SIMULATION MODEL TO IMPROVE THE SERVICE TIME AT GAMBANG CLINIC

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SUPERVISOR'S DECLARATION

"I hereby declare that i have checked this project report and in my opinion this report is adequate and satisfactory in term of scope and quality for the award of the degree of Bachelor of Industrial Technology Management with Honour".

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STUDENT'S DECLARATION

"I hereby declared that this project report is the result of my own research except as cited in the references. This report has not been accepted for any degree and is not concurrently submitted for award of other degree".

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DEDICATION

This thesis is dedicated to my parents and my friends who support me all the way during completing my study. They give me strength and encourage me to finish this report. I also would like to dedicate this thesis to my supervisors, Dr. Ali Asghar Jomah Adham who give me a lot of ideas, advice and suggestion throughout my study. Without their patience, sacrifices throughout this process, this thesis would not have been possible.

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ABSTARCT

The aim of this research is to improve the service time in the clinic. The service time in the clinic are important and depend to number of the patient that the clinic had in a day. A simulation of a system is the operation of a model of the system. The operation of the model can be studied, properties concerning the behaviour of the actual system or its subsystem that can be inferred. In its broadest sense, simulation is a tool to evaluate the performance of a system, existing proposed, under different configurations of interest and over long periods of real time. By using the simulation, the actual output is appears and it can be improved the system by using Arena software. Therefore, the important part in service time in the clinic is the queuing duration along the process in the clinic. Moreover, the Arena software can analyze the actual system and it can be modified to be more successful system. The objectives of this study are to improve the efficiency of the service time, to analyze system and working process, and to decrease the patient waiting duration. Furthermore, the result shows that by using Arena simulation, the service time at the clinic can be improved.

ABSTRAK

Tujuan kajian ini adalah untuk meningkatkan masa perkhidmatan di klinik. Masa perkhidmatan di klinik adalah penting dan bergantung kepada beberapa pesakit bahawa klinik itu ada dalam sehari. Simulasi sistem adalah pengendalian model sistem. Operasi model yang boleh dikaji , sifat-sifat yang berkaitan dengan tingkah laku sistem sebenar atau subsistem yang yang boleh disimpulkan . Dalam makna yang lebih luas , simulasi adalah alat untuk menilai prestasi sistem, sedia ada dicadangkan , di bawah konfigurasi yang berbeza kepentingan dan dalam tempoh yang panjang masa sebenar . Dengan menggunakan simulasi , masa sebenar adalah muncul dan ia boleh diperbaiki sistem dengan menggunakan perisian Arena . Oleh itu , bahagian yang penting dalam masa perkhidmatan di klinik adalah tempoh beratur di sepanjang proses di klinik. Selain itu , perisian Arena boleh menganalisis sistem yang sebenar dan ia boleh diubah suai untuk menjadi sistem yang lebih berjaya . Objektif kajian ini adalah untuk meningkatkan kecekapan masa perkhidmatan, untuk menganalisis sistem dan proses kerja , dan untuk mengurangkan tempoh menunggu pesakit . Tambahan pula , hasilnya menunjukkan bahawa dengan menggunakan simulasi Arena , masa perkhidmatan di klinik yang boleh diperbaiki.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

A simulation of a system is the operation of a model of the system. The operation of the model can be studied, properties concerning the behavior of the actual system or its subsystem that can be inferred. In its broadest sense, simulation is a tool to evaluate the performance of a system, existing proposed, under different configurations of interest and over long periods of real time. Simulation modeling has been used in a wide range of physical and social sciences and engineering fields. For different types of situations and systems, different types of models are used. In classifying simulations, there are important distinctions among the types of models that are being simulated, and among the types of program structures that are used to carry out the simulation.

Furthermore, there are many benefits of using the simulation model such as it can be used to compress a time frame, a simulation model run on a computer system can be used to investigate quickly the effects of a change in a real life situation that take place over several years. It also can be used to study complex systems that would otherwise be difficult to investigate. Moreover, it can be used in engineering and product design to investigate the effect of changes without producing a physical prototype. Then, it can be used to investigate situation that would be dangerous in real life.

There are a variety of techniques available today that can be applied for the analysis of existing systems. Presently, the simulation approach is the popular technique used in the management of healthcare. Simulation has been applied successfully in many different areas such as manufacturing, system services, medical sector, transportation, supply chain and so on. In addition, simulation approach is one of the best techniques for decision-makers to review, analyze and evaluate any operating systems from the simplest to the most complex condition to be solved.

Therefore, the simulation model is the best method that should use to improve the service time at clinic. Clinic is the most important place for the patients to get their treatment. In University Malaysia Pahang, there have one clinic that gives services to the staff and students. The clinic receives a quite large numbers of patients every day, so the clinic becomes full mostly of the time. There have some problem that the patients not really comfortable with the clinic which is the queuing time for the patients get their services. Making the patients wait for any reason in the phase of treatment is not good because the disease that the patients had will get worse.

Reducing patients waiting times is the responsibility of managers, and there well will be several solution options to choose. As all of these optional choices would lead a cost, it may not be estimated as appropriate goals and objectives determined. Simulation technique refers to completing the processes of revised procedures, carrying out the trials and estimating the error times of the processes. With this method, new process designs possible reactions to changes could be learned. There are many solutions for the problem related to waiting durations in clinic as the options are increasing number of man power and changing the shape of quality. Before making a choice, working process should be analyzed and reviewed as to identify the factors of patients waiting time .Reducing the patient duration has become important as to serve more patients.

One of the important elements in improving services in the clinic is managing the patient flow. The patient flow represents the ability of healthcare system to serve patients quickly and efficiently throughout the treatment period. When the flow of the system operates properly, then the flow of patients becomes smoother and all the processes involved can be resolved with minimum delay. A good patient flow indicates

that a patient queuing can be reduced or minimized, while the inefficient patient flow contribute to the problem of long and outstanding queue. The queuing theory and patient flow systems are often associated with simulation techniques. Simulation is a powerful tool for the evaluation and analysis of a new system designs, modifications to existing systems and proposed changes to control systems and operating rules.

Time is always a valuable asset for patients in seeking treatment at any healthcare centre, either public or private provider, and even more valuable for patients who are in critical conditions. Doctors and specialists also need to maximize their service time since some of them are assigned with administrative works, reading medical reports, and keep moving from one department to another department. Waiting idly in the waiting room is not a productive situation where patients can spend their waiting time to do other activities that might benefit them rather than sitting for nothing.

1.2 PROBLEM BACKGROUND

The clinic is the place that people who get sick receive their treatment and get their medicine. They need treatment as soon as possible they enter the clinic. They also need to follow all the procedures of the clinic which is they need to wait until the previous patient exit the room then they can enter the room to get treatment from doctor. First, when they enter the clinic they need to show their identification of student or staff at the counter and then the assistant at the counter will give them the waiting number. They need to wait according their number to get the treatment. It will give some problem because it will take times when there are many patients in the clinic.

There are many problem when want to get treatment at the clinic. First is the queuing takes long time. The queuing takes long time because at University Malaysia Pahang, there are many people include staff and student. In a day, there will have many patients that need treatment at the clinic. Then, they need to take long time to get the service. Students usually busy because their time so worth and they need to study and attend the class. It also gives problem for staffs because they need to do their work. Second is the quality of the service. The most important part to get treatment is quality of service. When the clinic has many patients, there will have some problem with their

service. The service times of the clinic become slower because total of patient increase. They will not give the best service because they need to be fast to give treatment to others patient. The third problem is the less of staff. The important thing, when we want to reduced the waiting and service time, we need to increase the staff in the clinic .For this clinic, they need to add some doctors and nurse because it will make their service more efficient and smooth.

The clinic also needs to add more room for the patients according to their disease. It will much easier for the staff t the clinic and for patients because it will improve the service time at the clinic. The duration waiting time also will reduce and it will help the patient to do their usually work because it will take a short time for them to get treatment at the clinic.

1.3 PROBLEM STATEMENT

1.3.1 Queuing Takes Long Time

The queuing takes long time because at University Malaysia Pahang, there are many people include staff and student. In a day, there will have many patients that need treatment at the clinic. Then, they need to take long time to get the service. Students usually busy because their time so worth and they need to study and attend the class. It also gives problem for staffs because they need to do their work.

1.3.2 Quality of Service

The most important part to get treatment is quality of service. When the clinic has many patients, there will have some problem with their service. The service times of the clinic become slower because total of patient increase. They will not give the best service because they need to be fast to give treatment to others patient.

1.3.3 Less of Staff

The important thing, when we want to reduced the waiting and service time, we need to increase the number of the staff in the clinic .For this clinic, they need to add some doctors and nurse because it will make their service more efficient and smooth.

1.4 OBJECTIVE

i.To improve the efficiency of the service time
ii.To analyze system and working process
iii.To decrease the patient waiting duration

1.5 RESEARCH QUESTIONS (RQ)

Based on the research objectives above, research questions are formulated as follows:
RQ1: How to improve the efficiency of the service time at the clinic?
RQ2: Why need to analyze system and working process at the clinic?RQ3: How want to decrease the patient waiting duration at the clinic?

1.6 SCOPE

The scope for this study is for the students and staffs of University Malaysia Pahang. The clinic is important for them to get treatment. They do not need to get treatment outside which are far away because the clinic are in University Malaysia Pahang. They also can reduce cost when get treatment at this clinic because the payment already include in the fees of study. Student usually did not enough time to go clinic that far away to get treatment because they need to study, complete the assignment and attend the class. It will give some burden for them if they just need take medicine for the usually pain such as headache, stomachache and others. They will feel much comfortable if the clinic have complete equipment and systematic. The clinic also give benefit to staffs because they have big responsible for UMP and they can go get

treatment to the clinic as soon as possible they get sick. It also reduced their worth time because they need to do their work.

1.7 METHOD

In order to execute the objective of the study the simulation method was considered. First of all, the simulation model of the existing system was demonstrated. On the simulation model installed, the scenarios have been established in order to determine critical factors which effects patient waiting durations. Thus, the goal of the study was to improve service times by considering method using simulation. In the built simulation model, all of the processes for patients applied to the clinic were considered beginning from their entry to the system and their exit from the system. In order to decline applied capacity plans and patients waiting durations a simulation model was executed in the clinic.

1.8 SIGNIFICANT OF STUDY

This study will imitate the patient waiting duration process that provide by the clinic using the simulation software. This imitation is to understand the patient service time process that is provided by the clinic. This includes understanding the patient service flow and identifying the problem that a patient have when they get treatment at the clinic. At the same time, the simulation study of this process will evaluate the actual service time at the clinic. There will have the new approach to improve service time at the clinic.

1.9 EXPECTED RESULT

At the end of the study, the expected result is able to identify the solution and improvement to the clinic. Therefore, the first is the duration of waiting time more shorter than usual and this will make the patient more comfortable to get their treatment. Then, it also can reduced the job to the staff, so the staff can do their work efficiently. Moreover, it also improve the system of the clinic and it will give a lot of benefits to patients.

In addition, the expected result of this study are important to the patients of the clinic because they want the smooth process during to get their treatment. They also want the shorter waiting duration because they need to do something else and their time are important, so they do not want to waste their time. Furthermore, the clinic will minimize their waiting duration, add more staff in the way to improve the service time at the clinic. The clinic could also add more doctor room, pharmacy, and others.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter will discuss about the literature review of service time at the clinic and simulation. First, it will review the concept about the clinic service time operation and this will review about elements and include giving treatment to the patient in clinic. Lastly, this chapter will review some of literature on simulations as a research tool

2.2 UMP CLINIC

The clinic is a place that people who get sick, get their treatment. The clinic is important because people sometimes get sick, mostly students and staffs in UMP. The clinic sometimes will get busy because there a lot of patients include students and staffs in UMP. The clinics are important because it is only nearest clinic for students and staffs in UMP. They totally depend to the clinic for their health care. The problem will occur when the clinic did not manage their service time well. The students are really concerned about duration time because they need to complete their work and also need to attend the class. They will not have enough time for wait and queuing to get their treatment at the clinic. The clinic needs to improve their service time to make their patients feel more comfortable and not waiting too long when they want get their treatment.

2.2.1 Patient Flow Concept

The important element in improving the efficiency in the healthcare services is managing the patient flow. The patient flow will show the ability based on the clinic system to serve patient efficiently and quickly throughout the period of the treatment. The flow of patient will become smooth if the flow of the system operates smoothly (A. F. Najmuddin, I. M. Ibrahim, S. R. Ismail, 2010). Furthermore, a good patient flow means that the queuing is shorter and a poor patient flow is when the patient queuing delay or longer (Hall, 1999).

Moreover, the characteristic of an efficient patient flow is by minimize patient waiting time, high patient throughput, short duration to wait, low clinic overtime, while maintain the staff utilization rates (Jun et al, 1999). Thus, patient flow analysis to define specific areas of inefficiency in patient visit and decrease the duration time of patient visit. These researcher found that patient flow analysis is an effective method for identify the inefficiency gathered patient flow data. Therefore, patient flow analysis are related to three main factors which is patient routing and flow schemes, scheduling and availability of resources, and patient scheduling and admissions (Jun et al, 1999).

Furthermore, incorporation of patient flow in a scheduling problem when the patient are given a fixed scheduling slots within the increase waiting time that are recommended for each flow (Patrick et al, 2008). Then, these researchers analyze the effect of using fast track lame to decrease waiting time of low patient flow in an emergency room. Thus, the emergency rooms are divided according to the level of patient sickness and the low patient flow is usually needed to take long time. It was found that a fast lane use a minimal amount of resources could minimize patient waiting time (Garcia et al, 1995).

Moreover, this researcher showed that changing a procedural policy could minimize the patient waiting time in the emergency room and increase in patient throughput (Ritondo and Freedman, 1993). Then, performed simulation to examine factors such as physician idle time relative to patient waiting time, and found that the

patient would have long waiting time if the physician overbooked the schedule (Goitein, 1990).

2.2.2 Queuing Concept

The queuing concept is common procedure for people to get their service or treatment. Patients are concern with time and they are not willing to wait for a long time to get treatment. Queuing indicates that queue or waiting line causes inconvenience to organizations. The clinic should try to minimize the total waiting duration for the patient (Katz, et al, 1991). Moreover, the patient evaluation of service quality affected by the perceived waiting time and also actual waits time. The satisfaction of the patient will disturb by amount of time that they need to spend (Davis and Vollman, 1990).

Furthermore, one of the issues in queue concept is the patient perceptions of the waiting time and also the actual amount of time that patient need to wait (Davis and Heineke, 1994). Then,(1) any system in which arrivals place demand upon a finite capacity resource can be called s a queuing system. (2) The queuing application is to minimize the cost of giving the treatment at clinic through minimization of delays and efficiency in the system (Singh, 2006). The queuing manages the patient flow by using the system. If the patient flow is good, it means it can minimize the delay and when the system is broken, it will increase the duration time (Hall, 1991).

Then, the queuing theory is mathematical approaches that apply to the analysis of waiting lines within the operations (Nosek and Wilson 2001). Furthermore, queuing theory uses queuing model to assess and can improve the patient flow through a queuing system (Gorney, 1981; Bunday, 1996). These researcher notice that queuing theory is important operation research tool, applicable for various system and queuing model can be build in a fraction of time for develop a simulation model (Jiang and Giachetti, 2008). Moreover, it is easy when use queuing while it does not require dedicated software codes, which give regular users, can afford to use it.

Furthermore, these researcher investigate the causes of delay in a clinic by adopted a queuing network model. The queuing analysis notices that the delays were due to scheduling problem rather than the registration area. It was include that although significant differences exist between the model assumptions and the real model. The queuing network models provide insight of the appointment clinic for the operation (Albin et al, 1990).

2.2.3 Patient Satisfaction.

The patient satisfaction is important to a clinic because when patient are satisfied with the service or treatment, they will continuously get the treatment at the same place. There are two approaches to increasing patient satisfaction regarding time. First, is through enhancing the patient waiting time and also through decreasing actual waiting time for patient to get their treatment (Davis and Heineke, 1994; Katz, Larson, and Larson, 1991). Moreover, the patient satisfaction not only affected by attribution of causes for the waiting or patient expectations but also by waiting time (Taylor, 1994).

Furthermore, the patient satisfaction is based on the quality of the service or treatment. Thus, the conceptualization of the patient satisfaction should be increase to include other evaluations in addition to get the high quality perception by the patient (Ross et al, 1987). Then, (1) the patient satisfaction are based on evaluation of the service or treatment. Instead, the patient satisfaction is an effective response or emotion to a service that they receive. (2) This position does not assume the patient do not make evaluation. More specifically, cognitive evaluation within the framework of patient expectation (cf.Oliver,1981).

These researchers define the satisfaction as the patient behavior toward medical care or treatment (Hulka et al, 1970).Then, patient satisfaction is the patient judgments toward the quality of the treatment that they receive and other relevant sources that can represent the level of patient satisfaction. Within the patient satisfaction, this definition has been opened accepted (Wolinsky,1976; Hines et al,1977; Doyle and Ware,1977; Ware et al,1918 and Dunt, 1978).

Thus, the first perspective notices that the situation is a big source of variation in evaluates the satisfaction. It posits that the patient satisfaction should be define as evaluation of the patient in term of quality of service in a healthcare situation and not just the global behavior across episodes (Shore and Frans, 1986).Therefore, these researchers notice that assessing satisfaction for patient encounters may give a fuller understanding of the nature of doctor and patient relationship (Inui and Carter (1985).

2.3 SIMULATION

Simulation can be define as process of conducting experiments with the model and designing model of real system to understand about the behavior of the system for the operation of the system (Sharnon, 1975). Simulation are refers to the collection of application and tool to imitate the characteristic of the real system that are usually use with the suitable software. Simulation also can be extremely general term since the ideas across many fields.

Moreover, the operation of the model can be studied and the properties that include the characteristic of the actual system or its subsystem can be inferred. Simulation also a tool to evaluate the performance of a system, proposed or existing, over long periods of real time and under different configurations. Then, the simulation is used before an existing system is a new system built or altered, to optimize system performance, to prevent under or over-utilization of resources and to minimize the chances of failure to meet specifications (Sharnon, 1975).

Furthermore, the purpose of simulation is to achieve specific goals that are related to evaluation or learning. The simulation are not replace the need for study in the clinical practice setting but allows the students to develop their decision making skills, critical thinking and assessment in a supportive environment and safe places (Medley and Horne, 2005; Valler-Jones et al, 2011). Then, while documented and research with using simulation is increasing, there is limited research pertaining to give evidence based on theory or principles on how students can study using simulation (Walton, Chute and Ball, 2011).

Next, this also allows for the evaluation and the assessment of the student performance whereby if the student inaccurate patient assessment or slow clinical decision making, demonstrate a mistake, patient sickness is not affected and student also have chance to learn based on their experience. Simulation also needs to improve patient safety and linking the student theoretical knowledge with the practice (Ricketts, 2011). Therefore, simulation are not a technology but is an educational strategy (Decker, Sportsman, Puetz and Billings, 2008; Gaba, 2004; Ricketts, 2011).

2.3.1 Simulation Advantages

Simulations have their own advantages and it has ability to deal with difficult models of correspondingly complicated system. Furthermore, advance in flexibility, ease of use and simulation software power have moved the approach from the real of error-prone low level programming and valid the decision making. This is proven that simulation is the best tool to solve the problem.

Moreover, the simulation gives the opportunity to model statistic system that cannot be modeled accurately by mathematical model or by a deterministic. Then, for the usually cases which is in constructs, simulation is more feasible than experimenting with a physical model or the real system. The simulation allows a system to be studied over a bespoke time frame and it also allows us to study a system through varying the parameters and the inputs (Law et al, 2000).

Furthermore, simulation modeling is the most frequently used operations research tool. Hence, the advantage of the simulation are obtain a better understanding of the system by developing a mathematical model of a system and can observe the system operation in details over long time period. It also develops designed and robust systems and minimizes system development time. Then, it can study the effects of certain informational, organizational, policy change on the operation of the system by altering the system model. It can reduce the risk of experimenting with the real system (Maria, 1997).

Besides that, (1) the time constants of the system are not suitable with the experimenter. Simulation usually are performed because the real experiment proceed very quickly that it can difficult be observed or the real system proceed very slowly that the experimenter is long dead before the experiment is completed. The simulation will allow us to slow down or speed up the experiment. Then, (2) it control variables, and system parameters may be not access. Simulation usually performed because they allow us to access the input, where using the real system some input maybe cannot be access for manipulation (Gaines,1979).

2.3.2 Arena Software

Arena represents an improvement in simulation technology by enabling enterprise-wide simulation. The Arena is a comprehensive system that can addresses overall of a simulation study from input data analysis to the analysis of simulation output data. Moreover, Arena is focus to bring the use of simulation to broad new class of users. Its application focus to addresses the need of organization include decision support for many areas include medical system, logistics, data communication and others. Then, the benefit from simulation that is simulated can make high level of effort required to employ simulation technology successfully. The key to make simulation technology larger used is to make the method significantly easier to use and learn without sacrifice flexibility and modeling power (John E.Hammann and Nancy A.Markovitch, 1995).

The Arena simulation system was developed by System Modeling Corporation. It is one step animation system and graphical modeling that depend on concepts from hierarchical modeling and object-oriented programming (See Pegden, 1995). Moreover, the Arena software is widely used to model and stimulate supply chains and industrial process. The main major benefit of using this software is to anticipate the effect of designing difficult processes. Furthermore, it also produces Markov-system simulations that are depending on discrete events and maybe for duration of events and distributions for entering entities into the system. Then, this software also has the familiar look of Microsoft products. Next, Microsoft Visio flowcharts can be transfer into Arena

software. This software also can read from Access files and Excel (Bruce J.Neubauer and Shelley K. Stewart, 2008).

2.3.3 Steps in Simulation Model

Simulation model contained the process that usually start from the easy and simple then it will become higher and difficult. Modeling is arguably the most important part of a simulation study. Moreover, a simulation model is the same good as simulation study. The simulation modeling are usually consists eleven steps (Maria, 1997). There is also having the simulation modeling study steps by (Law et al, 2000).

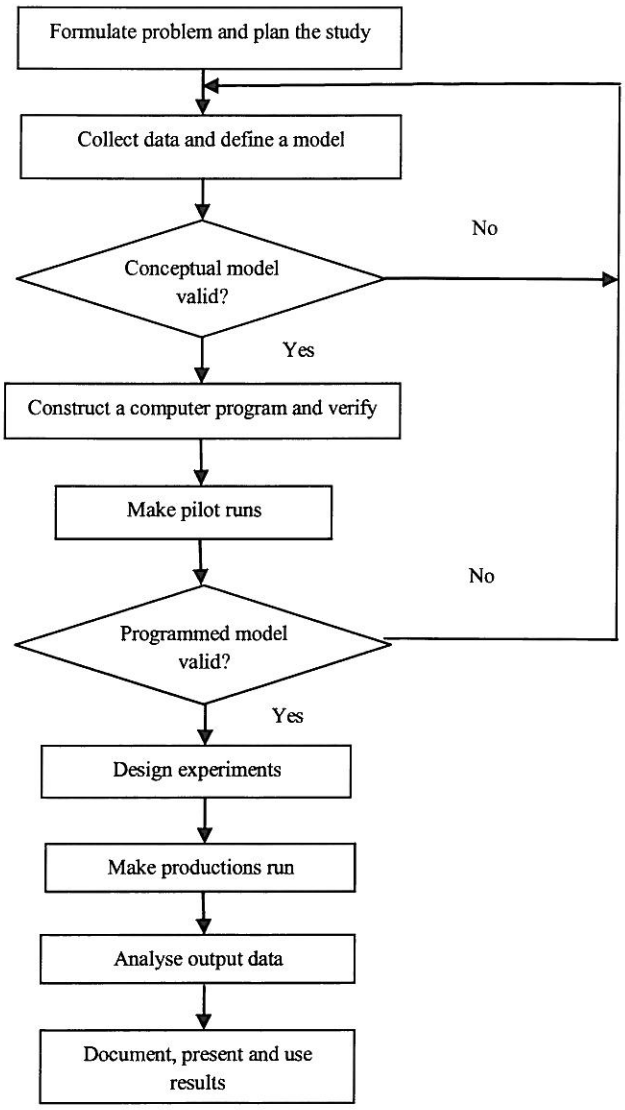

Figure 2.1: Steps in Simulation Modelling Study (Law et al, 2000)

i) Identify the problem. First, at this stage we should define the problem and collected all the information about the problem. Then, state all the problems and the objective clearly. We must be careful at this stage, so could not identify the wrong problem and the stage will be continuous.

ii) Formulate the problem. In this stage, when formulate the problem are usually select the bound of the system that need to be study. Then, define a few specific issues that need to be addressed and all the objectives of the study. Thus, identify the end user for simulation model and problem also need to formulated as precisely as possible.

iii) Collect and process real system data. This stage is where the data was collected on system specifications. Although all data is collected, there will some of them are not valid and it just only estimation or assumption.

iv) Formulate and develop a model. This stage will develop network diagrams and schematic of the system. Simulation software is acceptable for this conceptual models and verification of that the simulation model executes as intended.

v) Validate the model. This stage is comparable between the performances of a real system with the performance under known conditions. This stage also will perform the statistical inference tests to get the model examined by system that experts. Then, state if have any problem and assess the confidence that the end user place.

vi) Document model for future use. This stage includes assumptions, input variable in detail and the document objectives. Then, need to define and observe the causes for changes in the performance measure by using the variable of the simulation.

vii) Select an appropriate experimental design. These stages, there are needed to select the levels of each input variable, a few input variables that are likely to influence it and the performance measure. Then, there are need to be documenting the experimental design.

viii) Establish experimental conditions for runs. In this stage, there are needed to address the most important information and the question that obtain accurate information. Then, should define if the system are non-stationary (performance measures changes over time) or stationary (performance measure does not change over time). Next is select the run length, select the suitable starting conditions and select the length of the warm-up period if it is required. The sample size must not larger, at least three to five runs for each configuration to provide the needed confidence in the performance measure assumptions.

ix) Perform simulation runs. In this stage, the simulation run are need to perform according to step and eight that state above.

x) Interpret and present results. In this stage, there are need to compute the numerical assumptions of the desired performance measure for each configuration. Then, construct the graphical display, document the results and state the conclusions. There are where the result is obtained from the simulation is recommended and then it provides to solve the potential problem.

xi) Recommend further course of action. In this last stage, the other performance measures of interest will be a throughput of parts of the system. It also concludes the further process to estimate the average and the maximum length of the operation.

2.4 A SUMMARIES MODEL APPROACH

Colby Thomas, Mattie, 2013 and the abstract is workers are clinic had options that are based on limited to, understand all the effect of the problem and quickly to make an assumption. Real time, location systems (RTLS) are used to define the patient flow and their schedule procedures also can define optimally and resources and combine them to patients. Next, the implementation of the simulation patient model can give the real time patient data. By combining simulation model and real time location system (RTLS), the clinic can provide the uncomfortable situations that happen in the clinic. Most simulation models study and optimize the patient flow and try to reduce the

patient waiting time. Then, the uses of simulation model is to display the process in a clinic and optimize others aspects of the clinic. Moreover, Any Logic program was chosen because it based off Java it can run by using any computers without using additional software to support. This program also has ability for the optimization and the data from real time location system (RTLS) can feed into the model. In conclusion, the simulation modeling has made progress in improving efficiencies in the clinic because the entire optimization model will show how the facility is performing in real time.

Dipl.-Ing. Michael Thorwarth, September 2011 and the abstract are limited resources and high patient demand has made patient waiting long time. This research aim to develop a simulation that based Decision Support System (DSS) to enable the process of simulation based on the solution to increase quality at the healthcare. Then, this approach is included in the simulation that based on Decision Support System (DSS) by make the workers provide a comprehensive assumption onto the crucial aspects that effect process and the service. Then, the first the clinic objective is to identify the process flow within emergency department (ED) and details about the long queues. Furthermore, it also prepares the method that allows measuring certain key performance indicators (KPIs). The second objective are define the documentation time of the medical staff and third are optimize of the workers set up and distribution within emergency department (ED). In conclusion, to understand about the characteristic of healthcare in general is developed and structure with systematic into approach to design a Decision Support System (DSS). Moreover, the Decision Support System (DSS) is to design so it can easily transfer to other healthcare.

Chen Choy Yuen, November 2009 and the abstract are to increase the productivity for healthcare by using simulation software because believe that simulation can increase the efficiency and quality of the existing service process flow at the healthcare. Then, the main objective is to analyze the designed layout and select the solution of the problem that the healthcare have and to improve service floor layout of this healthcare. First, it start by define the problem and collect the data for the data analysis and pick the best feed to process into step of simulation. Moreover, by run the experiment on the chosen alternatives to increase the output patient number and all this

were modelled in the WITNESS Simulation software. Furthermore, by prepare the quickly service it will decrease the patient waiting time and the patient mostly are willing to pay premium price to the healthcare for decrease their waiting duration to get the treatment. It also makes the patient as their loyalty patient at the healthcare because they will feel comfortable for the smooth service at the healthcare. Then, it also increases the patient satisfaction in the healthcare. In conclusion, this method also can decrease the lead time of give medical consultant the patient in the healthcare. Hence, the objectives of this project have been achieved and service at the healthcare will more efficient.

Miguel Amador Rosa, November 2012 and the abstract are by using Discrete Event Simulation to solve the problem in Auto medical. The objective are of decision problem were focused on service quality and operating costs. Moreover, by using new method this could give details understanding about Auto medical through a structure system analysis, with the logic variables in the problem. Discrete Event Simulation was used to define the uncertainty of the procedure in operation. Then, model and simulation were implemented using the SIMUL8 simulation software. Furthermore, to solve the problem by using simulation method usually an iterative approach where the current system is modelled is need to be a simulation. Moreover, with the result of the simulation it can state the conclusion regarding the true representation of the model. The model can be better by modified to the original system or define the different to the original system. In conclusion, the results of this method aim to have a solution by using the simulation software.

Ronak Gandhi, May 2013 and the abstract are appointment scheduling include choose a strategy for sequencing patient appointment which is the duration for waiting time decrease and decrease the idle time and overtime for the doctor. This project objective is to maximize the number of scans per day at the clinic. Then, the objective were identify by proceed simulation of the workflow of the clinic by using the simulation software. Moreover, the simulation model did not precisely reflect the clinic and the disparity was given to limitations in the simulation model. Then, the simulation model was proceeding when the data was collected. This project was done by using SIMUL8 software. After the simulation model was constructed, the model was arranged

because to identify problem by the current workflow at the clinic. Then, it will done by looking the differences the data performance measures of the current workflow to the data of the performance measures that got from the simulation. Furthermore, a discrete event simulation model was constructed regarding the current appointment rules and statistics by using SIMUL8 software. This will prepare an overview of the simulation model and elaborate about the validation results. In conclusion, this project are aim to improve the current process in the clinic. Then, the simulation model was still felt to give ability into changes that could affect the performance measures at the clinic.

Mark Treadwell, May 2006 and the abstract are simulation model can prepare an accurate representation of resident flow through points of dispensing (PODs), but not necessary for public health to access. The queuing method gives a multitude of analytical model that can be used in many situations. Then, there also have the situation which did not have the model that usually those are include multiple servers. Moreover, a completed data were gathered all the models that are most generalized and useful for the application. A layout assessment method also developed to give suggestion in way to design points of dispensing (PODs) for increase the efficiency. Furthermore, discrete event simulation software allows the user to make a model of the real thing and the arrival rates and service time are random number that fit to a distribution regarding by time of the current system. Next, when create the user it can changes the system and identify the response. This will make the user know way to process changes that can give effect to a system without knowing the time. In conclusion, the method that was created improves the assumption of points of dispensing (PODs) performance measures.

Marie Persson, May 2010 and the abstract are focusing on healthcare management and mostly to the problem of waiting list management and operating room planning. Then, one part of the planning process is to define a Master Surgery Schedule (MSS). An MSS mean cyclic timetables that focus the allocation of the surgical groups into not same blocks of operating room time. Moreover, the problem of found the unsure in demand of patient arrival by using of simulation techniques. Simulation method is suitable to solve healthcare problem. Simulation has two types which is continuous and discrete. Furthermore, the popular method that healthcare most using is discrete-event simulation (DES). This method can analyze of patient flow, forecasting,

and others. In conclusion, by using certain method the average patient waiting time are minimize while operating room utilization is maximize.

Alan J.Kalton, Medini R.Singh, David A.August, Christopher M.Parin and Elizabeth J.Othman, April 1994. The abstract are the clinic has identify higher increase in patient load in many years. The big success of the clinic started to affect its smooth service. Then, patients are complaint about duration of waiting in the clinic and delays for the patients to get their next appointment. Moreover, to solve the problem that happens in that clinic a simulation study was chosen. The objectives of this clinic are to minimize patient waiting time, to ensure complication of clinic service has change in term of operation and scheduling, and others. Moreover, the aim of this study is to define the method for operation in clinic is improve by using simulation method. It also can compare the performance of the new rule with the system using in simulation. Furthermore, the simulation model was proceeding by using General Purpose System Simulation (GPSS). This software was chosen because of its flexibility, speed and others. In conclusion, this simulation method most gives benefit to the clinic and allows flexibility of the simulation model.

Xiaowei Hu, May 2013 and the abstract are healthcare have to solve the problem which is maximizing burden to deliver quality and service which is efficient while want to solve of increase cost. Then, the increase of patient waiting time to get their treatment had been complaint by patients almost in each clinic. Moreover the aim of this study is develop a simulation model for the existing system in clinic, validate model by using current data and proceeding what-if scenario analysis to minimize of duration waiting time for patient. In conclusion, by using the validated simulation model will identify suitable parameter values to minimize duration waiting time.

Francisco J.Ramis, Jorge L.Palma, Victor F.Estrada and Gloria Coscolla, August 2002. The abstract are to prepare a generic simulator that be used in a network of a clinic, which is to minimize the service process, the assignment of personnel and others. Moreover, the main objective of this study is to minimize the duration in the system of the patients. The model was validated by the expert and usually software which is EXCEL and ARENA. This software can be use to minimize the duration waiting time

of the patients. Furthermore, the data need to collect first before run the program. The process will start when the patient arrived at the clinic, and register at the counter. Then, the patient will wait their turn and when the patients exit the clinic. Furthermore, in order to make a model, it needs to identify variables, attribute entities, and others. Then, to validate the system from the model production run were made and the results validated with the workers. In conclusion, the clinic wants to improve the service for their patients and they had defined the software that could reduce duration waiting time for service.

Francisco Sabbadini, Mario De Oliveira, Antonio Araujo Jr, Jose Glenio Barros and Rosinei Batista, January 2014. The abstract are the healthcare have problem and want to improve the quality of care. The patients need to wait to get their treatment and delays can make risk of sequels are increases. Then, long duration waiting time can make the patients not comfortable and it also can put pressure on the workers of the healthcare. Moreover, the important measure is to minimize the waiting time for treatment and it are to improve the effectiveness of the service and controls cost. Then, the objective for this study is to identify a method to improve the quality of the current system and access. Furthermore, for the healthcare will using discrete event simulation. It is because the results from this study also can implement to other healthcare. The simulation uses the real problem and then formulated it as a logical model. Then, change the logical model into a computer model and others. Then, the computer model needs to test to see whether it follows the analyst want. Furthermore, the conceptual model is formulated by using analysis that get from patient flow. There are many option to execute a simulation and the usually method to make discrete event simulation are events, process and events. In conclusion, this approach can improve the quality at the healthcare and their access.

MM Gunal and M Pidd, April 2014 and the abstract are the method that usually used in modelling healthcare system is the Discrete Event Simulation (DES).This study are aim to improve the healthcare performance modelling. Then, there are many applications of simulation techniques which is heuristic optimization. Moreover, beside Discrete Event Simulation (DES) there are many other applications such as agent-based modelling and system dynamics. This healthcare is more focusing on Discrete Event

Simulation (DES) modelling of patients flow through the healthcare facilities. Then, this healthcare also focuses on duration waiting time for the patients. The duration waiting time are including when the patients arrive at the healthcare and wait until they turn to get the treatment. Furthermore, the delays in generally take of many minutes. The using of Discrete Event Simulation (DES) will conclude a whole of the healthcare and their aim is to give a decision support method to the healthcare applications. In conclusion, by using this method it can increase the service time at the healthcare.

Nabeel Mandahawi, Sameh AL-Shihabi, Abdallah A. Abdallah and Yousuf M.Alfarah, Jun 2010. The abstract are Design for Six Sigma (DFSS) has been implemented in many organizations as their method to redesign or design processes. There also have different performance measure such as waiting time (WT) and length of stay (LOS). Moreover, discrete event simulation (DES) model were built by using Pro Model software. Then, this model has been validated and verified. In order to increase their patients flow and overall care, they propose a triage system. There are many advantage of proposed system which is the patients will get their treatment based on their illness level rather than their arrival time. It can reduce potential adverse effects by monitoring patients but still wait to get their treatment. Furthermore, a simulation model for the modified service was used to define the triage process design prior to implementation. In conclusion, this study can develop a triage discrete event simulation (DES) model to present the triage process and define the length of stay (LOS) and waiting time (WT) for the patients at the healthcare.

2.5 SUMMARY

In this chapter, are describing about the problem of service time that happen in the clinic. Then, it also describe about simulation and the advantage for using the simulation. Moreover, it have introduction of software that will use which is Arena software. There also describe the steps of simulation model and lastly the summaries of articles and journals. These summaries describe the problem that have in clinic and they use simulation model by using different software. There many knowledge and information that can gain from this articles and journals to proceed this study.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This study will focus on the method and software that will use in simulation by using Arena software. Simulation refers into the realization of an imitation of some spacious, wide and much complex system. Besides that, simulation result can prove of the operation characteristic by observing and generating the artificial the past system. Then, simulation system are widely use as tools of solve the problem in management stage and the most suitable for problem solving methodology (Banks, 1999).

This chapter, the overall objectives of this study will describe about research methodology to complete by research. Then, there will also define on the way the research undertake the research. The factors that will include in this research methodology are about the way to conduct the study. There are many processes to complete this study.

Moreover, this study is about to identify and define the best method and tools to solve the problem on patients service time. Then, the most suitable software for this study is Arena software as simulation programming to give the best solution for the problem. Therefore, before run the process of this software the data are needed because the software can be used according the data that we collected.

3.2 DETAILS OF PROBLEM STATEMENT

In this study there is variety of problem statement which based on service time. The first problem statement is queuing that takes long time. It happen because too many patients that need the treatment in a day. It can make the patient feel uncomfortable with this situation. The second problem is the quality of the service. It because when the clinic has many patients so they cannot give full attention to the patient and give the service as fast as their can. Moreover, the problem is the clinic did not have enough workers. It happens because when the clinic lack of workers, it will maximize the service time to the patients. Therefore, the problem statement are need after the objective of this study are stated which is to improve the efficiency of the service time, to analyze system and working process and to decrease patient waiting duration.

3.3 METHODOLOGY

This study will use simulation model by using Arena software as the method to improve service time at the clinic. Moreover, by using simulation the analysis can be use in real system without using any cost because people can make the changes of the process by using the software before apply it in real system. Furthermore, the operation of the model can be studied and the properties that include the characteristic of the actual system or its subsystem can be inferred. Simulation also a tool to evaluate the performance of a system, proposed or existing, over long periods of real time and under different configurations. Then, the simulation is used before an existing system is a new system built or altered, to optimize system performance, to prevent under or over-utilization of resources and to minimize the chances of failure to meet specifications.

This study will use Arena software and the simulation study will define the actual patient service and make it to improve service time at the clinic. The Arena is a comprehensive system that can addresses overall of a simulation study from input data analysis to the analysis of simulation output data. Moreover, the Arena software is widely use to model and stimulate supply chains and industrial process. The main major benefit of using this software is to anticipate the effect of designing difficult processes.

3.3.1 Simulation Model and Arena Software

Simulation definitely is a process of creating and designing a computerized model of proposed system to conducting the experiments to give the best understanding of characteristics of the system. Therefore, by using simulation the analysis can be use in real system with not use any cost. Moreover, simulation is a high effective method of testing new processes without having to carry out actual experiments. The simulation is similar with the real process and accurate representations are required.

Then, the model must be validated and verified to start the simulation. Furthermore, the simulation needs to accord the objective of the study. Simulation is the best tools to get solution of the problem that happen in an organization. In this study, a simulation model was developing by using Arena software. The simulation study will examine the actual patient service time and improvement to increase the service time for patients at clinic.

3.4 PATIENT SERVICE DESIGN DESCRIPTION

The first step in patient service at the clinic is start when the patient arrives at the clinic. Then, the patient will go to the counter of registration and they will meet the doctor. If the patient need to goto laboratory, they will enter the laboratory. This stage will come some pressure for the patient if they need to wait a long time taken to see the result. They will not satisfy if they get into this situation. Moreover the simulation model can detect the service time taken for duration waiting time to get the treatment. Then, if the patient needs the follow up visit, they will need to make appointment to see doctor again. After that, if the patient needs to take the medicine for their illness, they will go to the pharmacy to take the medicine. The last stage is if the patient did not have to take any medicine, they will exit the clinic and return home.

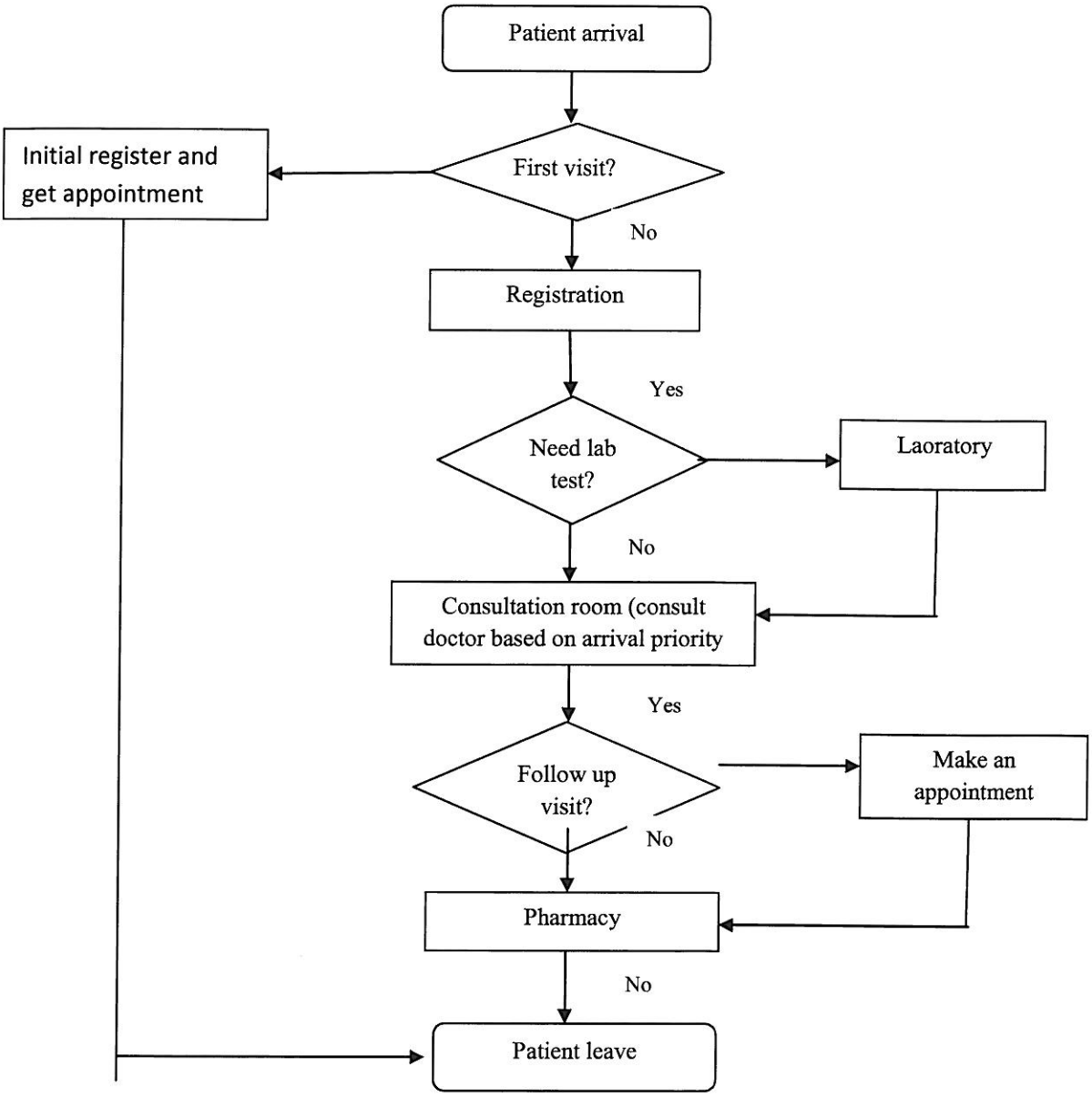

Figure 3.1: The flow diagram of patient service in the clinic

3.5 PROCESS DESCRIPTION

In the clinic, there is process flow of queuing time when to get treatment in that clinic. Therefore, the process are started when the patient enter the clinic until the patient leave the clinic. Moreover, there have four processes after the patient enter the clinic. The patient needs to follow the process in order to get smooth treatment and environment during inside the clinic. The four processes that mentioned earlier are:

i. Counter Registration
ii. Doctor Room
iii. Laboratory (if needed)
iv. Pharmacy

3.5.1 Counter Registration

The patient usually will go to the counter registration first when enter to the clinic. Therefore, the patient needs to show their identification card to the staff. It will include the students and the staff at University Malaysia Pahang. After that, the staff will give the file that have all about information about the patient include the kind of sick that they have. Moreover, for the patient that did not get any treatment at there yet, the staff will ask the patient to fill the information at the file. The staff also will give number for patient wait their turn. After that, the patient need to waiting for their number will call to get the treatment in the doctor's room.

3.5.2 Doctor Room

The patient will enter doctor's when their turn arrive. There are the common processes where the doctor will check the patient and discuss about the patient illness. Then, the doctor will decide the type of medicine that he wants to give to his patient. The doctor will wrote the illness information in the file that the patient brought in the room and the doctor also give the list of needed medicine to give to pharmacy section. After that, the patient will go out from the doctor's room.

3.5.3 Laboratory

The patient will go the laboratory if it necessary to them. Therefore, in the laboratory the staff will do some experiment and check more detailed of patient illness and for example, the staff will do the urine test, blood test, and others. There is where the doctor and the patient curious about their illness and healthy and the staff will find out more detailed about that. It will take longer time because the staffs need to do much work and it takes time to get the result.

3.5.4 Pharmacy

Furthermore, the patient need to go to the pharmacy and take their medicine after out from laboratory. Moreover, most of the patient did not need to go to the laboratory and they will just go to the pharmacy. The patient will give the list of medicine that the doctor gave to them at the pharmacy section. After that, the patient just needs to wait until their name being called to take the medicine. The staffs at the pharmacy take a bit time for them to choose and get the right medicine to the patient. Then, when the turn for customer come to take the medicine and the staff will elaborate a little bit about the medicine for the patient eat the medicine with the right time and also right amount. After that, the patient will leave the clinic.

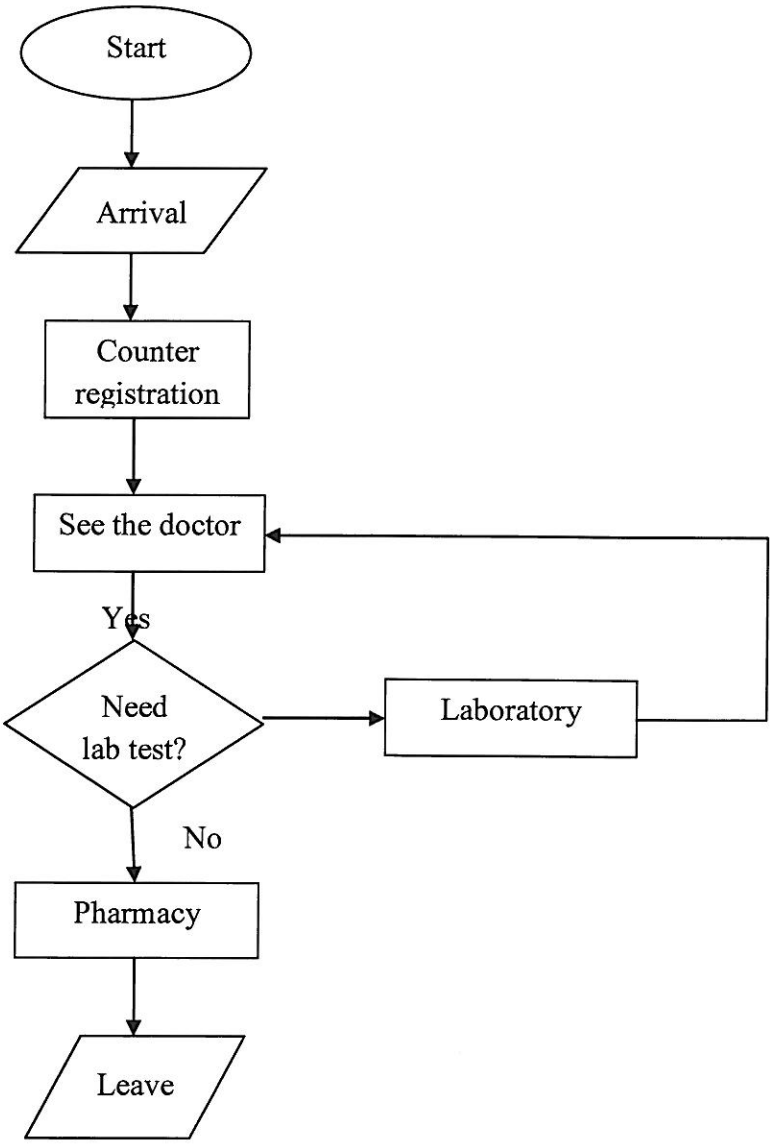

Figure 3.2 show the flow of process in the clinic

3.6 MODEL DEVELOPMENT

In the clinic, there are several processes to get the treatment. It is including the queuing time for the patient to waiting during to have their treatment. There is the patient arrival, counter registration, doctor room, laboratory (if needed), pharmacy, and the last is patient leave the clinic. The process will conclude when the patient enter the clinic until the patient leave the clinic. The *CREAT* module in ARENA is the module which giving an instruction of create part to start the process. Moreover the example of *CREAT* module in this study is the patients arrive at the clinic.

Furthermore, there is *PROCESS* module used in this model. The *PROCESS* module gives the instruction to show the process that include in this study. Mostly there will have several processes at this study which is counter registration, doctor room, laboratory, and pharmacy. Moreover, they all are example for process in the *PROCESS* module that used in this study. Besides that, there are also have *DECIDE* module that used in this model. The *DECIDE* module gives instruction when there are need to go in two or more process. It will show whether need to go to the certain process or just go forward the other process. The example for *DECIDE* module in this model are whether the patient needed to go to the laboratory or just get the medicine at the pharmacy.

Moreover, the *DISPOSE* module is used in this model. The *DISPOSE* module gives instruction of close part to end the process. It usually used to end or finish the process in this study. The example of *DISPOSE* module is when the patient leaves the clinic. Furthermore, when the patient leaves the clinic, it is the end of the process. In addition, simulation models developed in ARENA is used to represent the current process of queuing time in the clinic. Therefore, the animated view of the parts flow is able to be seen clearly and easy to understand the process that needed when to get treatment in the clinic.

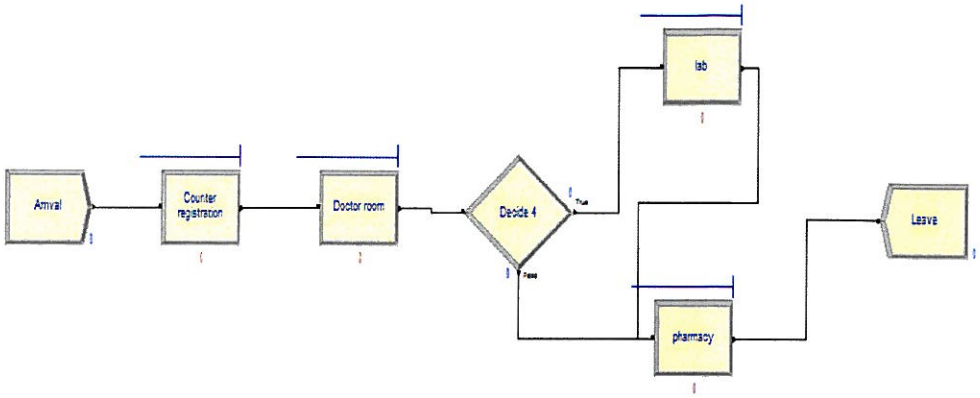

Figure 3.3 constructed simulation model using ARENA

3.7 IDENTIFY THE ORGANIZATION

This study will be conduct at Gambang clinic that located in Universiti Malaysia Pahang. Moreover, this decision was made due to many patients that want get their treatment in a day. The data will be collected and gathered with permission by worker at the clinic who in charge. Then, observation towards service to patient and operation of this clinic will proceed before collecting the data. Therefore, the aim of this observation is to the information and the real view of service at the clinic. Furthermore, the data that gathered during observation will be the drives to the solving problem process.

3.8 DATA COLLECTION

Collecting data appropriate factors of the system of interest is one of the pivotal steps and initial in modeling. The data will be collect based on the current service at the clinic. Then, using the simulation is needed to improve the service time at the clinic. The data will focus on duration of patients waiting time, patients flow, queuing and others. Moreover, one of the issues in queue concept is the patient perceptions of the waiting time and also the actual amount of time that patient need to wait (Davis and

Heineke, 1994). Then,(1) any system in which arrivals place demand upon a finite capacity resource can be called s a queuing system. (2) The queuing application is to minimize the cost of giving the treatment at clinic through minimization of delays and efficiency in the system (Singh, 2006). The queuing manages the patient flow by using the system. If the patient flow is good, it means it can minimize the delay and when the system is broken, it will increase the duration time (Hall, 1991).

3.8.1 Population and Sampling

In this study, the population are includes all the patients that need to get their treatment at the clinic. Therefore, the sampling are the patient that ramdomly chosen because want to take their waiting duration to get the service at the clinic. Moreover, for this study, there need 50 to 100 respondent of the patient to identify their service time.It will include started the time the patient enter the clinic, their waiting duration, treatment by doctor, they get medicine at pharmacy, and lastly they exit the clinic. In addition, the real times of the system are need in a way to improve service time at the clinic.

3.8.2 Data Analysis

The study conducted in this research is the analysis of data. The data obtained by analyzing by using Arena software because by using this software it can identify the current system and also can improve the current system in the clinic. There are many way to collect the data such as from the observation, from the clinic report and others. Furthermore, data collections are important because needed to run the system.

3.8.3 Observation

The observation in the clinic also needed because will gain knowledge and some information that will use in this study. This observation is important because with the observation, the problem of service time at the clinic will identify and it useful to apply in this study and get the solution of the problem by using simulation model and Arena

software. Furthermore, with the observation also can understand the flow or process of patient service at the clinic.

3.9 SUMMARY

In this chapter, it could define the details about simulation model and Arena software. The benefit from developing a simulation model is to gain information that can be used to improve the service time. Moreover, the success of implementation is depending on the good previous steps that already performed. After analysis the data and generate the system, the new data will be recorded and compare with the past data to ensure that the new data are better than the old one. This is for the achievement of this study to improve patient service time in the clinic. The simulation mostly useful in define in what factors that difficult which effect the process. Furthermore, simulation can help to improve the service time at the clinic with high quality of service and with short duration waiting time.

CHAPTER 4

DATA ANALYSIS AND MODEL DEVELOPMENT

4.1 INTRODUCTION

In this chapter, there will more detailed description on the process flow of queuing in the clinic. The area of this study only covers the process flow at clinic inside University Malaysia Pahang. Moreover, this description is in order to provide a clearer view of where is actually this study is about and what is actually happening in the clinic.

Furthermore, data analysis provides the driving force for simulation model. Then, without the input data, the simulation is incapable in generating any data. Data collection method has been described in the previous chapter. Simulation model usually recommended being simple at the beginning and then expending.

4.2 MODEL VALIDATION

Simulation models are usually used in decision making and problem solving. Therefore, basically all process are affected by the decision making that based on such model are all duty concerned whether a model and its results are correct. This concern is reflected through model verification and validation, which the most important aspects in simulation modeling. Moreover, model validation is the important part of the development process, because it will show whether that model would be accepted or not.

Furthermore, the results obtained to solve the problems that happen at the clinic. It also will provide accurate information about the model system, and create a model same but more improved than actual used at the clinic. Then, the formula that used to calculate the validation is;

$$\% \text{ Differences} = \frac{(\text{Simulation})107 - (\text{Actual data})100}{(\text{Actual data})100} \times 100 \qquad (4.1)$$

$$(\text{Actual data})100 = 7\%$$

According to percentages differences of the formula, there will be two situation that will be explain whether the model will be accepted or not;

1) If the result of percentage differences were smaller than 10%, then, the simulation model is valid.

2) If result of percentage differences were bigger than 10%, then, the simulation model is not suitable for being used.

4.3 MODEL EXPERIMENTATION

Once the model has been validated and verified, the experimentation of model phase or what if analysis can commerce. Therefore, the used can start to experiment various scenarios. The each scenario will represent the case that benefit for the user which is the patient at the clinic. Then, the number of scenarios to be experimented is depend to the circumstances that necessary and needed to be investigated. Moreover, for this research, many scenarios can be tested, but only three scenarios are listed in this chapter including the actual scenarios that happen in that clinic.

The "what if" analysis in simulation are the one of important part that are needed to be used in experimenting those scenarios. What if analysis is crucial to the management because it contribute to the alternative course of action for decreased the duration of queuing time in the clinic. In this chapter, three scenarios were analyzed.

Scenario 1: The actual simulation at the clinic

This scenario is the actual scenario that happens in the clinic. The current total of patient in a day can be around 100. Therefore, by using Arena simulation, it can be more improve or just state the actual situation. Therefore, by using Arena simulation, it stated that 107 people in a day. Then, the current scenario is quite good but it can improve to a better situation.

Furthermore, the model was run for 10 replications with entities 107 patient. Moreover, for accumulated time, the higher average is at the doctor room which is 472.89. Then, the lowest accumulated time is at laboratory which is 279.48. Therefore, the accumulated time at counter registration is 316.29 and at the pharmacy are 355.68.

Therefore, for queue waiting time, for the highest average are at the doctor room queue which are 70.9939. The lowest for queue waiting time are at the pharmacy queue which is 0.3630. Moreover, the highest average for number waiting is at the doctor room queue which is 24.5739 and the lowest average for number waiting is at the pharmacy queue which is 0.08152618.

Table 4.1 Accumulated time

Accum VA Time	Average	Half Width	Minimum Average	Maximum Average
Counter registration	316.29	15.56	277.72	351.64
Doctor room	472.89	2.37	468.21	477.57
Lab	279.48	87.32	98.4104	455.13
Pharmacy	355.68	3.90	345.22	363.18

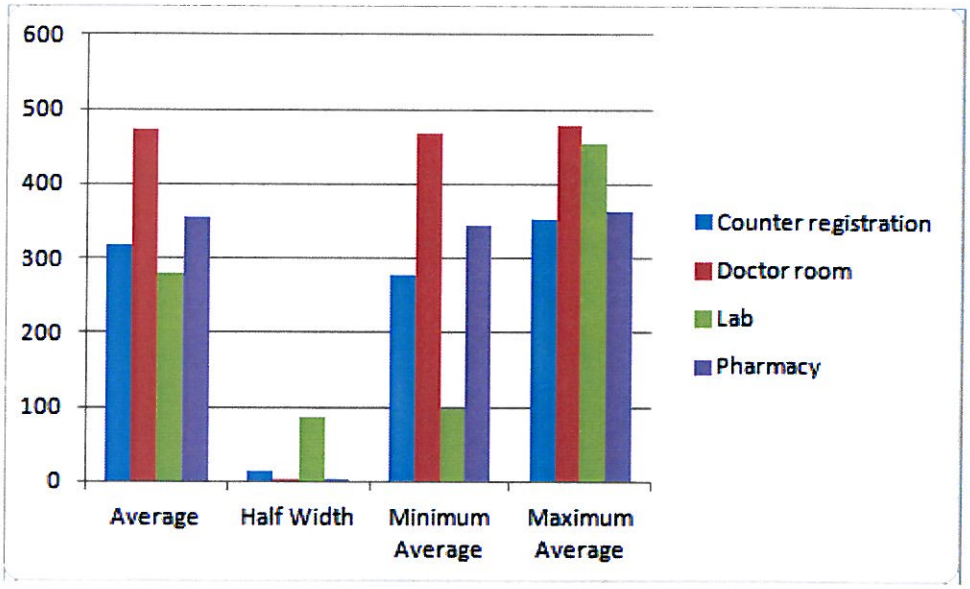

Figure 4.1 graft for scenario 1

Table 4.2 Queue time

Waiting Time	Average	Half Width	Minimum Average	Maximum Average
Counter registration. Queue	1.6578	0.27	1.1793	2.4234
Doctor room. Queue	70.9939	9.08	48.5752	89.9621
Lab. Queue	22.6161	18.64	0.00	68.8496
Pharmacy. Queue	0.3630	0.11	0.1035	0.6084

Table 4.3 The number time

Number Time	Average	Half Width	Minimum Average	Maximum Average
Counter registration. Queue	0.5723	0.11	0.3833	0.9189
Doctor room. Queue	24.5739	4.20	13.3953	34.9589
Lab. Queue	0.6257	0.62	0.00	2.2420
Pharmacy. Queue	0.08152618	0.03	0.02307719	0.1367

Scenario 2: Adding one more doctor room in the clinic

This scenario is the simulated scenario that will increase the service time in the clinic. Therefore, the current total of patient in a day can be around 100. Therefore, by using Arena simulation, it improved to 138 people in a day. Then, it is the effective way by adding the doctor room will increase the patient in a day. Besides that, it shows that the queuing times for patient to get their treatment are decrease.

Furthermore, the model was run for 10 replications with entities 138 patient. Moreover, for accumulated time, the higher average is at the pharmacy which is 459.88. Then, the lowest accumulated time is at counter registration which is 320.70. Therefore, the accumulated time at doctor room 1 are 351.89, at the doctor room 2 are 344.54, and at the laboratory are 408.18.

Therefore, for queue waiting time, for the highest average are at the laboratory queue which are 52.2934. The lowest for queue waiting time are at the counter registration queue which is 1.7526. Moreover, the highest average for number waiting is at the pharmacy queue which is 8.2062 and the lowest average for number waiting is at the counter registration queue which is 0.6139.

Table 4.4 Accumulated time

Accum VA Time	Average	Half Width	Minimum Average	Minimum Average
Counter registration	320.70	19.13	283.90	365.73
Doctor room1	351.89	30.03	308.66	488.27
Doctor room2	344.54	27.19	281.00	403.49
Lab	408.14	30.76	317.96	456.71
Pharmacy	459.88	7.20	441.11	472.93

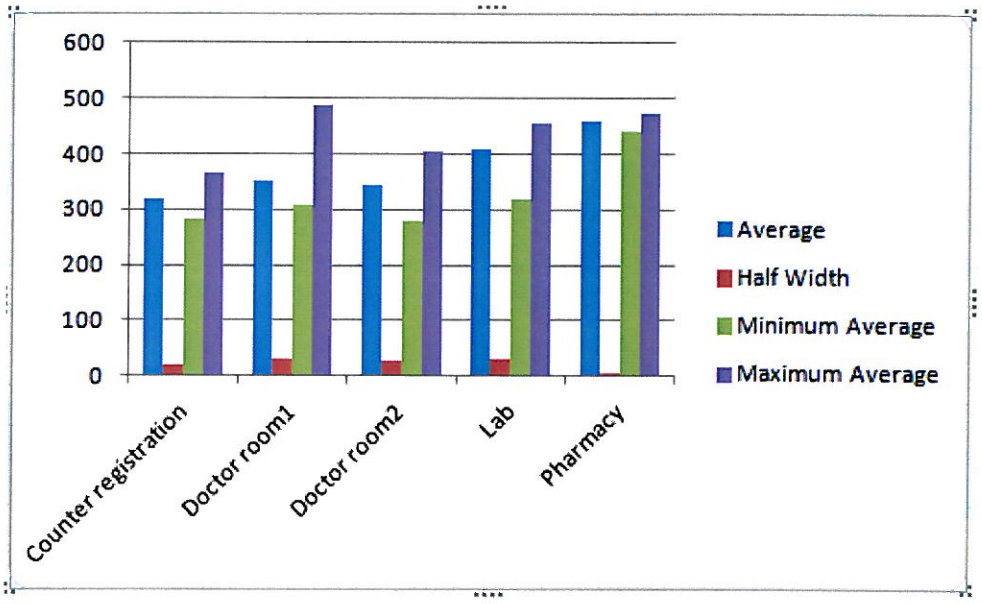

Figure 4.2 graft for scenario 2

Table 4.5 Queue time

Waiting Time	Average	Half Width	Minimum Average	Minimum Average
Counter registration. Queue	1.7526	0.30	0.9550	2.3780
Doctor room1. Queue	4.6975	2.33	1.6090	13.0602
Doctor room2. Queue	4.3783	1.16	1.6713	7.3257
Lab. Queue	52.2934	21.69	14.6596	106.00
Pharmacy. Queue	24.2325	7.75	9.9909	40.9875

Table 4.6 The number time

Number Time	Average	Half Width	Minimum Average	Maximum Average
Counter registration. Queue	0.6139	0.13	0.3059	0.8868
Doctor room1. Queue	0.8640	0.53	0.2413	2.8483
Doctor room2. Queue	0.7751	0.25	0.2323	1.4240
Lab. Queue	1.8968	0.96	0.3331	4.6781
Pharmacy. Queue	8.2062	2.96	2.8920	14.5225

Scenario 3: Add one more laboratory in the clinic

This scenario is the simulated scenario that not increase the service time in the clinic but stated same with the actual scenarios. Therefore, the current total of patient in a day can be around 100. Therefore, by using Arena simulation, it stated for 107 people in a day. Then, it is not really the effective way by adding the laboratory will increase

the patient in a day. Besides that, it shows that the queuing times for patient to get their treatment are not decrease.

Furthermore, the model was run for 10 replications with entities 107 patient. Moreover, for accumulated time, the higher average is at the doctor room which is 472.41. Then, the lowest accumulated time is at laboratory 2 which is 152.76. Therefore, the accumulated time at counter registration are 326.29, at laboratory 1 are 192.06, and at the pharmacy are 357.15.

Therefore, for queue waiting time, for the highest average are at the doctor room queue which are 76.1301. The lowest for queue waiting time are at the pharmacy queue which is 0.5310. Moreover, the highest average for number waiting is at the doctor room queue which is 27.1256 and the lowest average for number waiting is at the laboratory 2 queue which is 0.03493043.

Table 4.7 Accumulated time

Accum VA Time	**Average**	**Half Width**	**Minimum Average**	**Maximum Average**
Counter registration	326.29	13.62	283.98	356.06
Doctor room	472.41	4.55	456.13	477.87
Lab1	192.06	68.89	32.7598	353.03
Lab2	152.76	58.13	30.8113	282.70
Pharmacy	357.15	5.34	343.36	365.91

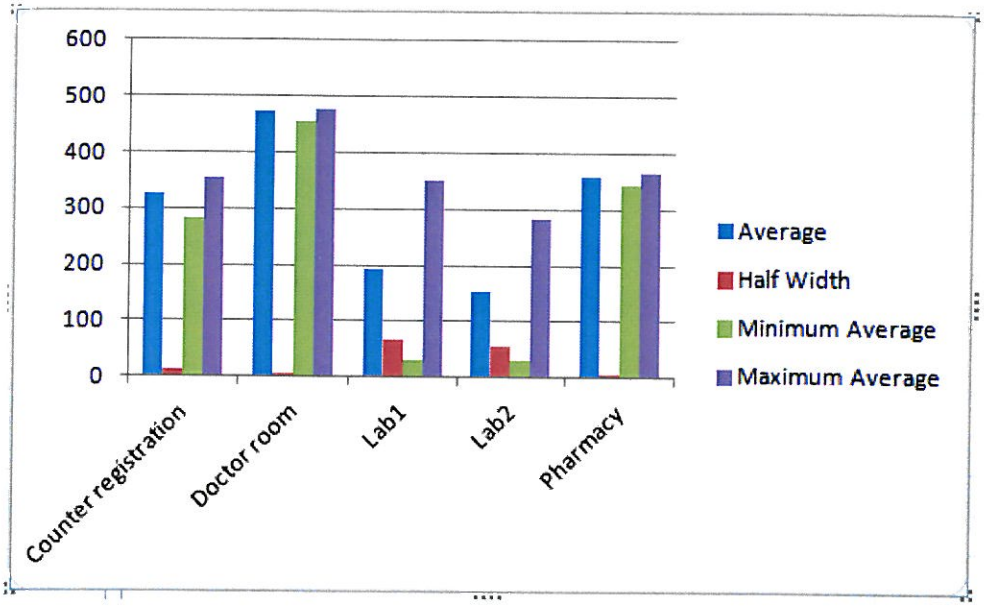

Figure 4.3 graft for scenario 3

Table 4.8 Queue time

Waiting Time	Average	Half Width	Minimum Average	Minimum Average
Counter registration. Queue	2.0352	0.48	1.1806	2.9697
Doctor room. Queue	76.1301	11.85	44.4718	91.0013
Lab1. Queue	10.5179	7.92	0.00	37.6700
Lab2. Queue	2.7492	2.00	0.00	6.7676
Pharmacy. Queue	0.5310	0.15	0.2689	0.8736

Table 4.9 The number time

Number Time	Average	Half Width	Minimum Average	Maximum Average
Counter registration. Queue	0.7208	0.3616	0.3059	1.1013
Doctor room. Queue	27.1256	14.9993	0.2413	36.2328
Lab1. Queue	0.1873	0.00	0.2323	0.8034
Lab2. Queue	0.03493043	0.00	0.3331	0.0965
Pharmacy. Queue	0.1192	0.05993292	2.8920	0.2002

4.4 SUMMARY

In this chapter, there have include the process flow of process in the clinic. Therefore, it used to understand more detailed about the process at the clinic. Then, it also include the process of apply the software simulation by using the current situation. It used to see and investigate the current situation at the clinic. Moreover, there also have "what if" analysis which is the changes that we make by using the software to get a better result of the process. By using the Arena software, it can make the clinic get the idea to make their process is better and it also can improve their service time.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

In this chapter, there will be a series of discussion on the model experimentation. The "what-if" analysis will carry out to the study and to see the changes that made n the model affect the output of the whole process in the clinic. Furthermore, there will also have some recommendations or suggestions provide in this chapter as well. It is important because the clinic can apply what the best result to improve their service time.

Therefore, the clinic can discuss and adapt the recommendation for get the better process at the clinic. The simulation software can give better result of what happen in the future and give initiative to do the changes of the process and add more section process to make service time smooth and faster. Furthermore, the simulation is the multifunctional use, so it can apply of many situation and type of process in the organization.

5.2 RECOMMENDATIONS

Waiting time and output from the designed model are important to a clinic because the smooth or not the process is depending to the queuing time. Then, it is not easy to identify the section or at which processes are affected. Therefore, there is the reason why the simulation is advised in studying for queuing process in the clinic and wants to improve the service time at the clinic.

Moreover, the simulation has been proven as a cost- saving tool and it also assists the user in making a reliable decision. In simulation, there are many things can be done. Then, a test can carry out easily just by changing the desired aspect that the clinic want process to be.

Furthermore, when modification is applied on the developed model, it can make the simulation run as the way it has been set in the time setup. Therefore, it means that the simulation software is able to compute a result on desired length of time which is based on all setting time such as arrival time, time at counter registration, time at doctor room, time at laboratory, time at pharmacy, and the leave time. It is able to run the models in year or in months in simulation software to come out the future result.

The time of expansion and compression in simulation allow the process in the clinic to faster or slow down the simulation process for deeply investigation by see the flow in the process. Moreover, the simulation is the tool that can save time rather than by observation at the clinic. The simulation process also can be fast forward in order to see the final result. It can make the clinic decide the best decision to improve their service time at the clinic.

5.3 CONCLUSIONS

Therefore, there are several processes that are needed to follow when in the clinic. The processes consist of four sections. It is difficult to determine where exactly the source of long queuing in that clinic. The simulation tool makes the process of identifying which sections take a long queuing more easily than observing one-by-one in the actual situation at the clinic.

Furthermore, it will begin with the model development in the Arena simulation software, the model needed to be validated and verified. After the validation and verification of model, the "what if" analysis will carry out for model experimentation. Thus, this is where there have several scenarios generated to look for improvement of service time of the queuing process in the clinic.

Moreover, in this study, the problems that are found in the clinic are at doctor room, counter registration and at the pharmacy. After the experimentation for the simulation model, the simulated output able to achieve the total of 138 patients in a day. It shows the improvement rather than the actual number of patient which is 107. Then, the clinic could their service time and can decrease waiting duration time. Besides that, the whole process of simulation is in the software, but not affects the real process in the clinic. Thus, the simulation is the effective way in improving the service time at the clinic.

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APPENDICES

APPENDIX A

GANTT CHART PSM 1

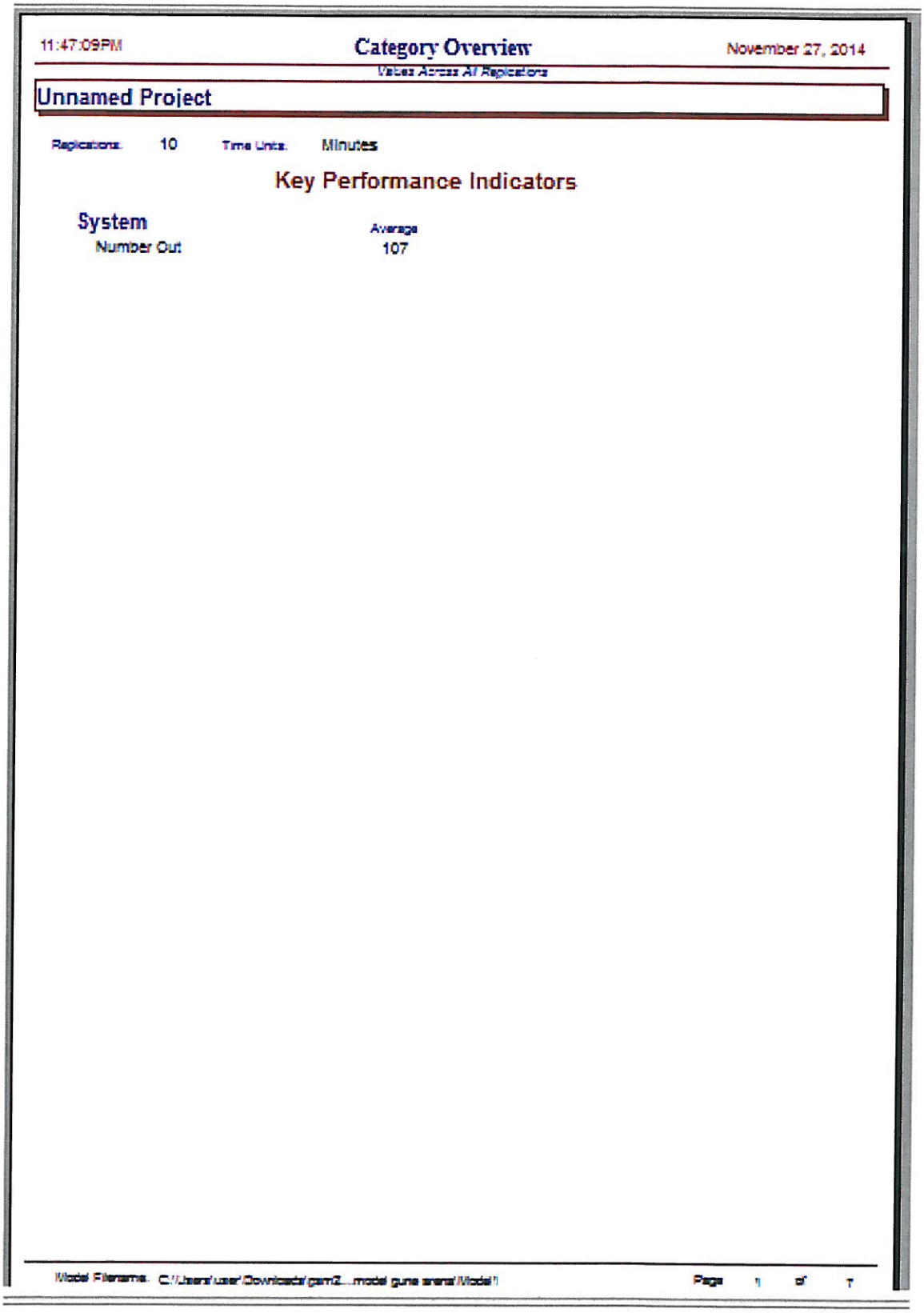
Task	Week															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Discuss with supervisor about title and objectives																
Submit the title of research and the objectives to FYP coordinator																
Meeting with supervisor to develop project proposal																
Discuss with supervisor about chapter 1 with supervisor and do the chapter 1																
Discuss with supervisor about literature review need in the issues of research and do chapter 2																
Discuss with supervisor about chapter 3 and get the guidelines to develop research methodology																
Discuss with supervisor about the software that are going to used																
Submit final report and log book to supervisor																
Prepare presentation slide																
Presentation of FYP 1																

GANTT CHART PSM 2

Task	Week												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Discuss with supervisor about the decided software													
Collect and conduct data analysis													
Discuss with supervisor about the data collection													
Submit Draft of report to supervisor about chapter 4													
Supervisor comment and advice for any correction													
Submit Draft of report to supervisor about chapter 5													
Supervisor comment and advice for any correction about chapter 5													
Submit final report and log book to supervisor for evaluation													
Prepare the poster for presentation													
Presentation of FYP 2													

APPENDIX B

Key Performance Indicators for Scenario 1



11:47:09PM **Category Overview** November 27, 2014

Values Across All Replications

Unnamed Project

Replications: 10 Time Units: Minutes

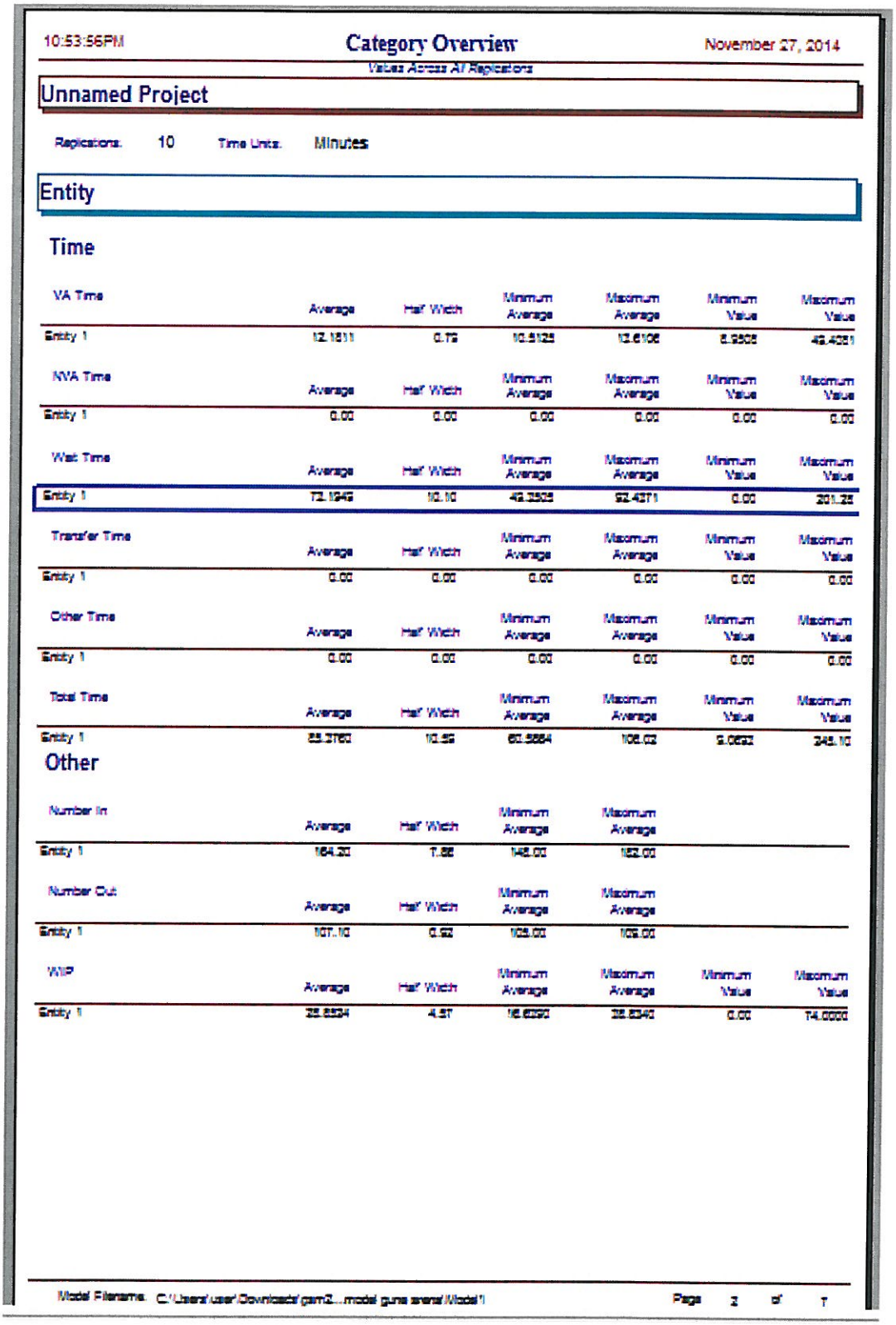
Key Performance Indicators

System

	Average
Number Out	107

Model Filename: C:\Users\user\Downloads\gam2...model guns arena\Model1 Page 1 of 1

Entity for Scenario 1



10:53:56PM **Category Overview** November 27, 2014

Values Across All Replications

Unnamed Project

Replications: 10 Time Units: Minutes

Entity

Time

VA Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	12.1811	0.79	10.5125	13.6106	5.9508	49.4251

NVA Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00

Wait Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	72.1945	10.10	49.3505	92.4371	0.00	201.25

Transfer Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00

Other Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00

Total Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	84.3760	10.52	61.5664	106.02	9.0632	245.10

Other

Number In	Average	Half Width	Minimum Average	Maximum Average
Entity 1	164.20	7.66	148.00	182.00

Number Out	Average	Half Width	Minimum Average	Maximum Average
Entity 1	107.10	0.92	103.00	109.00

WIP	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	25.8334	4.57	16.6290	35.8340	0.00	74.0000

Model Filename: C:\Users\user\Downloads\gsm2...model guns arena\Model1 Page 2 of 7

Process for Scenario 1

10:53:56PM **Category Overview** November 27, 2014

Values Across All Replications

Unnamed Project

Replications: 10 Time Units: Minutes

Process

Time per Entity

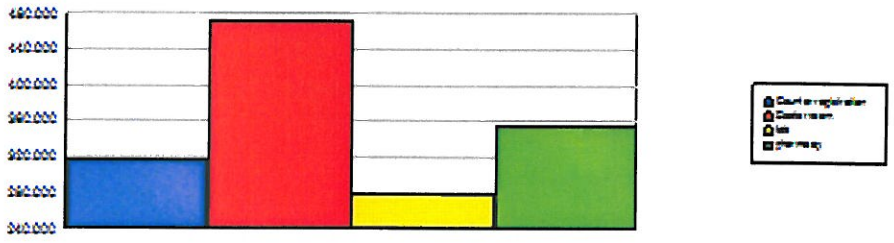
VA Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Counter registration	1.9440	0.00	1.9407	1.9475	1.9167	1.9992
Doctor room	4.3305	0.01	4.2957	4.3621	4.0007	4.9873
lab	34.8225	0.61	32.8035	35.7667	31.1672	38.3428
pharmacy	3.3209	0.01	3.2978	3.3543	3.0001	3.9456

Wait Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Counter registration	1.6562	0.27	1.1782	2.4365	0.00	12.6470
Doctor room	70.2548	9.00	48.2095	89.1441	0.00	181.32
lab	22.7453	17.91	0.00	69.1216	0.00	120.61
pharmacy	0.3656	0.11	0.1025	0.6141	0.00	2.4165

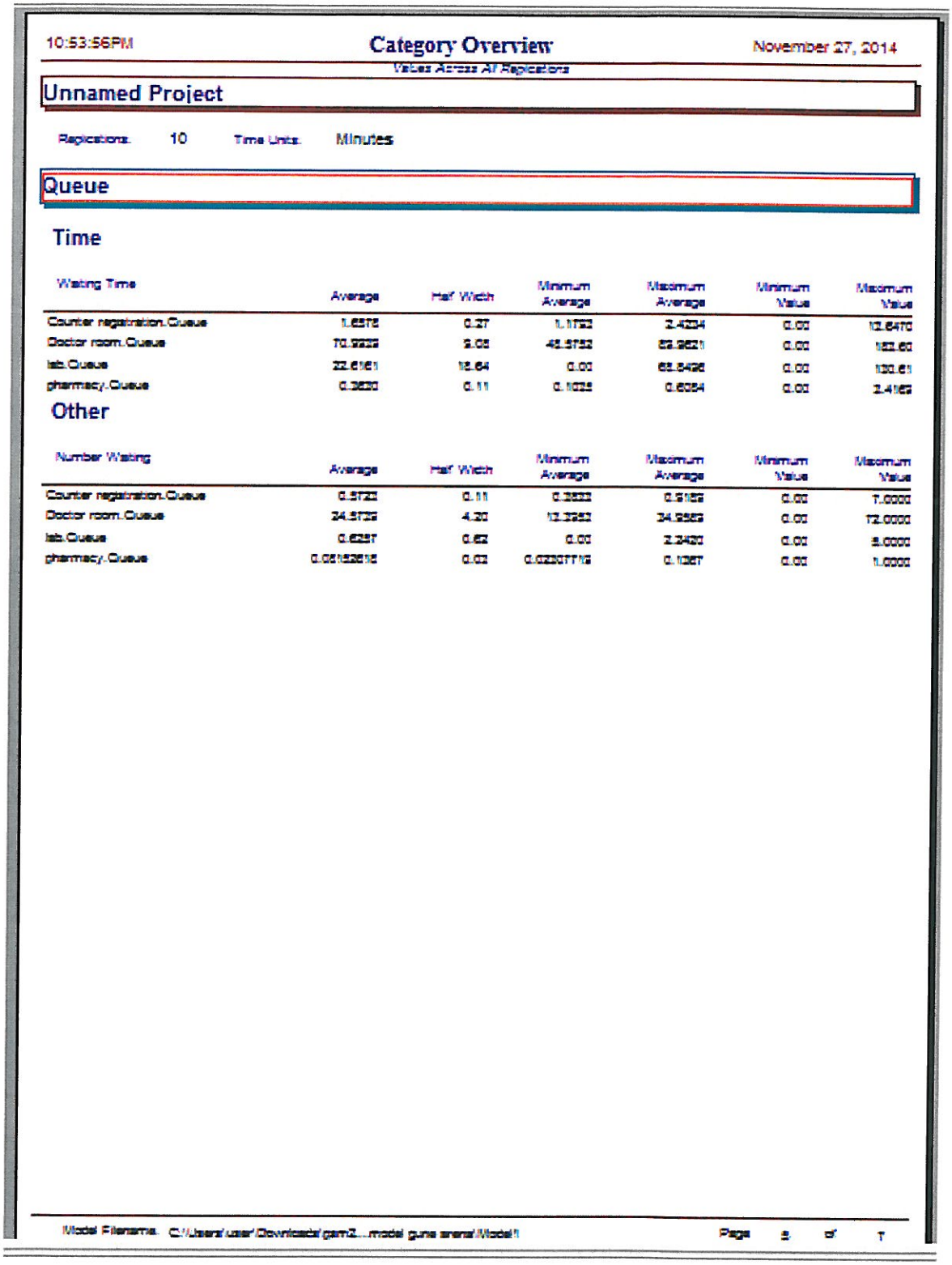
Total Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Counter registration	3.6002	0.27	3.1227	4.3782	1.9167	15.9734
Doctor room	74.6154	9.00	52.6716	93.4821	4.0156	185.54
lab	57.5703	18.03	32.8035	100.43	31.9622	162.95
pharmacy	3.6867	0.11	3.4196	3.9278	3.0001	6.8055

Accumulated Time

Accum VA Time	Average	Half Width	Minimum Average	Maximum Average
Counter registration	216.23	15.56	211.12	251.64
Doctor room	472.62	2.37	466.21	477.37
lab	279.46	87.32	95.4104	488.12
pharmacy	288.62	3.93	348.22	362.16



Queue for Scenario 1



10:53:56PM **Category Overview** November 27, 2014

Values Across All Replications

Unnamed Project

Replications: 10 Time Units: Minutes

Queue

Time

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Counter registration.Queue	1.6575	0.27	1.1792	2.4234	0.00	12.6470
Doctor room.Queue	70.9222	9.05	48.5752	89.9621	0.00	182.60
lab.Queue	22.6161	18.64	0.00	69.8496	0.00	190.61
pharmacy.Queue	0.3630	0.11	0.1025	0.6054	0.00	2.4162

Other

Number Waiting	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Counter registration.Queue	0.5722	0.11	0.3933	0.9189	0.00	7.0000
Doctor room.Queue	24.5722	4.20	12.3252	34.2585	0.00	72.0000
lab.Queue	0.6287	0.62	0.00	2.2420	0.00	8.0000
pharmacy.Queue	0.0215[illegible]	0.03	0.0220[illegible]	0.1387	0.00	1.0000

Model Filename: C:\Users\user\Downloads\gam2...model guns arena\Model1 Page 3 of 7

Resource for Scenario 1

10:53:56PM **Category Overview** November 27, 2014

Values Across All Replications

Unnamed Project

Replications: 10 Time Units: Minutes

Resource

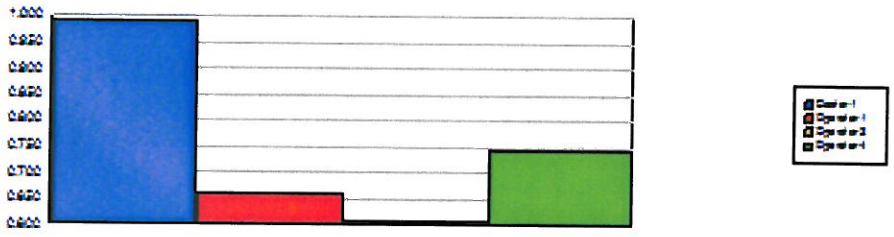
Usage

Instantaneous Utilization	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Doctor 1	0.9587	0.00	0.9520	0.9660	0.00	1.0000
Operator 1	0.6602	0.02	0.5810	0.7222	0.00	1.0000
Operator 2	0.6065	0.19	0.2305	0.9426	0.00	1.0000
Operator 4	0.7430	0.01	0.7202	0.7604	0.00	1.0000

Number Busy	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Doctor 1	0.9587	0.00	0.9520	0.9660	0.00	1.0000
Operator 1	0.6602	0.02	0.5810	0.7222	0.00	1.0000
Operator 2	0.6065	0.19	0.2305	0.9426	0.00	1.0000
Operator 4	0.7430	0.01	0.7202	0.7604	0.00	1.0000

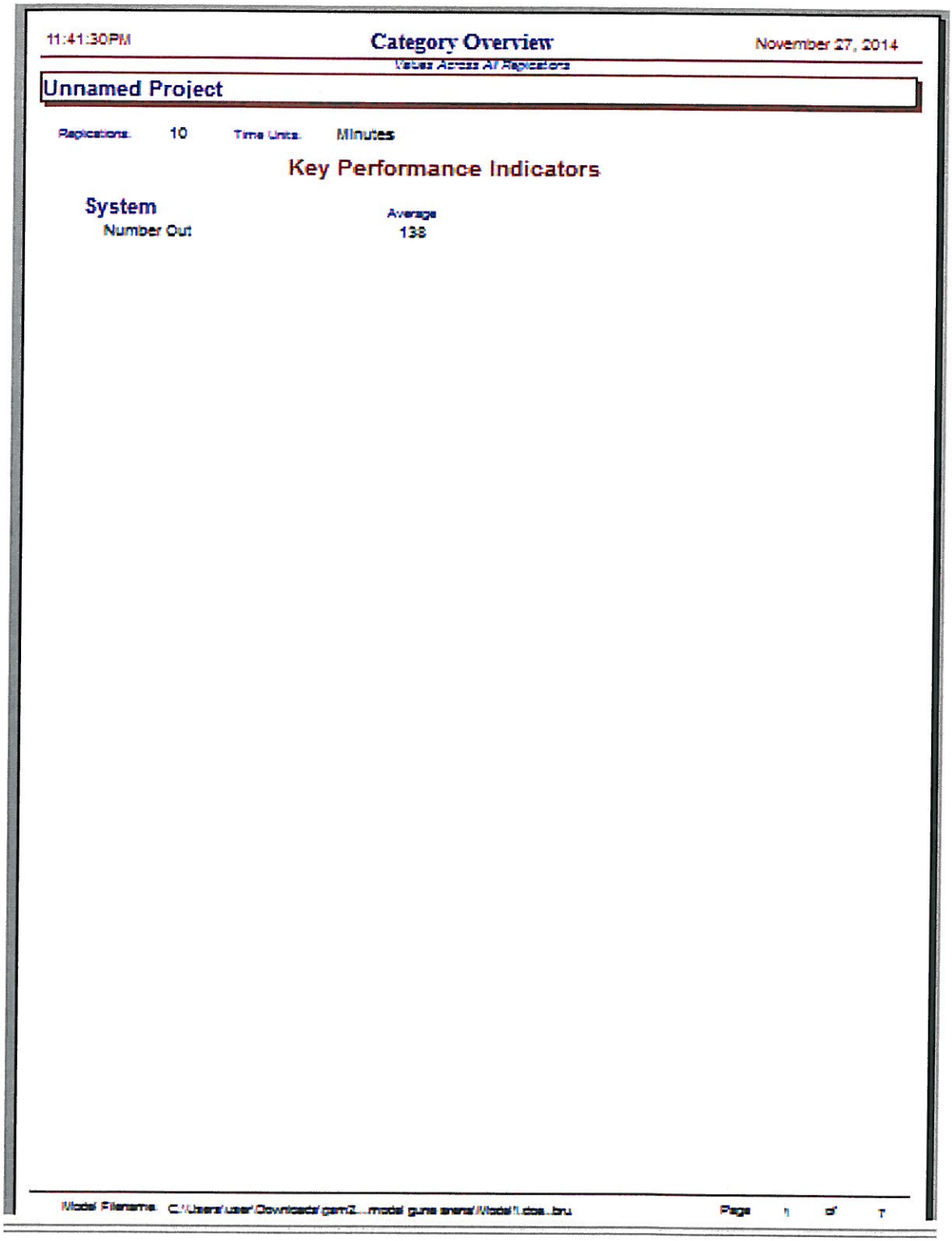
Number Scheduled	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Doctor 1	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Operator 1	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Operator 2	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Operator 4	1.0000	0.00	1.0000	1.0000	1.0000	1.0000

Scheduled Utilization	Average	Half Width	Minimum Average	Maximum Average
Doctor 1	0.9587	0.00	0.9520	0.9660
Operator 1	0.6602	0.02	0.5810	0.7222
Operator 2	0.6065	0.19	0.2305	0.9426
Operator 4	0.7430	0.01	0.7202	0.7604



Model Filename: C:\Users\user\Downloads\gsm2...model guns arena\Model1 Page 6 of 7

Key Performance Indicators for Scenario 2



11:41:30PM **Category Overview** November 27, 2014

Values Across All Replications

Unnamed Project

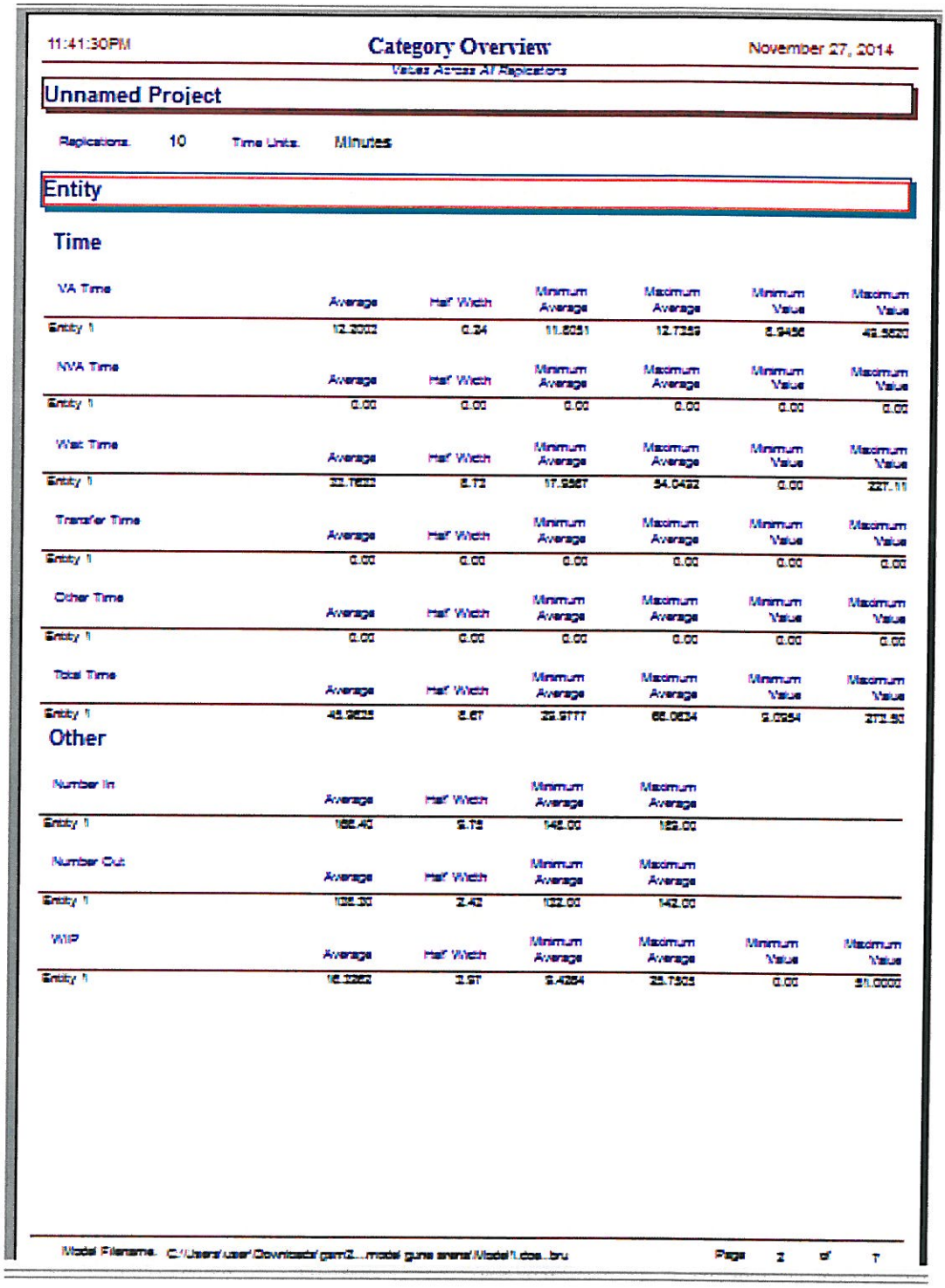
Replications: 10 Time Units: Minutes

Key Performance Indicators

System	Average
Number Out	138

Model Filename: C:\Users\user\Downloads\gam2...model guns arena\Model1.doe..bru Page 1 of 1

Entity for Scenario 2



11:41:30PM **Category Overview** November 27, 2014

Values Across All Replications

Unnamed Project

Replications: 10 Time Units: Minutes

Entity

Time

VA Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	12.2002	0.24	11.6051	12.7259	8.9456	48.5620

NVA Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00

Wait Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	33.7622	8.72	17.5367	54.0492	0.00	227.11

Transfer Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00

Other Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00

Total Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	45.9625	8.67	29.9777	66.0634	9.0954	272.50

Other

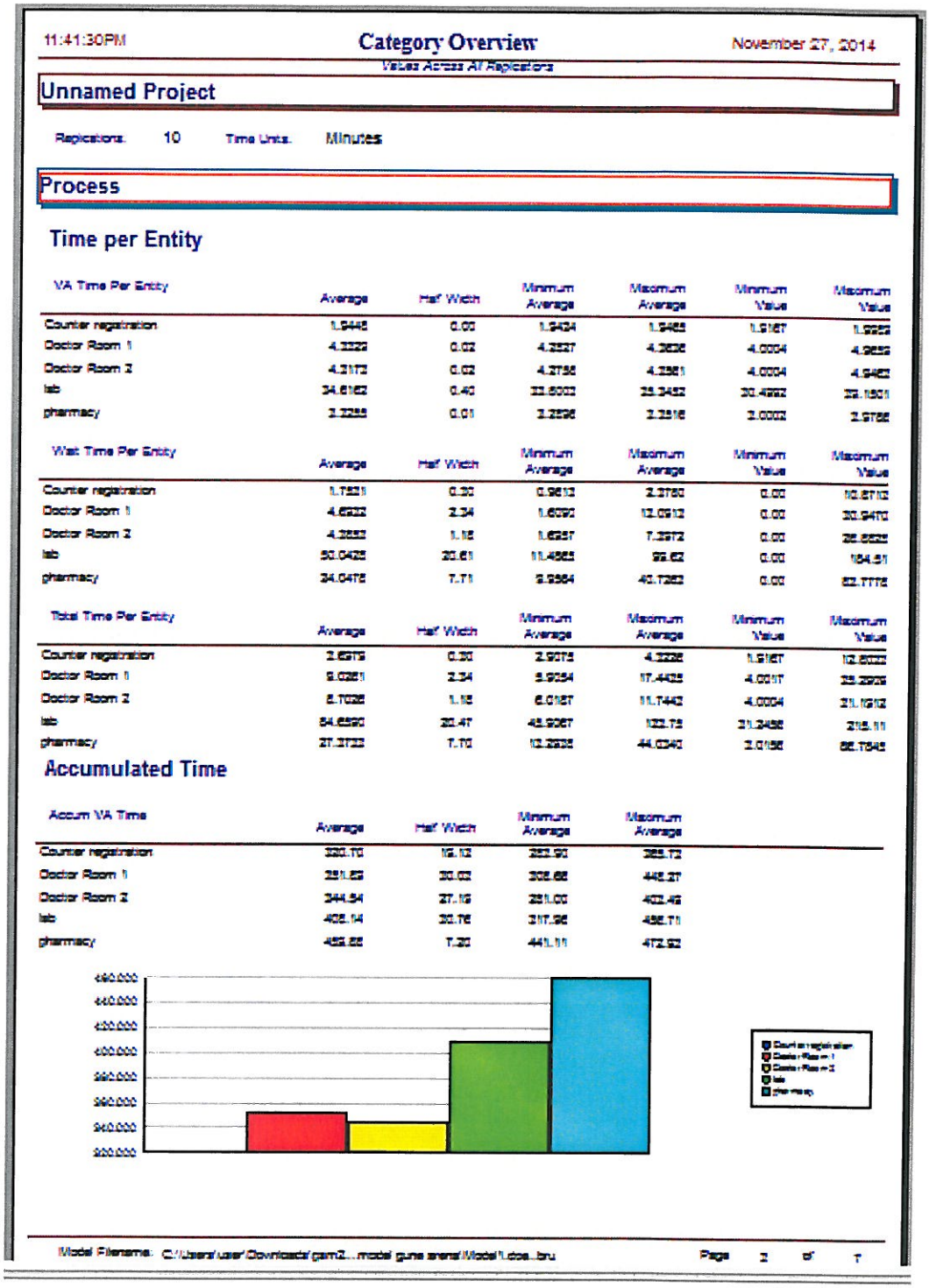
Number In	Average	Half Width	Minimum Average	Maximum Average
Entity 1	166.40	9.72	146.00	182.00

Number Out	Average	Half Width	Minimum Average	Maximum Average
Entity 1	126.30	2.42	122.00	142.00

WIP	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	16.3262	3.97	9.4264	28.7305	0.00	91.0000

Model Filename: C:\Users\user\Downloads\gam2....model guns arena\Model1.doe...bru Page 2 of 7

Process for Scenario 2



11:41:30PM **Category Overview** November 27, 2014

Values Across All Replications

Unnamed Project

Replications: 10 Time Units: Minutes

Process

Time per Entity

VA Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Counter registration	1.9448	0.00	1.9434	1.9465	1.9167	1.9833
Doctor Room 1	4.3322	0.02	4.2527	4.3636	4.0004	4.9652
Doctor Room 2	4.3172	0.02	4.2756	4.3561	4.0004	4.9482
lab	34.6162	0.40	33.6003	35.3452	30.4992	39.1601
pharmacy	3.3255	0.01	3.2596	3.3516	3.0003	3.9766

Wait Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Counter registration	1.7531	0.30	0.9613	2.2760	0.00	10.8713
Doctor Room 1	4.6232	2.34	1.6092	12.0912	0.00	30.9470
Doctor Room 2	4.2553	1.16	1.6257	7.2972	0.00	26.8222
lab	50.0425	20.61	11.4565	99.62	0.00	164.51
pharmacy	34.0475	7.71	9.9564	40.7262	0.00	82.7772

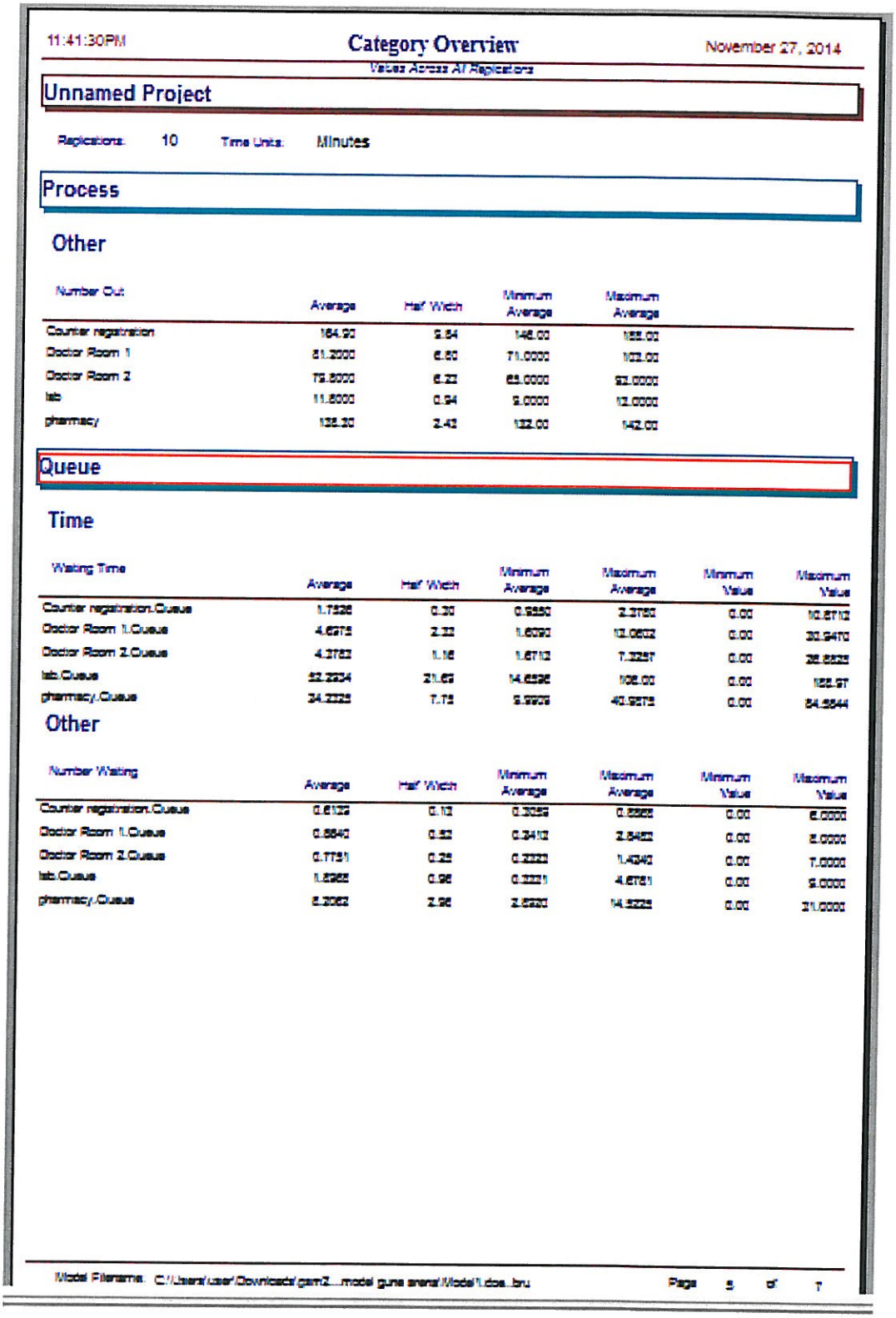
Total Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Counter registration	3.6979	0.30	2.9075	4.2226	1.9167	12.8033
Doctor Room 1	8.9261	2.34	5.9254	17.4425	4.0017	35.2929
Doctor Room 2	8.7026	1.16	6.0167	11.7442	4.0004	31.1612
lab	84.6590	20.47	45.9067	122.73	31.3456	215.11
pharmacy	37.3723	7.70	12.2935	44.0340	3.0156	86.7545

Accumulated Time

Accum VA Time	Average	Half Width	Minimum Average	Maximum Average
Counter registration	330.70	16.12	283.90	365.72
Doctor Room 1	351.69	30.02	308.66	446.27
Doctor Room 2	344.54	27.19	291.00	402.46
lab	405.14	30.76	317.96	456.71
pharmacy	459.66	7.20	441.11	472.52

Model Filename: C:\Users\user\Downloads\jam2...model guns arena\Model1.doe...bru Page 2 of 7

Queue for Scenario 2



11:41:30PM **Category Overview** November 27, 2014

Values Across All Replications

Unnamed Project

Replications: 10 Time Units: Minutes

Process

Other

Number Out	Average	Half Width	Minimum Average	Maximum Average
Counter registration	164.90	9.54	146.00	182.00
Doctor Room 1	81.2000	6.60	71.0000	103.00
Doctor Room 2	79.8000	6.22	65.0000	92.0000
lab	11.6000	0.94	9.0000	13.0000
pharmacy	135.30	2.42	132.00	142.00

Queue

Time

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Counter registration.Queue	1.7526	0.30	0.9550	2.3760	0.00	10.6712
Doctor Room 1.Queue	4.6275	2.33	1.6090	12.0602	0.00	30.9470
Doctor Room 2.Queue	4.3763	1.16	1.6713	7.3257	0.00	26.6525
lab.Queue	52.2224	21.63	14.6526	106.00	0.00	182.97
pharmacy.Queue	34.2325	7.75	9.9909	40.9275	0.00	84.5544

Other

Number Waiting	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Counter registration.Queue	0.6122	0.12	0.3058	0.8868	0.00	6.0000
Doctor Room 1.Queue	0.5642	0.52	0.2410	2.5452	0.00	5.0000
Doctor Room 2.Queue	0.7751	0.25	0.2322	1.4240	0.00	7.0000
lab.Queue	1.2965	0.96	0.2231	4.6751	0.00	9.0000
pharmacy.Queue	5.2062	2.96	2.5920	14.5225	0.00	21.0000

Model Filename: C:\Users\user\Downloads\gam2....model guns arena\Model1.doe..bru Page 5 of 7

Resource for Scenario 2

11:41:30PM **Category Overview** November 27, 2014

Values Across All Replications

Unnamed Project

Replications: 10 Time Units: Minutes

Resource

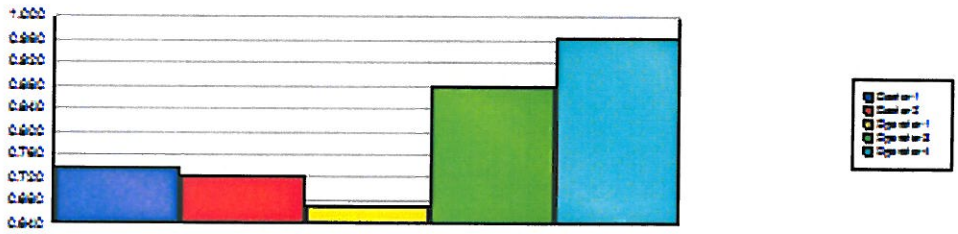
Usage

Instantaneous Utilization	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Doctor 1	0.7272	0.06	0.6444	0.8258	0.00	1.0000
Doctor 2	0.7226	0.06	0.5911	0.8452	0.00	1.0000
Operator 1	0.6697	0.04	0.5940	0.7633	0.00	1.0000
Operator 2	0.8790	0.07	0.8634	0.9366	0.00	1.0000
Operator 4	0.9617	0.01	0.9228	0.9868	0.00	1.0000

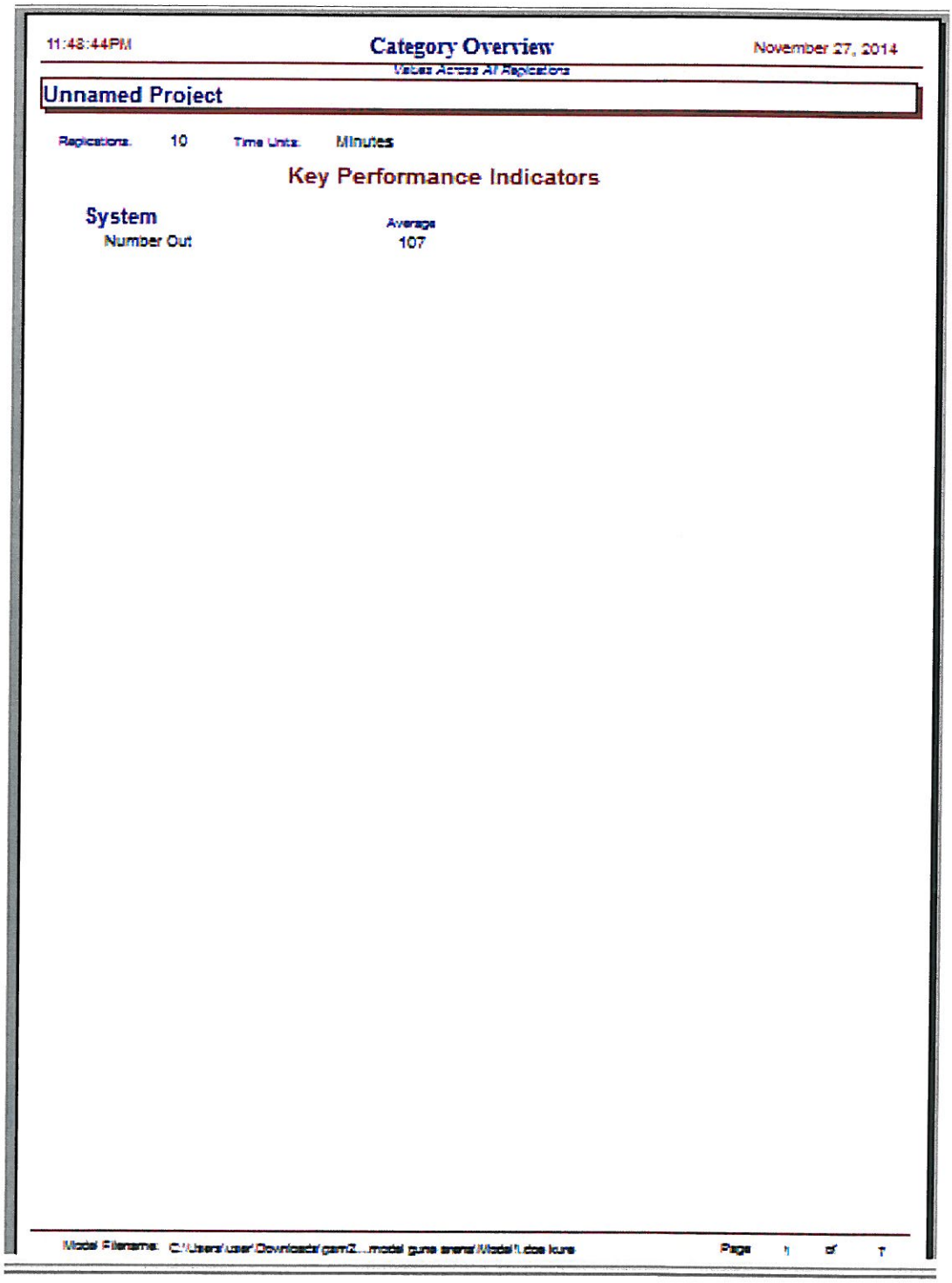
Number Busy	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Doctor 1	0.7272	0.06	0.6444	0.8258	0.00	1.0000
Doctor 2	0.7226	0.06	0.5911	0.8452	0.00	1.0000
Operator 1	0.6697	0.04	0.5940	0.7633	0.00	1.0000
Operator 2	0.8790	0.07	0.8634	0.9366	0.00	1.0000
Operator 4	0.9617	0.01	0.9228	0.9868	0.00	1.0000

Number Scheduled	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Doctor 1	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Doctor 2	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Operator 1	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Operator 2	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Operator 4	1.0000	0.00	1.0000	1.0000	1.0000	1.0000

Scheduled Utilization	Average	Half Width	Minimum Average	Maximum Average
Doctor 1	0.7272	0.06	0.6444	0.8258
Doctor 2	0.7226	0.06	0.5911	0.8452
Operator 1	0.6697	0.04	0.5940	0.7633
Operator 2	0.8790	0.07	0.8634	0.9366
Operator 4	0.9617	0.01	0.9228	0.9868



Key Performance Indicators for Scenario 3



11:48:44PM **Category Overview** November 27, 2014

Values Across All Replications

Unnamed Project

Replications: 10 Time Units: Minutes

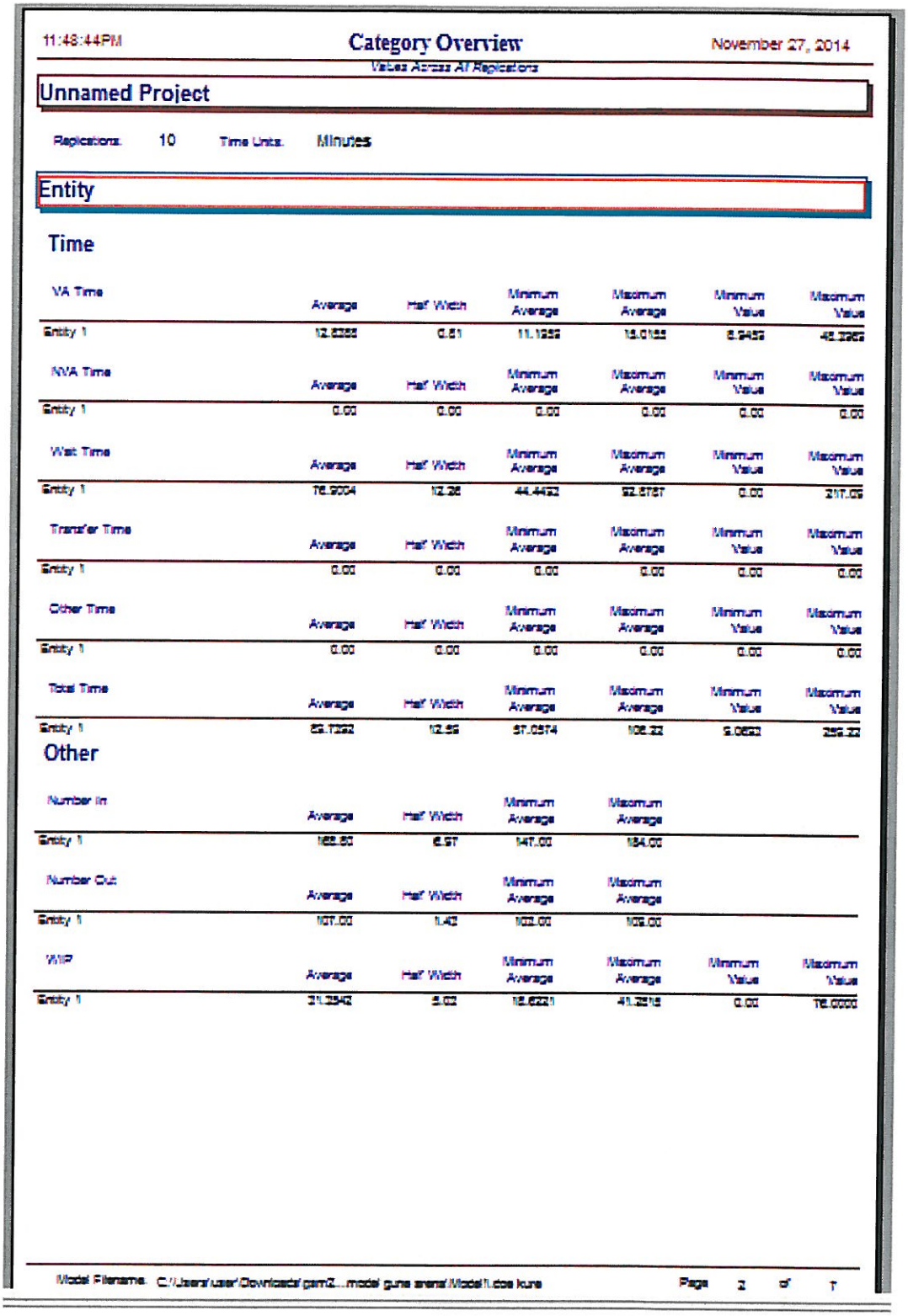
Key Performance Indicators

System

	Average
Number Out	107

Model Filename: C:\Users\user\Downloads\gsm2...model guns arena\Model\Ldoe kure Page 1 of 1

Entity for Scenario 3



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Values Across All Replications

Unnamed Project

Replications: 10 Time Units: Minutes

Entity

Time

VA Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	12.6288	0.51	11.1258	15.0155	6.9452	45.2969

NVA Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00

Wait Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	78.9004	12.26	44.4432	92.6767	0.00	217.09

Transfer Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00

Other Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00

Total Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	89.7292	12.56	57.0574	108.22	9.0652	259.22

Other

Number In	Average	Half Width	Minimum Average	Maximum Average
Entity 1	168.80	6.97	147.00	184.00

Number Out	Average	Half Width	Minimum Average	Maximum Average
Entity 1	167.00	1.42	162.00	169.00

WIP	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	31.3542	4.02	18.6221	41.2218	0.00	76.0000

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Process for Scenario 3

11:48:44PM **Category Overview** November 27, 2014

Values Across All Replications

Unnamed Project

Replications: 10 Time Units: Minutes

Process

Time per Entity

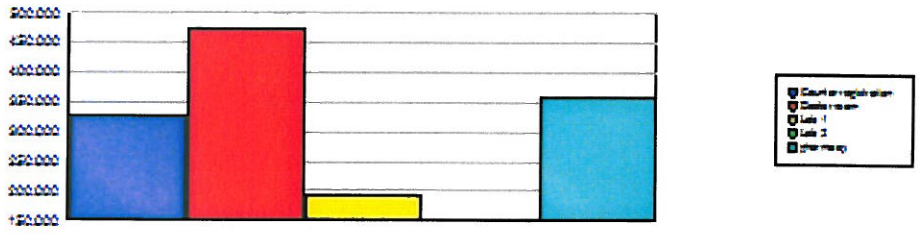
VA Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Counter registration	1.9445	0.00	1.9422	1.9468	1.9167	1.9972
Doctor room	4.2301	0.02	4.2629	4.2690	4.0001	4.9526
Lab 1	34.6467	0.65	32.7525	35.9435	31.2726	38.6425
Lab 2	34.4145	1.05	30.6113	36.1225	30.1450	38.7442
pharmacy	3.3276	0.02	3.3133	3.3787	3.0002	3.9567

Wait Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Counter registration	2.0400	0.48	1.1605	2.9565	0.00	17.4187
Doctor room	75.2360	11.60	42.7514	90.1903	0.00	192.61
Lab 1	9.5540	7.70	0.00	36.1461	0.00	104.77
Lab 2	2.9276	2.21	0.00	8.3116	0.00	21.3257
pharmacy	0.5342	0.15	0.2714	0.8216	0.00	5.9206

Total Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Counter registration	3.9546	0.45	3.1256	4.9220	1.9165	19.3595
Doctor room	79.6661	11.60	46.0264	94.5462	4.0144	202.65
Lab 1	44.5307	7.77	32.7525	70.2345	31.2726	137.09
Lab 2	37.4224	2.59	30.6113	43.5676	30.1450	63.9492
pharmacy	3.8720	0.15	3.5699	4.2088	3.0002	9.4962

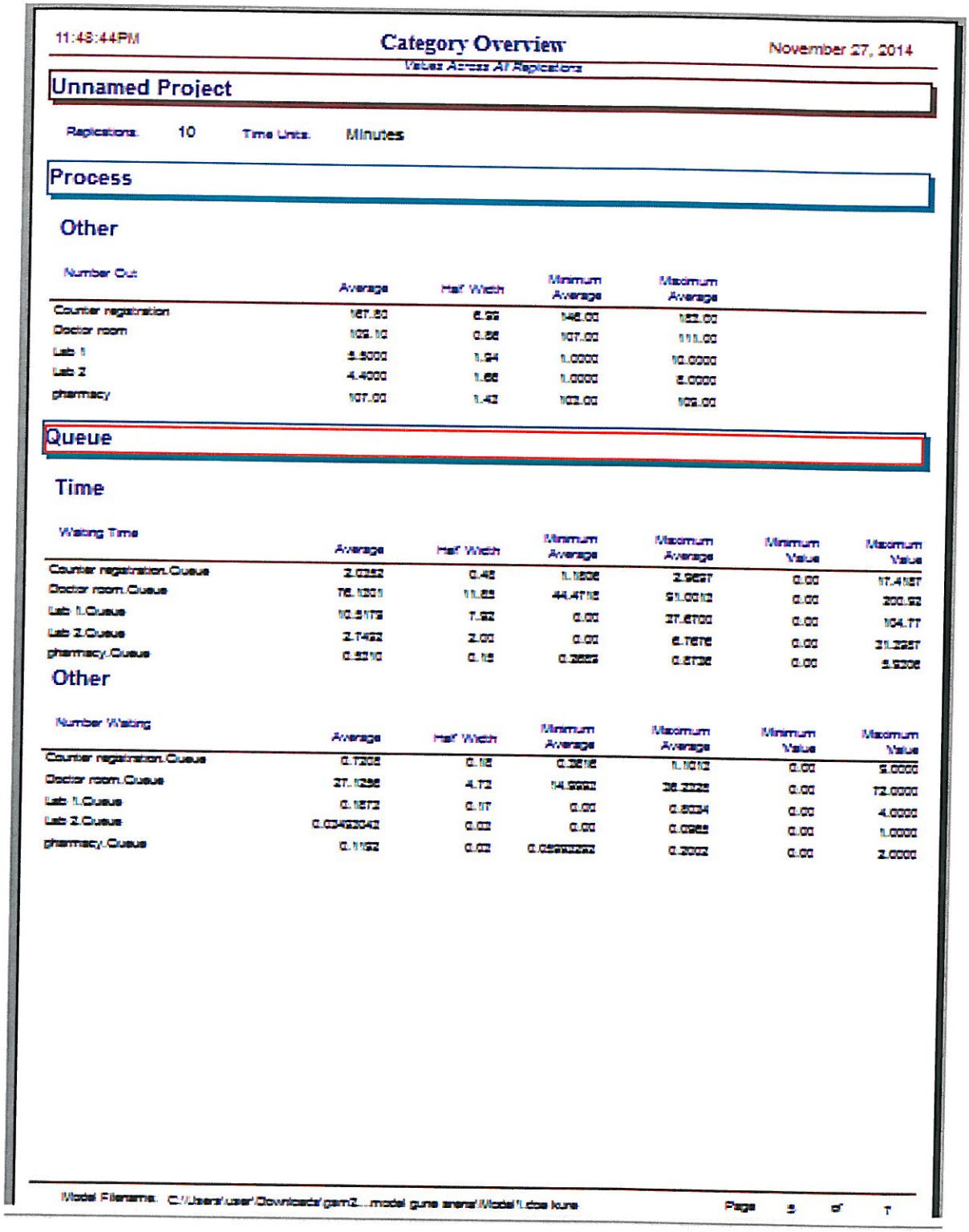
Accumulated Time

Accum VA Time	Average	Half Width	Minimum Average	Maximum Average
Counter registration	336.29	13.62	283.95	356.06
Doctor room	472.41	4.85	456.13	477.87
Lab 1	192.06	65.85	32.7525	353.02
Lab 2	152.76	56.13	30.6113	252.70
pharmacy	257.16	5.34	242.36	265.91



Model Filename: C:\Users\user\Downloads\gam2...model guna arena\Model1.doe kure Page 2 of 7

Queue for Scenario 3



11:48:44PM **Category Overview** November 27, 2014

Values Across All Replications

Unnamed Project

Replications: 10 Time Units: Minutes

Process

Other

Number Out

	Average	Half Width	Minimum Average	Maximum Average
Counter registration	167.80	6.99	146.00	183.00
Doctor room	109.10	0.56	107.00	111.00
Lab 1	5.5000	1.94	1.0000	10.0000
Lab 2	4.4000	1.66	1.0000	8.0000
pharmacy	107.00	1.42	102.00	109.00

Queue

Time

Waiting Time

	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Counter registration.Queue	2.0252	0.42	1.1206	2.9627	0.00	17.4167
Doctor room.Queue	76.1301	11.85	44.4716	91.0013	0.00	200.92
Lab 1.Queue	10.5179	7.92	0.00	27.6700	0.00	104.77
Lab 2.Queue	2.7422	2.00	0.00	6.7676	0.00	31.2257
pharmacy.Queue	0.5310	0.15	0.2662	0.6736	0.00	5.9206

Other

Number Waiting

	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Counter registration.Queue	0.7205	0.16	0.3816	1.1012	0.00	9.0000
Doctor room.Queue	27.1256	4.72	14.9992	36.2226	0.00	72.0000
Lab 1.Queue	0.1872	0.17	0.00	0.5034	0.00	4.0000
Lab 2.Queue	0.03492042	0.03	0.00	0.0965	0.00	1.0000
pharmacy.Queue	0.1162	0.02	0.05992282	0.2002	0.00	2.0000

Model Filename: C:\Users\user\Downloads\gam2...model guna arena\Model1.doe kure Page 5 of 7

Resource for Scenario 3

11:48:44PM **Category Overview** November 27, 2014

Values Across All Replications

Unnamed Project

Replications: 10 Time Units: Minutes

Resource

Usage

Instantaneous Utilization	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Doctor 1	0.9570	0.01	0.9516	0.9960	0.00	1.0000
Nurse 1	0.4162	0.15	0.06834956	0.7255	0.00	1.0000
Nurse 2	0.3327	0.12	0.06419027	0.5690	0.00	1.0000
Operator 1	0.6509	0.03	0.5921	0.7447	0.00	1.0000
Operator 4	0.7464	0.01	0.7162	0.7845	0.00	1.0000

Number Busy	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Doctor 1	0.9570	0.01	0.9516	0.9960	0.00	1.0000
Nurse 1	0.4162	0.15	0.06834956	0.7255	0.00	1.0000
Nurse 2	0.3327	0.12	0.06419027	0.5690	0.00	1.0000
Operator 1	0.6509	0.03	0.5921	0.7447	0.00	1.0000
Operator 4	0.7464	0.01	0.7162	0.7845	0.00	1.0000

Number Scheduled	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Doctor 1	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Nurse 1	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Nurse 2	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Operator 1	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Operator 4	1.0000	0.00	1.0000	1.0000	1.0000	1.0000

Scheduled Utilization	Average	Half Width	Minimum Average	Maximum Average
Doctor 1	0.9570	0.01	0.9516	0.9960
Nurse 1	0.4162	0.15	0.06834956	0.7255
Nurse 2	0.3327	0.12	0.06419027	0.5690
Operator 1	0.6509	0.03	0.5921	0.7447
Operator 4	0.7464	0.01	0.7162	0.7845