2 CASE STUDIES DESCRIPTION

In order to solve queuing problem at Kuantan cinema by identify the most suitable type of queue to implement it in real environment, it is necessary to carry out case studies which give a data to us for evaluate the implementation. Thus, the service sector is targeted, focusing on customer-service processes which are rich in human behaviour, with both entities and resources being human (Tumay 1996).

Discrete Event Simulation (DES) is a dynamic model of a real dynamic system for the reason both of understanding the pattern of the system or of evaluating different strategies for the control of the system operation. The quality of DES solutions is their capacity to impersonate the elements of complex structure and conduct of real system. Many models, including advanced enhancement models, cannot consider the dynamic of a real system. It is the ability to copy the flow of the

real system that gives Discrete Event Simulation it is one of a kind approach to analyse obtained results.

One of a key aim of this thesis is to develop different queuing type using discrete event simulation based on waiting time and no. of customer served to improve productivity of the Kuantan cinema. There are two type of waiting line systems, single and multiple waiting line that have been implement in other places depending on the type or service that they provide and size of the area in that place.

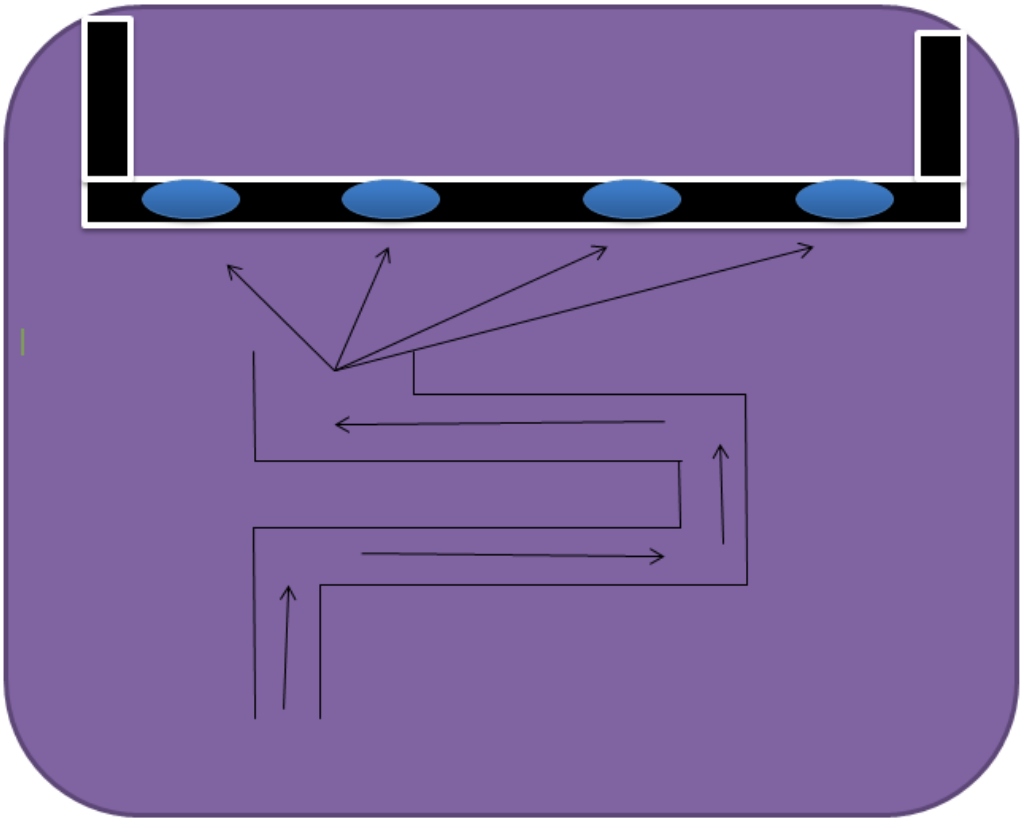

Figure 3.1 : illustration of queue operation in ECM Kuantan cinema

Figure above is illustration of the queueing system that had been implemented in ECM Kuantan cinema. Four counter service provided and single line for customer queue to buy a ticker cinema. All customer arrive need to queue first in the single line before get any services, they cannot choose which counter they want to go because each counter provide same services. The environment and area of the cinema force the queue system to be single line and multi-services.

Following the information accumulation process, information is broke down for use in the connected model and model building. Part of the data information system is to choose the landing example of the customer in each of the contextual investigations, by selecting proper quantifiable dispersions and parameters. Chapter 4, 5 and 6 give a separated trade of each contextual analysis.

3.3 CONCEPTUAL MODEL DEVELOPMENT

In view of the two contextual investigations, two same central calculated models are made for DES, speaking to the expansion and level (Robinson 1994) of the framework under scrutiny. The thought for a DES model is created, speaking to the crucial technique process stream (process-arranged strategy) of the three logical examinations operation (a complex lining framework) using a stream diagram.

In the fundamental process flow, the human practices (responsive and proactive) are included request to show where the practices happened. Stream diagrams are utilized to speak to DES theoretical models since DES concentrates on procedure streams. In addition, the individual-centric methodology is created utilizing state chart. State graphs demonstrate the conceivable distinctive conditions of a substance and characterize the occasions that bring about a move starting with one state then onto the next. Part 4, 5 and 6 talk about further points of interest of theoretical models for every case study.

3.4 MODEL IMPLEMENTATION, VERIFICATION, AND VALIDATION

Simulation models are assembled once the extension and level of single line models and multi-line models have been determined. Figure 3.1 layouts the steps grasped for model usage and approval process. To collect reproduction models, AnyLogic™ 6.5 Educational variation (XJTechnologies 2010) is used, because of the capacity of the item to make DES models in one device. Once the recreation programming has been picked, the accompanying stage is to build and program the Simulation model.

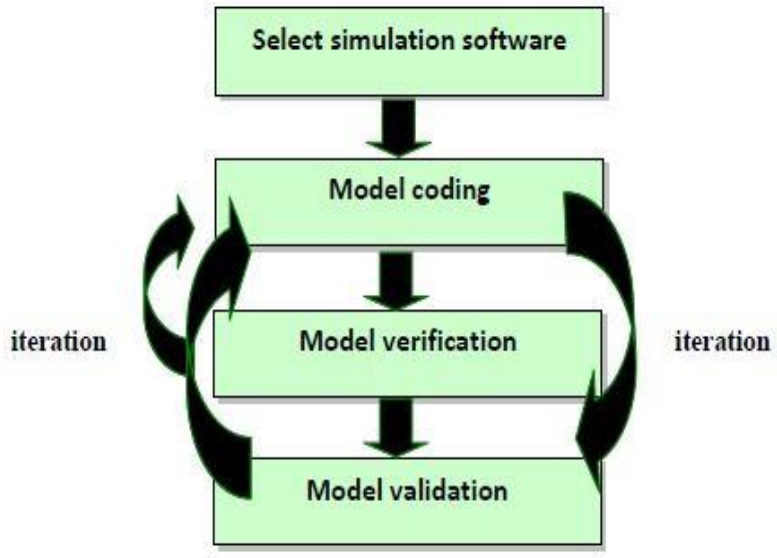

Figure 3.2 : The model implementation, verification and validation process flow

Alongside the improvement of the single-line and multiple-line models, the verification and validation procedures are performed with a specific end goal to create great representation of true service systems. Confirmation goes for testing the PC based model against the applied model. Check is performed to show that all parts of the model can work precisely. The model was affirmed through making little strides, every one thusly and guaranteeing that the completed stride was working honourably before continuing with the accompanying stride.

The acceptance method was directed to investigate the precision of the model when contrasted and the genuine framework. To do all things considered, the ordinary number of clients was picked as the measure of model legitimacy. In such manner, the genuine ordinary number of clients touched base at framework amid 5 working days was contrasted and the typical number of clients procured in 5 cycles of the simulation display .The conventional examination between these two qualities exhibits a commendable difference (3.7%) which sets up the legitimacy of the mimicked model.

A more detailed discussion on these model implementation and validation processes is provided in Chapters 4, 5 and 6.

3.5 EXPERIMENTATION

Two arrangements of experiments are done for every situation study with a specific end goal to accomplish the exploration destinations. The research method utilized is a quantitative research methodology of infinite single-line queue and multiple-line queue. Existing models of single-line and multi-line technique were produced to investigation the single-line and multiple-line queuing system of ECM cinema in Kuantan Pahang. At the point when such issues are defined as far as a queuing model, the relating choice variables generally are s (number of servers at each facility), μ (mean service rate per busy server) and ʎ (mean arrival rate at each facility). Utilizing these presumptions, we can portray the working attributes with the following formulas for both single-line and multiple-line:

s = the number of servers in the system

p = $\frac{\lambda}{s\mu}$ the average utilization of the system

$P_0 = [\sum_{n=0}^{s=1} \frac{(\lambda/\mu)^n}{n!} + \frac{(\lambda/\mu)^s}{s!} (\frac{1}{1-p})]^{-1}$ = the probability that no customers are in the system

$L_Q = \frac{P_0(\lambda/\mu)^s p}{s!(1-p)^2}$ = the average number of customers waiting in line

$W_Q = \frac{L_Q}{\lambda}$ = the average time spent waiting in line

L = λW = the average number of customers in the service system

$P_n \begin{cases} \frac{(\lambda/\mu)^n}{n!} P_0 & for\ n \leq s \\ \frac{(\lambda/\mu)^n}{s!s^{n-s}} P_0 & for\ n > s \end{cases}$ = The probability n customers are in system at a given time

The purpose for the model result and model inconvenience tests is to analyze the execution of the lining line and holding up time to get the administration when demonstrating human conduct in both single-line and various line. Before directing trials, it is critical to perceive comparative execution measures for single-line and numerous line models. The execution measures are the key pointer of the execution of the reproduction models amid the experimentation stages. Four guideline

execution measures are perceived for all trial: holding up time, staff utilization, the amounts of clients served and not served. These four measures are gotten in light of the fact that they are the most comparable and among the most imperative in the administration arranged frameworks (Robert and Peter 2004)..

3.6 CHAPTER SUMMARY

In conclusion, Chapter 3, which is research methodology used to describe the case study of ECM cinema , Kuantan, Pahang briefly. From the case study, three types of scenarios are carried on to form Model 1, Model 2, and Model 3 are distressed comparing result of simulation and obstacle in modelling DES. The results between Model 1 will be compared with Model 2 and Model 3 in the next chapter.

CHAPTER 4

IMPLEMENTATION AND DISCUSSION

4.1 INTRODUCTION

In this study, execute to identify modelling human queuing in ECM cinema at Kuantan Pahang, is presented in this chapter. The actual scenario of pattern queueing system that they implemented which is single line multi services are clarify and an experimentation is run into how these queueing system effect the simulation model.

The chapter begins with an explanation of the case study and goes a head the build of conceptual modelling based on case study. DES model development has been utilized to verify and validate the case study. At that point the three sets of conducted experiment identify result of the model and level of difficulty are described and discussed. Lastly, all collected result will be exanimate and present.

4.2 IMPLEMENTATION OF SIMULATION MODELS

The development of conceptual models for case study 1 are as portrayed in chapter 3. All the model build using DES method and same basic conceptual model and the environment to implementation of both simulation model is different. The advancement for DES show starts by building up the fundamental procedure stream of the fitting room operation. At that point, the examined human practices (responsive and proactive) are added to the fundamental procedure stream with a specific end goal to show where the practices happened in the queue operation Kuantan cinema.

The operation in the queue line begins when clients land at the cinema and queue to get a service. In the event counter that are not accessible or staff are busy, the arriving customers will hold up in the line until they are served. If the counter is in active, the staff will respond to the waiting customers by serve them one by one. In single line of queue, customer will go randomly to the counter that already finish serve other customer before and the process will keep going until there is no customer in the line.

4.3 EXPERIMENTATION

In this experimentation verification and validation process is performed at the same time with development of the basic simulation models for Discrete Event Simulation (DES). The verification processes are examined. Two type of validation process are performed: black box and sensitivity analysis validations.

The black box validation has been utilized for the primary validation process in which the simulation result from all three simulation models are compared with the real operation output in term of quantities. Statistical test has been use for this validation. Standard parametric statistical test – T-test is picked because of the central limit theorem. Such theorem state that the distribution of the mean of the picked number of runs(100) is more likely than not ordinary.

The use of T-test prompts to the assumption that all comparative measures. For example, customer waiting time, staff utilisation, number of customer served and so on. All that can receive in this review are regularly appropriated

The customer waiting time and utilisation of staff serving are chosen as the execution measure since the historic data of both measures is available to perform this test.

4.3.1 Model Implementation, Verification, and Validation (Scenario 1)

In this chapter, case study will be the main focuses and more specific on operations in buy ticket for watch cinema at ECM Kuantan Pahang. The scenario was selected as a result of collaboration with stuff at ECM Kuantan cinema. It is to collect more information about the queuing system that Kuantan cinema implemented and observation of staff and customer and problem that maybe occur in the system.

Figure 3.1 (see at chapter 3) illustrates the actual operation at Kuantan cinema ticket counter, the arrow represents the queue customer to buy ticket cinema and there is four services for customer to buy ticket, which shows the type of queue system single queue and multi-serve. The operation in counter ticket cinema begin when customer start arrive at the one of the counter. If the four counter busy with customer to buy ticket, other customer need to queue in single line waiting which counter finish first.

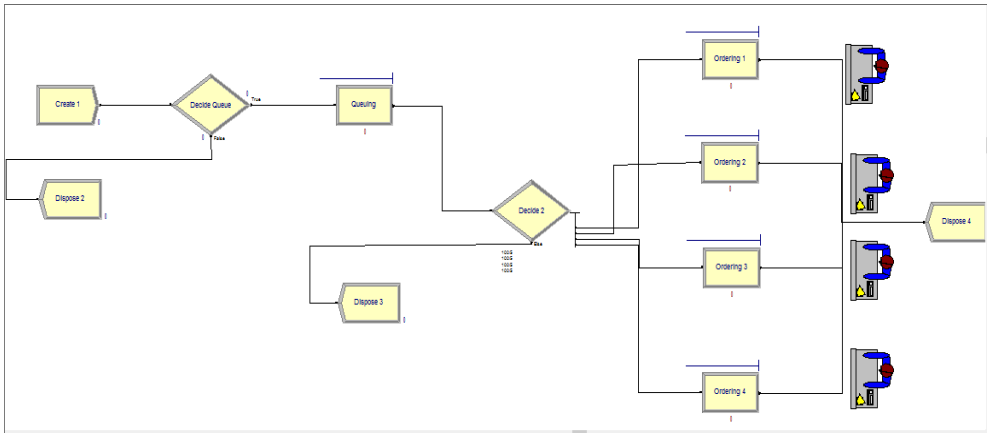

Figure 4.1: Flowchart of queue operation in ECM Kuantan cinema.

Figure 4.1 show the queue operation at ECM Kuantan cinema ticket using arena simulation software. In the flowchart the operation is start with create 1 and set up the customer arrangement, maximum and minimum number customer that arrive and speed of the operation. The decide queue process will determine the behaviour of the customer to go to the queue or wait outside queue and end the process. Another

decide process which is decide 2 for customer to wait for the counter to be free and get the services or decide to go out from the queue and end the process.

Simulation models make use of model input parameter values as described as following:-

- Customer

Based on observation real system in arrival process of customer, the arrival rate is calculated. In simulation model the arrival rate is using random exponential distribution with a minutely changing arrival rate with arrival rate shown in Table 4.1. The data in the table has been use because it same with real data arrival pattern.

Time	Rate
9.00 – 10.00am	Approximately 10 people per hour
10.00 – 11.00am	Approximately 40 people per hour
11.00 – 12.00pm	Approximately 40 people per hour
12.00 – 1.00 pm	Approximately 60 people per hour
1.00 – 2.00 pm	Approximately 60 people per hour
2.00 – 3.00 pm	Approximately 43 people per hour
3.00 – 4.00 pm	Approximately 43 people per hour
4.00 – 5.00 pm	Approximately 30 people per hour

Table 4.1: Customer arrival rate

- Counter

In the simulation model, counter for services is named as Ordering. There are four counter(Ordering 1, Ordering 2, Ordering 3, Ordering 4) that mean in the cinema 4 counter is active all the time. The entire counter provides same services for customer to buy ticket to enter the cinema. Task priority is allocated on a first in first out basis. Table 4.2 shown the service time used to represent the task execution time of staff in DES model. The service times are present in minute and using triangle distributions are used to represent the service time in this model.

Service Time Parameters	Value
Ordering(Ordering 1,2,3)	Minimum:5,Mode:10,Maximum:15

Table 4.2: counter ordering service time

- Queue

The queue line is model using triangle distribution and minute as a unit in model. The priority of the model stated as medium that mean the queue line is an choose for customer to take in the queue o just wait outside queue. The parameter of the queue show in Table 4.3.

Delay Time Parameters	Value
Queueing	Minimum:1,Mode:5.67,Maximum:13

Table 4.3: Queueing time parameters

4.3.2 Model Implementation, Verification, and Validation (Scenario 2)

Figure 4.2 illustrate the flowchart of queue operation for the next scenario using arena simulation software. This is scenario two for queue system in ECM Kuantan cinema. This model for normal situation when not many customers come to buy a ticket cinema or there no new movie comes out, not all counter will be active. In the flowchart the operation is also start with create 1 where the customer properties are being set up.

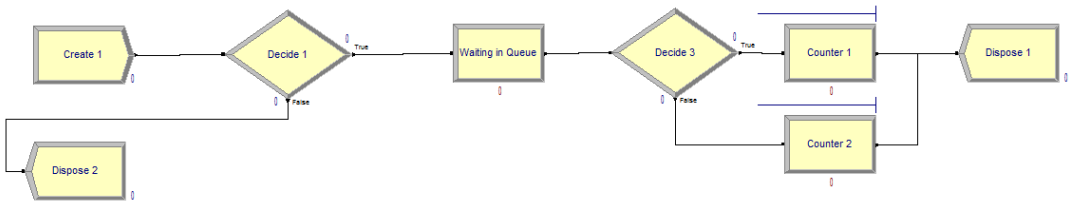

Figure 4.2: Flowchart of another scenario queue operation in ECM Kuantan cinema.

The flowchart scenario two shown that, the flow of queue operation for real scenario is the same as scenario 1, the flow of the queue system still using single queue and multi-service but the different is there only two counter that active for customer to get service. Simulation models make use of model input parameter values as described as following:-

- Counter

In this simulation model, there only two counter for customer to buy ticket in cinema. Chance for services to be busy is 50% because of only two active counter for daily routine. The service times are present in minute and using triangle distributions are used to represent the service time in this model.

Service Time Parameters	Value
Counter(Counter 1,2)	Minimum:5,Mode:10,Maximum:15

Table 4.4: service ordering service time

- Queue

The queue line in scenario two is design using single queue and multi-service same as scenario one, but the different is situation in scenario two that the customer arrival time is lower than arrival time in scenario one. In the cinema arrival time will influent by new movies and holiday. The parameter of the queue show in Table 4.5.

Delay Time Parameters	Value
Queueing	Minimum:1,Mode:5.67,Maximum:13

Table 4.5: Queueing time parameters (scenario two)

4.3.3 Model Implementation, Verification, and Validation (Scenario 3)

Figure 4.3 display that the flowchart of queue operation for the next scenario which is scenario 3 using arena simulation software. This show scenario 3 uses the different type of queue system. This is not being implemented in the real case study. Every counter has their own queue line, four line for customer to queue and before

take a line customer can choose queue line that they desire. In the flowchart the operation is also start with create 1 where the customer properties are being set up.

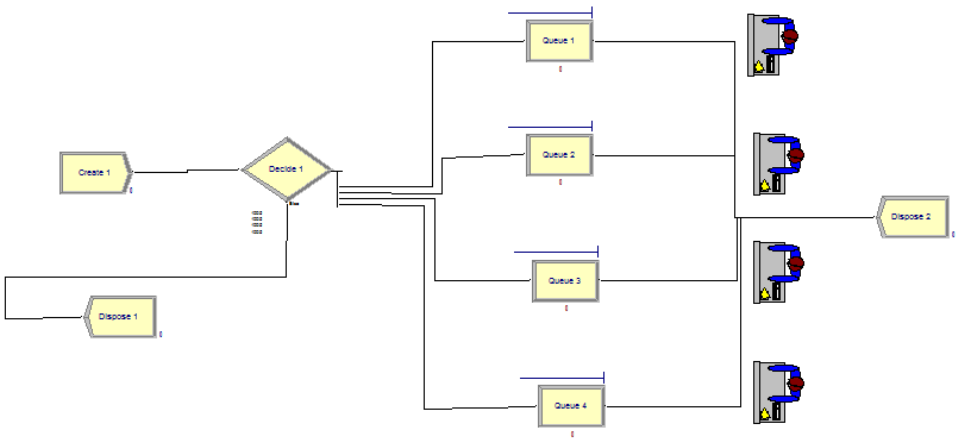

Figure 4.3: Flowchart of scenario 3 queue operation in ECM Kuantan cinema.

Operation of queue system using other type of queue system that is multi-queue. In multi-queue, four counter and four line of queue provided and the operation begin with when customer arrive in the cinema they can choose with queue line that customer want to enter. This type of queue has some phycology advantages for customer. Customer can enter the queue that not many people in it and feel waiting time shorter than other queue line. Simulation models make use of model input parameter values as described as following:-

- Queue

The queue line in scenario three is build using multi-queue and multi-service, the process in queue make the action seize delay release in every process queue so it will form a queue line and the waiting time will be measure. But the different is situation in scenario three, customer waiting time will be different for each line of queue. The parameter of the queue show in Table 4.5.

Delay Time Parameters	Value
Queueing(1, 2, 3, 4)	Minimum:5,Mode:10,Maximum:15

Table 4.6: Queueing time parameters (scenario three)

Scenario	Average Waiting Time (min)	Average Staff Utilize (min)
Scenario 1	82.65	49.5

Table 4.7 Scenario 1 average waiting time and staff utilize in unit minute

Scenario 1	Average Waiting Time (min)	Average Staff Utilize (min)	Average no. customer serve (people)
Queue	75.06	-	100
Counter 1	4.00	60	31
Counter 2	2.00	26	13
Counter 3	3.00	50	25
Counter 4	4.00	60	31

Table 4.8 Scenario 1 average waiting time, staffs utilize and number of customer serves in each of process

Scenario	Average Waiting Time (min)	Average Staff Utilize (min)
Scenario 2	90.43	60.21

Table 4.9 Scenario 2 average waiting time and staff utilize in unit minute

Scenario 2	Average Waiting Time (min)	Average Staff Utilize (min)	Average no. customer serve (people)
Queue	30.5	-	100
Counter 1	2.57	65	43
Counter 2	8.10	80	57

Table 4.10 Scenario 2 average waiting time, staffs utilize and number of customer serves in each of process

Scenario	Average Waiting Time (min)	Average Staff Utilize (min)
Scenario 3	60.8	48.5

Table 4.11 Scenario 3 average waiting time and staff utilize in unit minute

Scenario 3	Average Waiting Time (min)	Average Staff Utilize (min)	Average no. customer serve (people)
Counter 1	3.1	55	31
Counter 2	1.0	26	13
Counter 3	2.2	30	25
Counter 4	3.1	55	31

Table 4.12 Scenario 3 average waiting time, staffs utilize and number of customer serves in each of process

In the table above shows that, the result of the simulation process using arena simulation for all scenario that take place in this investigation which is real scenario and two suggested operation that want to implement in the real world for improving the service in ECM Kuantan cinema. There are average waiting time, staff utilize and no of customer for each of the counter. From the data in the tables above, we can do comparison to collect the result for the best operation in queue system for the cinema, between the scenario one and scenario two or scenario one and scenario three

First is comparison between scenario one and two. As the tables shown, average waiting time for 100 customer come to cinema in scenario 1 is 82.64 minute and average staff utilisation is 49.5 minute. For scenario 2 average waiting times for 100 customers is 90.43 minute and average staff utilisation is 51.21. Scenario one is more way better in term of waiting time compare to scenario two, but in staff utilisation there is not huge different between this two scenario even though scenario two only has two counter service. So, scenario one is more better than scenario two because the priority more to waiting time to serve the customer.

Next is comparison between scenario one and three. In the table shown, Average waiting time for scenario three is 60.8 minute and average staff utilisation is 48.5. Scenario three has better operation queue system compare to scenario one because, type of queue system multi-line and multi service give an advantage in waiting time. Average waiting time and staff utilisation for scenario three is lower

than scenario one, this is mean that customer need to wait in short amount of time to buy a cinema ticket.

4.4 DISCUSSION AND CHAPTER SUMMARY

As the conclusion for this chapter, refer to the result that has been collected using arena simulation software and visit the ECM Kuantan cinema. Scenario two has the better queue system for the cinema to upgrade the service oriented process and make the customer satisfy with the service that provided for them and improve the quality of the queueing system. Scenario two using multi-line and multi-service, that mean in each counter have their own queue line and customer have right to choose their desire queue to be serve in the counter. In the result of comparison shown, scenario two has low in average waiting time and staff utilisation compare to scenario one and two that can make the conclusion for this chapter that the better queue system is scenario two.

CHAPTER 5

CONCLUSION

5.1 INTRODUCTION

In this chapter there will be discussion on the whole operation of modelling human queueing system in ECM Kuantan cinema. All the collected data will be tested and all the result will be discuss and compare. Case study 1, execute to identify modelling human queuing in ECM cinema at Kuantan Pahang, is presented in this chapter. The actual scenario of pattern queueing system that they implemented which is single line multi services are clarify and an experimentation is run into how these queueing system effect the simulation model.

5.2 RECAP OF STUDY

The objective of this thesis is to identify the possible type model that can be implemented in the real situation at cinema. Second objective is to develop different queueing types using Discrete Event Simulation and the third is compare the developed queueing type models based on waiting times and no. of customer served. To achieve these objective three case studies has been conducted to perform evaluation and get the data. From the final result, comparison will be the way to observe the better queue system to be implemented in the Kuantan cinema. Comparison between average waiting time and no of customer serve in minute for all three scenarios, it will be the match to check which of this three scenario will be the better queue system that can be use in Kuantan cinema.

5.3 CONTRIBUTION OF STUDY

The comparison of the type queue system modelling is the main point contribution to simulation and operational research. Information of this comparison is valuable for the simulation users as it is vital they have some understanding of the modelling queue system in DES and know how to implement the best type of the queue depend on environment and situation. With the expectation of different queue operation model correlation, a great choice of simulation model can be made for solving the problem they have identified.

The research move further in the presentation and inform the benefit of using the right queue system as it provides a big impact to the real situation and also simulation result to be show from the investigate problem. Furthermore, in this research show more detail in each type of queue model and the best situation to implement it and also discuss about similarity and dissimilarities between single line multi-server and multi-line single server. This understanding is fundamental as it uncovers the advantages and the weaknesses of both simulation models identifying with the issue under investigation.

5.4 LIMITATIONS

The scope of the comparison is limited to research study in modelling human queue system using method DES. There are two type of the model queue can be implement in this case study. In addition, this comparison to understand the situation and environment of service-oriented system and only focus on the DES method to build the model.

Besides that, the limitation in this research is resources that being used in this investigation. In this study arena simulation is use to model the queue system and tests the result for comparison. The features and tools have some limitation in term of modelling and complexity.

5.5 FUTURE RESEARCH

This final section presents suggestions for future work to address the limitation of this study, as introduced in previous section above. This including some improvement idea the validity of the comparison result from the model outcome and model problem investigations.

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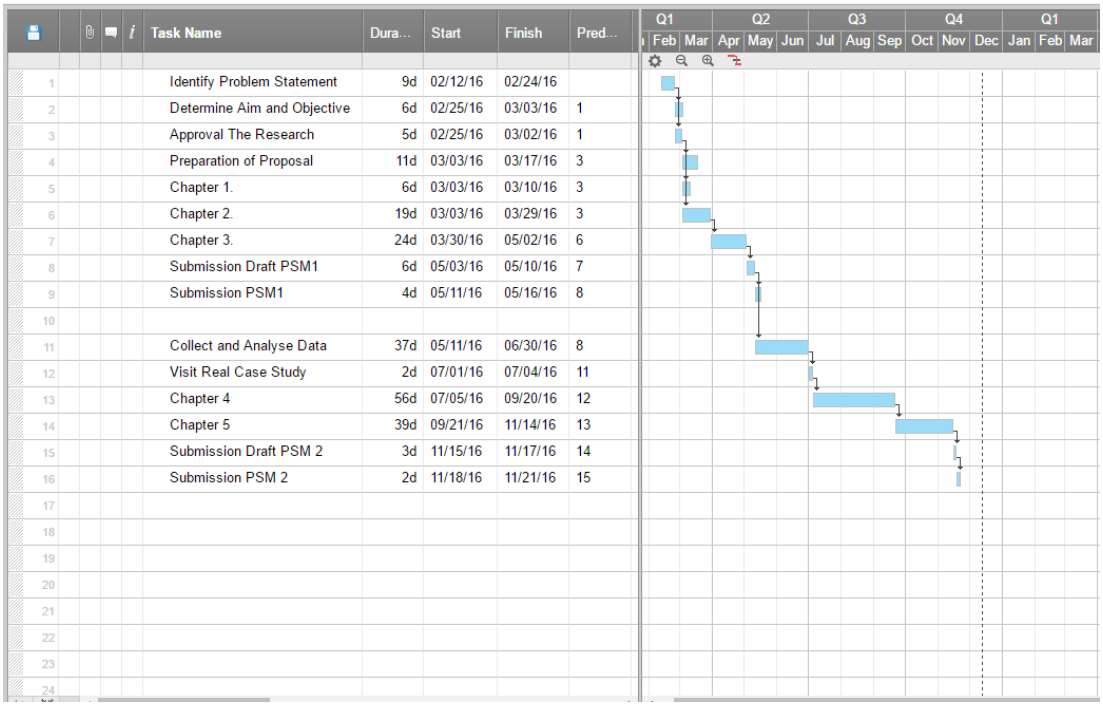
APPENDIX A



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1	Identify Problem Statement	9d	02/12/16	02/24/16	
2	Determine Aim and Objective	6d	02/25/16	03/03/16	1
3	Approval The Research	5d	02/25/16	03/02/16	1
4	Preparation of Proposal	11d	03/03/16	03/17/16	3
5	Chapter 1.	6d	03/03/16	03/10/16	3
6	Chapter 2.	19d	03/03/16	03/29/16	3
7	Chapter 3.	24d	03/30/16	05/02/16	6
8	Submission Draft PSM1	6d	05/03/16	05/10/16	7
9	Submission PSM1	4d	05/11/16	05/16/16	8
10					
11	Collect and Analyse Data	37d	05/11/16	06/30/16	8
12	Visit Real Case Study	2d	07/01/16	07/04/16	11
13	Chapter 4	56d	07/05/16	09/20/16	12
14	Chapter 5	39d	09/21/16	11/14/16	13
15	Submission Draft PSM 2	3d	11/15/16	11/17/16	14
16	Submission PSM 2	2d	11/18/16	11/21/16	15
17					
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Appendix A: Gantt chart