إقـــــرار

أنا الموقع أدناه مقدم الرسالة التي تحمل العنوان:

THE USE OF SIMULATION TO EVALUATE AND ENHANCE THE PERFORMANCE OF PASSPORTS AND CIVIL AFFAIRS SECTOR

(A CASE STUDY ON GAZA DIRECTORATE)

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THE USE OF SIMULATION TO EVALUATE AND ENHANCE THE PERFORMANCE OF PASSPORTS AND CIVIL AFFAIRS SECTOR

(A CASE STUDY ON GAZA DIRECTORATE)

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نتيجة الحكم على أطروحة ماجستير

بناءً على موافقة شئون البحث العلمي والدراسات العليا بالجامعة الإسلامية بغزة على تشكيل لجنة الحكم على أطروحة الباحث/ **إبراهيم عبد ربه سليمان أبو جبل** لنيل درجة الماجستير في **كلية *التجارة*/** قسم **إدارة الأعمال** وموضوعها:

The Use of Simulation To Evaluate And Enhance The Performance Of Passports And Civil Affairs sector

A Case Study on Gaza Directorate

وبعد المناقشة التي تمت اليوم الثلاثاء 20 ربيع الأول 1435 هـ، الموافق 2014/01/21 الساعة الثانية عشرة ظهراً، اجتمعت لجنة الحكم على الأطروحة والمكونة من:

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وبعد المداولة أوصت اللجنة بمنح الباحث درجة الماجستير في **كلية *التجارة*/** قسم **إدارة الأعمال**.

واللجنة إذ تمنحه هذه الدرجة فإنها توصيه بتقوى الله ولزوم طاعته وأن يسخر علمه في خدمة دينه ووطنه.

والله ولي التوفيق ،،،

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THE USE OF SIMULATION TO EVALUATE AND ENHANCE THE PERFORMANCE OF PASSPORTS AND CIVIL AFFAIRS SECTOR
(A CASE STUDY ON GAZA DIRECTORATE)

ABSTRACT

In this thesis, the proposed project intends to study the use of Decision Support Systems in simulating Gaza Civil Affairs and Passports Directorate (GCAPD) through identifying the current environment, analyzing the status, and proposing a new system using simulation to determine the optimal number of service providers for the system in order to reduce the postponement of the public services.

Arena 14.00 simulation software is used for developing and running the simulation experiments. Arena Input analyzer is used for fitting the probability distributions for different processes.

The simulation results for the current system showed that some problems related to the shortage of employees and other problems found due to some operating policies and decisions**.**

Results of optimized simulation model showed that performance of the GCAPD was better overall compared to the current system. Waiting time was reduced by 89% on average, while number of processed documents was increased by 44.2%.

The optimized solution for the GCAPD is acquiring to hire two new employees, one for printing in reception hall and the other is for montage in printing department and to transfer application forms every 60 minutes. The research emphasized that the simulation models should be applied to other real world applications in service and manufacturing systems specially systems that have waiting lines such as banks , hospitals and call centers and the Palestinian government should adopt and implement simulation for decision making in other public service facilities to improve service and to save effort and time needed to find problems and solutions since time of trial and error is over.

استخدام المحاكاة لتقييم وتحسين أداء قطاع الجوازات والاحوال المدنية
(دراسة حالة على مديرية غزة)

ملخص الرسالة

يهدف المشروع المقترح في هذه الاطروحة الى دراسة استخدام نظم دعم القرار في محاكاة مديرية غزة للجوازات والاحوال المدنية من خلال التعرف على البيئة الحالية، تحليل الوضع القائم، واقتراح نظام جديد باستخدام المحاكاة لتحديد العدد الأمثل من مقدمي الخدمات للنظام من أجل الحد من تأجيل واصدار الخدمات العامة.

في هذه الدراسة تم استخدام برنامج Arena 14.00 لبناء وتشغيل تجارب المحاكاة. وتم استخدام Arena Input analyzer لوضع توزيعات احتمالية ملائمة للأزمنة المسجلة في العمليات المختلفة.

وأظهرت نتائج المحاكاة للنظام الحالي أن بعض المشاكل متعلقة بنقص في الموظفين وغيرها من المشاكل ظهرت بسبب بعض سياسات وقرارات التشغيل. وقد بينت نتائج نموذج المحاكاة المحسن أن اداة مديرية غزة للجوازات والاحوال المدنية كان أفضل عموما مقارنة مع النظام الحالي .فقد تم تخفيض وقت الانتظار كثيرا بنسبة 89٪ في المتوسط، في حين تم زيادة عدد الوثائق التي يتم معالجتها وطباعتها بمعدل 44.2٪.

النظام المعدل والمقترح لمديرية غزة يحتاج لتوظيف عاملين أحدهما لطباعة الوثائق في صالة الاستقبال والأخر لعمل المونتاج النهائي في قسم الطباعة ونقل الطلبات لقسم الطباعة كل 60 دقيقة. وتؤكد الدراسة على أن نماذج المحاكاة يجب ان تطبق في مجالات الحياة سواء الخدمية او الصناعية وخاصة الأنظمة التي تحتوي على طوابير انتظار مثل البنوك، المستشفيات ومراكز الاتصال ويجب على الحكومة الفلسطينية اعتماد وتطبيق المحاكاة كأسلوب اتخاذ قرار في مؤسسات الخدمات العامة الأخرى وذلك لتحسين هذه الخدمات وتوفير الوقت والجهد في البحث عن المشكلات وإيجاد حلول لها لان زمن المحاولة والخطأ قد انتهى.

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ABBREVIATIONS

AIA	Arena Input Analyzer
ATM	Automated Teller Machine
DBMS	Database management system
DES	Discrete Event Simulation
DGMS	Dialog generation and management system
DSS	Decision support systems
ED	Emergency Department
GCAPD	Gaza civil affairs and passports directorate
ID	Identity card
KD-DSSs	knowledge-driven decision support systems
MBMS	Model-base management system
OVS	optimization via simulation
PCBS	Palestinian Central Bureau of Statistics
SIMAN	Simulations Manager
WSC	Winter Simulation Conference

CHAPTER ONE

INTRODUCTION

This chapter consists of the following sections:

1.1. Introduction

1.2. Research Problem

1.3. Research Objectives

1.4. Research Importance

1.5. Research Methodology and Design

1.6. Sources of Data

1.7. Previous Studies

1.1. Introduction

Government capacity to respond to societal demands for inclusive and high-quality public services is challenged by both internal and external factors, such as tight budgetary and fiscal environments, changing individual and societal preferences and needs, and new and complex societal problems. Governments have recognized that innovation can help increase the performance of public services in terms of outputs, efficiency, effectiveness, equity and responsiveness to user needs (OECD, 2011).

Discrete Event Simulation (DES) has been identified as one of the most used techniques in the area of operations management (Alabdulkarim et al. 2011). DES has also been used as a decision instrument. Especially in recognizing the bottlenecks and choosing the appropriate policies by means of simulation and optimization (Ali et al. 2008)

Simulation is used to model the behavior and subsequent performance of complex systems within a discrete time frame. Simulation has been used extensively for manufacturing systems modeling and increasingly it is used for service systems (Altuger and Chassapis 2009).

One feature of simulation is that one can change the parameters of a simulation model easily and try to observe the system performance under different sets of parameters. Therefore, it is natural trying to find the set of parameters that optimizes the system performance. This what is called optimization via simulation (OVS) (Hong and Nelson 2009).

The focus of this research will be on utilizing simulation to evaluate and enhance the performance of passports and civil affairs sector in Gaza. Therefore, it would be implemented on Gaza directorate.

The passports and civil affairs sector is divided into two departments. The General Administration of Civil Affairs and the General Administration of Passports. It issues four main documents to Palestinian citizens: Passports, Birth Certificates, Family Books and Identity Cards in addition to correction some information and Death Certificate .

1.2. Research Problem

The passports and civil affairs sector at the Ministry of Interior provides many services to the public. The most prominent of these services is printing identity cards, birth certificates and renewing passports It is noticeable that these services and transactions are what help people to manage their life such as asking for salary allowances, urgent travel, changing address (Hemdiat, 2012).

Therefore, the rapid completion of these transactions is a key demand of the public, but most of these services are completed in more than a day what creates an atmosphere of discontent. This situation requires substantial improvements in the Passports and Civil Affairs Sector to speed up the completion of services.

The proposed thesis intends to use Decision Support Systems in simulating Passports and Civil Affairs Sector through identifying the current environment, analyzing the status and testing its idealism, and proposing a new system using simulation to determine the optimal number of service providers for the system in order to reduce the postponement of the public services.

Accordingly, the problem can be formulated by the following questions:

A. Does the Passports and Civil Affairs Sector work at an optimal level?
B. Is there a delay in issuing documents to the public? If yes, what are the reasons?
C. What are the proposed solutions to improve the performance of the sector?

1.3. Research Objectives

The main objective of this research is to evaluate and enhance the performance of the passports and civil affairs sector in Gaza strip.

This main objective can be achieved by implementing the following specific tasks:

A. To identify the possible factors that may affect the workflow and increase the waiting lines of transactions at Gaza Directorate (bottlenecks).
B. To build a simulation model for passports and civil affairs directorate to develop the performance in order to reduce customers "transactions" waiting time.
C. To choose the optimal solution for a particular system which is suggested as our case study.
D. To suggest some recommendations that will draw the officials' attention to the importance of using quantitative methods and computer application in analyzing problems and taking the right decisions.

1.4. Research Importance

A- The proposed research is one of the first researches that is utilizing simulation to enhance the performance of a real-world system in Gaza as intended to do with passports and civil affairs sector.

B- While most studies concentrate on separated decision or business process problems, such as production planning, queuing problems, waiting time, business process evaluation and dealing with time machine failure; this research concentrates on the complete service system process and evaluation. Therefore, it is hoped that this research will, in a small way, contribute to the limited literature of complete system problems.

C- Gaza Directorate printed and registered about 1300 birth certificates and more than 1400 Identity cards in November 2012, which means issuing 100 to 130 documents daily. Therefore, issuing such documents need 24 to 48 hours to complete, services system must be developed to cope with the continuous increase on demand and to decrease waiting time by people. And in order to ease suffering, we suggest this research.

1.5. Research Methodology and Design

1.5.1. Research Methodology

The proposed case study is using simulation approach to evaluate and enhance the performance of the passports and civil affairs sector in Palestine. Gaza directorate is selected to make the research as it is the largest in Gaza strip also it is a complete system starts with requests and ends with printed documents. Arena simulation software is used to develop the simulation model of the public service office.

The developed framework comprises two parallel yet interrelated processes; the simulation process and the optimization process as shown in figure (1.1).The functionality of both processes eventually leads to obtaining a near-optimal solution to enhance the performance of the underlying system.

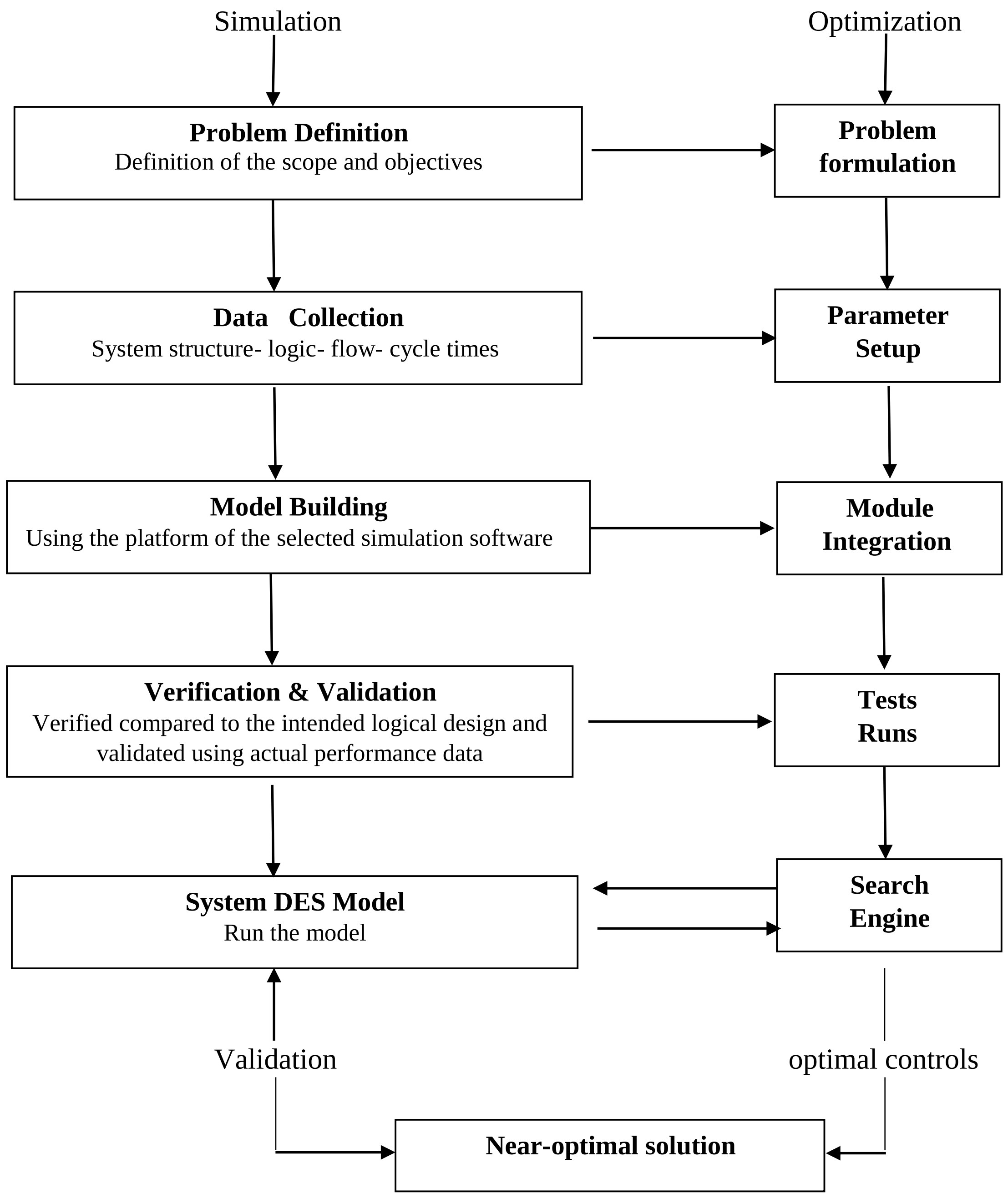


Figure (1.1) Framework for Simulation-based Optimization

1.5.2. Research Population

The population of this research includes all passports and civil affairs directorates in Gaza strip.

1.5.2.1. Research Sample

The sample of this research will be Gaza directorate because it is the biggest in Gaza Strip and provides service to 600000 person. It also has the complete system of service.

1.6. Sources of Data

1.6.1 The Primary Source

Inter-arrival, service rates and system procedures will be collected through direct observation and historical records.

1.6.2. The Secondary Source

Other sources of information will be used such as books, periodicals, published papers and articles to form a comprehensive understanding related to the research throughout the literature and the theoretical framework.

1.7. Previous Studies

1.7.1. Healthcare Applications:

1- Eskandari, H.et. al. (2011): "Improving the emergency department performance using simulation and mcdm methods"

The goal of this study was examination of processes in Emergency Department (ED) of a governmental hospital in Iran and identifying bottlenecks that lead to long waiting times. Simulation was used first to identify bottlenecks of the process and second to evaluate different scenarios developed for overcoming these bottlenecks in order to decrease waiting time of the patients in the ED. Fourteen scenarios have been developed and evaluated and the last scenario was selected as the best one. This scenario is a combination scenario which recommends considering priority for ED patients in the magnetic resonance imaging (MRI) and computerized axial tomography (CT) scan ward over non-ED patients whilst adding five mobile beds in inpatient ward and a new staff in financial department. By applying scenario 14 it is forecasted that waiting time of ED patients will be reduced by 42.3%.

2- Nafarrate, A. R. et. Al. (2011): "Design of centralized ambulance diversion policies using simulation-optimization"

Ambulance Diversion (AD) has been an issue of concern for the medical community because of the potential harmful effects of long transportation; however, AD can be used to reduce the waiting time in Emergency Departments (EDs) by redirecting patients to less crowded facilities. This paper proposes a Simulation-Optimization approach to find the appropriate parameters of diversion policies for all the facilities in a geographical area to minimize the expected time that patients spend in non-value added activities, such as transporting, waiting and boarding. In addition, two destination policies are tested in combination with the AD policies. The use of diversion and destination policies can be seen as ambulance flow control within an emergency care system. The results of this research show significant improvement in the flow of emergency patients in the system as a result of the optimization of destination-diversion policies compared to not using AD at all.

3- Rohleder T. et. al. (2011): "Using simulation modeling to improve patient flow at an outpatient orthopedic clinic ".

The study reported the successful process improvement efforts undertaken at an orthopedic outpatient clinic (cast clinic). The use of discrete event simulation models was shown to be particularly valuable for identifying process improvement alternatives and quantifying potential improvements in performance.

Results from running the model suggested changes to clinic procedures that included adding an x-ray technician staff member, scheduling patients in blocks of 2, 15 minutes apart, and scheduling the new patients who have not been to the clinic at the end of the clinic schedules. Also, the model showed the value of ensuring that surgeons arrived promptly at the start of the clinic sessions.

The model projected that these improvements would lead to an average reduction in patient time in the clinic of over 40 minutes. Because no changes occurred in the examination times (i.e., time with providers), this time basically represents reduction in patient waiting time. Furthermore, the model predicted that nearly 80% of patients would finish their visits in 60 minutes or less. The actual result after implementing the improvements was a substantial reduction in time in the clinic of about 22 minutes per patient on average.

4- Banomyong R. & Sopadang A. (2010): "Using Monte Carlo simulation to refine emergency logistics response models: a case study".

The purpose of this paper is to provide a framework for the development of emergency logistics response models.

The result of the simulated emergency logistics simulation output stated that the average time to help victims is 97.4 hours, while the maximum time is 213.1 hours and the minimum time to help victims is 27.5 hours. These numbers are based from over 30,000 simulation runs. From the simulated output, it was observed that the average time to help victims still exceeded the 72 hours limitation emergency logistics operation time. The simulation also identified that communication activity in the emergency logistics operation system is critical problem. Other identified constraints in the simulated emergency logistics response model are related to the communication activity between retailers' headquarters and their local branches that are near crisis areas in the South of Thailand, road clearing activity by the Thai army, and the goods distributing activity in the tsunami-affected area.

5- Duguay C. & Chetouane F. (2007): "Modeling and Improving Emergency Department Systems using Discrete Event Simulation".

In this study an Emergency Department of a regional hospital was modeled, analyzed and improved using discrete simulation. An analysis of waiting times by patient codes demonstrated high waiting times in comparison with Canadian standards. Thus, the goal of the study was to reduce waiting times by considering what-if analysis using simulation.

Several data were collected from Monday to Friday between 800 and 2000 h. Collection period choice was based on historical data and staff expertise. Modeling and simulation were performed using Arena software. Simulation shows that waiting duration from registration to available exam room was the most problematical (3 to 4 h at times). Five alternatives were formulated based on adding staff and exam rooms within budget limitation. The alternative with one physician and nurse added from 800 to 1600 h gave the best improvement level for waiting time. It allows treating an additional number of 16 patients. Simulation shows that number of examination rooms had no effect on waiting time if added without a matching increase in the staff.

6- Rytilä J. & Spens K. (2006): "Using simulation to increase efficiency in blood supply chains".

The overall aim of the research presented is to improve blood supply chain management in order to use the scarce resource of blood more efficiently. Computer simulation is used as a tool for increasing efficiency in blood supply chains.

An application of discrete event simulation modeling in the health-care sector, more specifically in the area of blood transfusion services. The model has been refined in cooperation with medical expertise as it is vital that practitioners are closely involved so that the model can be tested against their understanding as it develops.

The research found that decision makers can make better and less risky decisions regarding changes in the blood supply chain based on the knowledge created by simulation experiments. Simulation modeling can be used to make complex and chaotic systems comprehensible and more efficient. In health care, this means that scarce resources can be allocated better, and thereby simulation can aid in increasing the overall quality of health care.

7- **Buhaisi M. (2005):** " Using quantitative methods in decisions making: Applied study, Using the computerize simulation to solve waiting line problem in primary care center".

The study used simulation to solve waiting lines problem in a primary care health center. It was applied on El Sheikh Ridwan Primary Health Care Center in Gaza. The main objective of this study was applying quantitative methods for decision making to help the decision-makers to solve the problems in scientific methods.

The study proposed a system to solve the waiting lines problem in the center, by adding a physician, a baby's doctor, a dentist, and a new service point for the pharmacy. The new system shortened the time that patients spend to get the service from 2.5 hour to 1 hour only, and the system total cost from 9628.5 NIS/day to 8460 NIS/day.

1.7.2. Manufacturing Applications:

8- Tjahjono, B. & Ladbrook, J. (2011): "Simulation modeling of tool delivery system in a machining line."

The paper describes an industrial project aiming to enhance the existing simulation modeling suites used at a car engine factory in the UK. The company continues to enhance its simulation modeling capabilities towards so called the 'total plant modeling' which not only covers the production facilities but also key ancillary facilities. Tool delivery is one such ancillary process. The existing modeling practices at the company are limited to modeling tool changes and assume that tools meet their expected life and the replacement is always available. In reality, the tools are not always reaching the expected life, the facilities in the tool crib are a limiting resource and the tool inventory has to be minimized.
The simulation found that to maintain timely delivery of tools to the lines, it is critical to effectively prioritize the planning of the tool crib. Better management of tooling operators is also necessary in order to reduce the bottleneck inside the tool crib. One suggestion that can be made is that some complicated and time consuming operations could be outsourced and only a certain types of tool will be stocked on site.

9- Lemessi, M.et. al. (2011): "Simulation-based optimization of paint shops"

The paper presents an optimization function for paint shop design, its constraints, and the optimization algorithms used to evaluate valid alternatives. It also discusses execution speed issues when the proposed optimization process is applied to a set of case studies.
The proposed heuristic optimization approach reduces investment costs by minimizing number of carriers and path lengths. The optimization is implemented as an extension to an existing generic simulation model for paint shops. However, the proposed

approach can be applied to similar modeling techniques and factory-planning scenarios. In addition the optimization framework allows adding other optimization algorithms and objectives with minor effort. A user support system is presented, which helps users in conducting optimization-related tasks and interpreting results.

10- Eskandari, H. et. al. (2011): "Performance analysis of comercial simulation-based optimization packages: Optquest and Witness Optimizer"

The objective of this study is to evaluate and compare two commercial simulation-based optimization packages, OptQuest and Witness Optimizer, to determine their relative performance based on the quality of obtained solutions in a reasonable computational effort. Two well-known benchmark problems, the pull manufacturing system and the inventory system, are used to evaluate and compare the performance of OptQuest and Witness Optimizer. Significant validation efforts are made to ensure that simulation models developed in Arena and Witness are identical. The experimental results indicate that both optimization packages have good performance on the given problems. Both packages found near-global optimal (or satisfactory) solutions in an acceptable computation time.

11- Cheng, H. C. & Chan, D. Y. K. (2011): "Simulation optimization of part input sequence in a flexible manufacturing system"

The paper describes the development of a simulation model for production planning personnel to carry out optimization of part input sequence. The model simulates a flexible manufacturing system for the production of machined components. Using a custom built user interface, the planner imports production and demand data from an Excel spreadsheet into the model. The model optimizes part input sequence by simulating different combinations of part input sequences and determining the combination with the highest total slack time. Simulation conducted by the authors using this model shows that even a short, partial optimization run yields a schedule with improved slack.

1.7.3. Business process and queueing theory:

12- Al-Astal A. (2008): "The Use Of Simulation For Evaluating Branchless Banking Servicing Opportunities via Cell Phones: A case study on Palestine Islamic Bank".

The study investigates the impact of adopting Mobile Financial Services MFS applications on minimizing service channels costs, improving the performance of servicing levels, and providing new sources of revenue for Palestine Islamic Bank in Khanyounis.

In the study, two types of models to analyze and evaluate the impact of adopting banking servicing opportunities via cell phones are presented. The first is a simulation model used for shedding some light on which input parameters are most important and how they affect the responses of interest. The second depends on the outputs of simulation for finding the optimum combinations of input parameters by following Response Surface Methodology (RSM) as an optimization technique and assuming that certain level of customers representing the early adopters are will to used MFS. Arena simulation software and Design Experts statistical package are used.

By simulating the behavior of the queuing systems in the bank for both types of days at the level of 36.5% of customers are willing to use MFS, the study concluded that:

- During Normal Days there is an opportunity to generate a maximum of (15.92 $/Day) net profit from the current customers base.
- During Rush Days the total average cost and waiting time for ATM service channel will be reduced to (65.04 $/Day) and (3.17 Minutes) respectively which is again much less than the average cost and wait time for ATM area without using MFS. In addition, this level of MFS usage will allow for an opportunity of a maximum of (37.10 $/Day) net profit that might be generated from the current customers base.

13- Syberfeldt A. et. al. (2008):" Simulation-Based Optimization of a Complex. Mail Transportation Network ".

The paper presented the simulation-based optimization of a complex mail transportation problem. In this optimization, a DES model was coupled with an Evolutionary Algorithm to find transport solutions that achieve on-time deliveries, low cost operation, and low carbon dioxide emissions. To make the overall optimization process more efficient, a computationally cheap surrogate model was used to offload the optimization process. A surrogate model is particularly useful in optimization problems like the one considered in this paper, involving an immense number of possible solutions.
The optimization was evaluated using different real-world scenarios and the test results look very promising. The optimization was able to find solutions with 10-12% lower cost, 20-25% less tardiness, and 3-4% lower carbon dioxide emissions.

14- Barham F. (2008): " Simulation in Queuing Models: Using Simulation at Beit Eba crossing check-point ".

The thesis consider some queuing models to determine the measures of performance of a model. The most important measures are the waiting time in the queue and the size of the queue. The queue we are studying is the Beit-eba crossing check-point for both people arriving and people departing from Nablus City.

A comparison is made in order to determine the best fit model among two assumed models and the one under study(real one)using a suitable tool of simulation “SimQuick” which performs process simulation within the Excel spreadsheet environment.

Both of multiple-channel queues and single-channel queue have advantages and disadvantages. But the computed results show that the single-channel queue is more efficient than the multiple-channel queue using the collected data at Beit-eba crossing check-point that is the average waiting time for the single chanel-queue is less than the average waiting time for the multiple chanel-queues.

1.7.4. Comment on previous studies

Previous studies have agreed on the importance of quantitative methods in decision-making , and clarified their advantages in improving conditions in the service and industrial systems. These studies have shown the importance of simulation as one of these methods to solve the problem of waiting lines.

Studies have shown that some of the problems facing the industrial and service systems can be solved by building simulation models and following suitable scenarios to implement these solutions. These problems occur due to the work design or to some operational decisions.

The studies dealt with the problem of waiting lines in a number of industrial and service systems. The previous studies identified the reasons for the length of waiting lines and suggested some solutions to solve this problem.

While most studies concentrate on separated decision or business process problems, such as production planning, queuing problems, waiting time, business process evaluation and dealing with time machine failure; this research concentrates on the complete service system process and evaluation. Therefore, it is hoped that this research will, in a small way, contribute to the limited literature of complete system problems.

CHAPTER TWO

PUBLIC SERVICE

This chapter consists of the following sections:

2.1. Introduction

2.2. Defining Public Sector

2.3. Diversity of Services

2.4. Public Affairs

2.5. Civil affairs in Gaza

2.1. Introduction

Governments are characterized by the breadth of their powers in comparison with the private sector. Such powers involve the ability to establish and enforce legal requirements. The main objective of governments and other public sector entities is to deliver goods and services rather than to generate profits. Globally the public sector varies considerably in both constitutional arrangements and its methods of operation. The governance of governments and other public sector entities generally involves the holding to account of the executive by a legislative body (IPSASB, 2010).

Public services are a normal part of civilized human life. They are organized to meet political, social and economical needs. These services have not been developed as technical exercises in filling gaps where the market has failed, or is in need of temporary supplementary help. The history helps show how public services have been central elements in the development of communities, nations and economies (Hall, 2003).

2.2. Defining Public Sector

Public services are what make the state visible to its citizens. Public services are citizens' direct line to government. They make the state tangible through an almost daily interaction, direct or indirect. States are shaped by images and practices (Van de Walle & Scott, 2009).

The civil service sector or as simply stated public sector and as opposed to the private sector, is an environment of people and organizations that work together under the name of the government to serve the community (Mohammed, 2005).

OECD (2002) defines public sector as "All departments, offices and other bodies which furnish, but normally do not sell to the community, those common services, other than higher education, which cannot otherwise be conveniently and economically provided, as well as those that administer the state and the economic and social policy of the community."

It is generally accepted by scholars that the civil service sector is the heart of any governmental structure where executing the civil service duties is vital enough in attaining the supreme objectives of any nation that aspires for continuous development and prosperity (Mullins, 2002).

2.3. Diversity of Services

In almost every country, the services provided by government at national or local level include certain categories – the social services of healthcare, education and some form of social security; the utilities of water, energy and communications – including post, telecoms, roads, railways, and air transport; and the state security functions of police, justice, and defense. But the full size and scope of public services is invariably a matter of political debate, reflecting different economic and political interests and priorities in the country at any given time. There is no general principle for determining appropriate sectors. State services at various times and places include banking services, forestry, marketing of dairy products, manufacture of drugs. Some functions are traditionally supported by the political right, such as the prioritization of state security.

Some services may be viewed differently by different groups, for example the machinery of justice: business is most concerned that property rights and contractual obligations can be upheld through the courts, while other groups may be more concerned about accessibility to justice for the poor, which leads to greater emphasis on capacity-building and on non-judicial justice processes (Hall, 2003).

2.4. Public Affairs

Public affairs is by nature a multidisciplinary field, especially with the rise of third-party government (Bozeman, 1987), public enterprises, and extensive government contracting. The market for undergraduate public affairs will grow as the sectors work more closely together. As businesses receive greater proportions of revenue from government sources and are subject to more laws and regulations, the need for employees with an understanding, and a degree, in public affairs will likely grow. For businesses to respond effectively to public sector solicitations for private service delivery, they need management teams that understand the meaning of public value (Goldsmith & Burke, 2009).

2.5. Civil Affairs in Gaza

The Ministry of Interior - Civil Part - is responsible for issuing various documents to the public. Among these documents are identity card, passport, birth certificate and death certificate.

To do this task, five passports and civil affairs directorates are distributed all over Gaza Strip. These directorates can help facilitating the citizens' daily life.

Hemdiat (2012) mentioned some statistics that show the large numbers of daily application forms done within these directorates, which clearly proofs the difficulty of work and its huge size.

For example, the number of newborns in the Gaza Strip during the third quarter of the year 2012 was more than 14280. In this period, Gaza city registered about 5223 new baby, The North Governorate registered 2443 births, The Central Governorate registered 1933 births, 2928 births for Khan Yunis and 1757 births in Rafah.

During the third quarter of the year 2012, Gaza directorate completed about 30577 transaction. Among these transactions are 10782 ID cards, 1275 changing marital status, 1900 changing address, 9741 birth certificate and 495 death certificates.

CHAPTER THREE

SIMULATION FUNDAMENTALS

This chapter consists of the following sections:

3.1. Introduction

3.2. System Modeling

3.3. Modeling Concept

3.4. Definition of Simulation

3.5. Advantages and Disadvantages of Simulation

3.6. Areas of Application

3.7. Simulation of Service System

3.8. Simulation Software and Tools

3.1. Introduction

Simulation is one of the most powerful tools available to decision-makers responsible for the design and operation of complex processes and systems. It makes possible the study, analysis and evaluation of situations that would not be otherwise possible. In an increasingly competitive world, simulation has become an indispensable problem solving methodology for engineers, designers and managers (Shannon, 1998).

In this chapter the related literature for simulation will be presented with an emphasis on the applications in manufacturing and service sector. The tool used in the research-ARENA- will be examined, and the features of the software will be briefly introduced.

3.2. System Modeling

System modeling as a term includes two important commonly used concepts: *system* and *modeling*. It is imperative to clarify such concepts before attempting to focus on their relevance to the "simulation" topic. Hence, in this section we introduce these two concepts and provide a generic classification of the various types of system models.

3.2.1. System concept:

Any real-life system studied by simulation techniques is viewed as a system. A system, in general, is a set of elements or components that interact to accomplish goals. The elements themselves and the relationships among them determine how the system works. Systems have inputs, processing mechanisms, outputs, and feedback as shown in Figure 3.1(Stair and Reynolds, 2010).

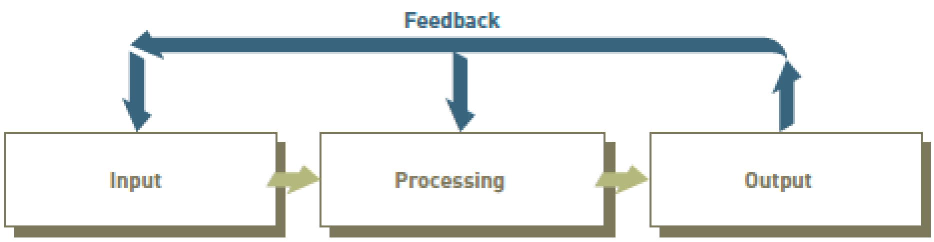


Figure (3.1): System components
Source: (Stair and Reynolds, 2010).

3.2.2. Types of systems

Evidently, there are many types of systems, and they can be classified in several classes. For example they may be classified as:

1. Physical and abstract system
2. Static and dynamic system
3. Open and closed system

3.2.2.1. Physical and Abstract System

Physical systems are those in which the components can be seen and felt. A telephone, a computer and a power system are all physical systems. It is comparatively easy to make quantitative measurements in physical systems. Abstract systems are essentially conceptual in nature. Quantitative appraisal is often complicated. It is usual to analyze abstract systems with the help of mathematical models. Social systems, economic systems and political systems are examples of abstract systems (Ravindranath, 2003).

3.2.2.2. Static and Dynamic System

Static systems are those in which the system parameters do not change much. In a dynamic system, the parameters as well as their interrelations may be in a constant state change. We may have to adopt statistical and probabilistic methods to study such systems. Stock markets, weather conditions, general elections are examples of dynamic systems (Ravindranath, 2003).

3.2.2.3. Closed and Open System

This is perhaps the most useful classification from the point of view of system study. Figure 3.2 shows these systems pictorially.

A completely closed system does not allow any environmental factor to influence its performance. Such as systems are rare. In partially closed system, the environmental factors have a limited effect. Any desirable factor can be admitted and other can be cut off. Interdependent systems are usually partially closed. An open system, as the name implies, allows the environmental factors to interact freely with the system. Most of the systems we come across are open systems. Such systems have certain characteristics, which distinguish them from other systems (Ravindranath, 2003).

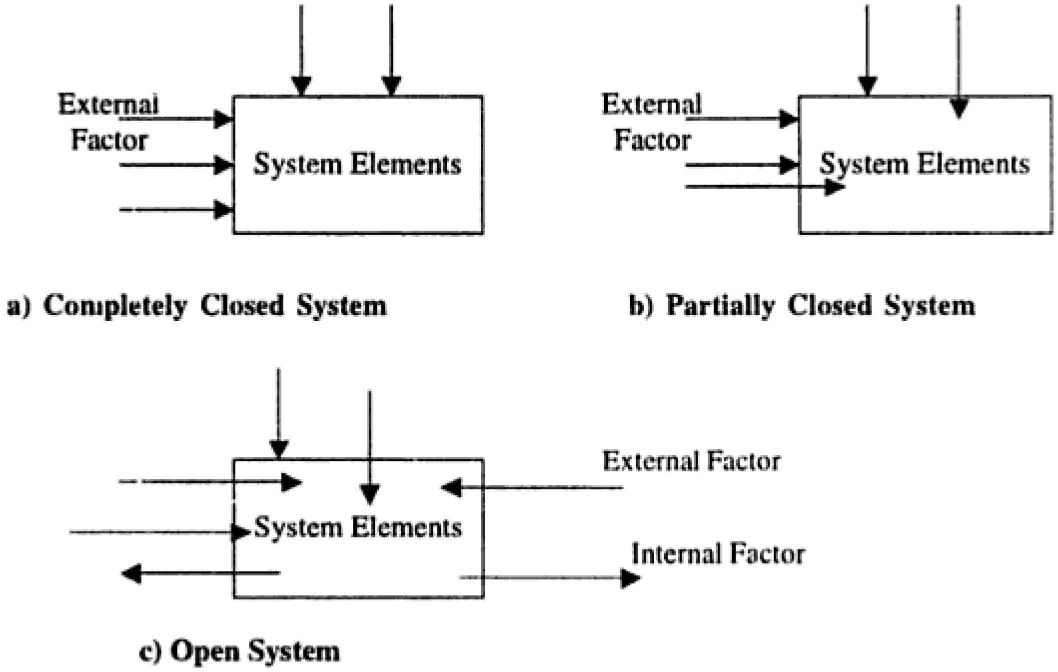


Figure (3.2): Types of systems
Source: (Ravindranath, 2003)

3.3. Modeling Concept

The word modeling refers to the process of representing a system with a selected replica model that is an easier to understand and less expensive to build compared to the actual model. The system representation in the model implies taking into account the components of the system .This includes representing system elements, relationships, goal, inputs, controls, and outputs (El-Haik & Roy, 2005).

Maria (1997) stated that a model is similar to but simpler than the system it represents. One purpose of a model is to enable the analyst to predict the effect of changes to the system. On the other hand, it should not be so complex that it is impossible to understand and experiment with it.

Generally, a model intended for a simulation study is a mathematical model developed with the help of simulation software.

3.3.1. Types of models

Different types of models can be classified into four major categories: physical models, graphical models, mathematical models, and computer models (El-Haik & Roy, 2005).

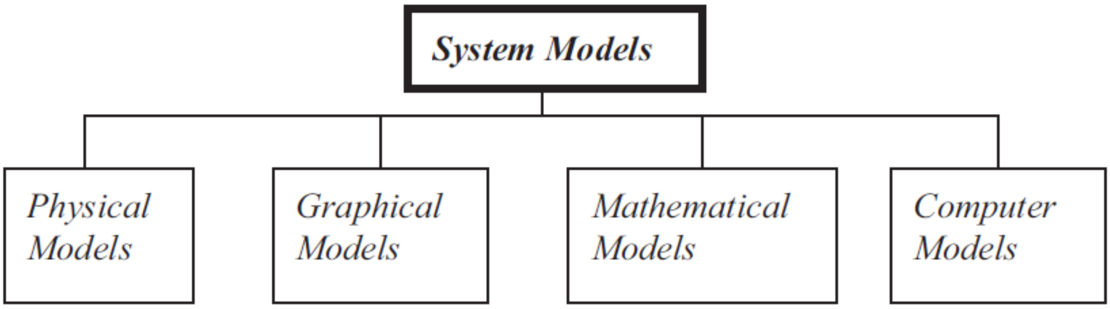


Figure (3.3): Types of models
Source: (El-Haik & Roy, 2005)

3.4. Definition of Simulation:

Although the term simulation can have different meanings depending on its application, it generally refers to use computer to perform experiments on a model of real system. It is a process which mimics the relevant features of a target process. Experiments by simulations may be undertaken before a real system is operational, to support its design, to show how the system might react on changes in its operational rules. Also, they allow evaluating the system's responses on changes in its structure. They are particularly suitable for situations when system is influenced by great number of factors, and when great number of variables exists. In such situations it is almost impossible to develop one and only adequate analytical model.

Simulation is the imitation of the operation of a real-world process or system over time. Whether done by hand or on a computer, simulation involves the generation of an artificial history of a system, and the observation of that artificial history to draw inferences concerning the operating characteristics of the real system (Banks et al., 2010).

Simulation is a method for implementing a model. It is the process of conducting experiments with a model for the purpose of understanding the behavior of the system modeled under selected conditions or of evaluating various strategies for the operation of the system within the limits imposed by developmental or operational criteria. Simulations are usually programmed for solution on a computer." (DAUP, 2005).

3.4.1. Types of Simulation

Simulations have been used successfully in many fields including engineering, production management, business, the sciences, technology, architecture, entertainment, government, military and logistics/ transportation. Several types of computer simulation are commonly studied for use in engineering and business environments. These include continuous, Monte Carlo and discrete event (McHaney, 2009).

3.4.1.1. Continuous Simulation

Continuous simulation is concerned with modeling a set of equations, representing a system, over time. This system may consist of algebraic systems, game theoretic models, statistical models or differential equations set up in such a way as to change continuously to represent the ebb and flow of parameters associated with the system state.

Population growth, urban growth, hurricane predictions, weather forecasting, disease spread and fermentation models are all examples of systems that are suitable candidates for continuous simulation models (McHaney, 2009).

3.4.1.2. Monte Carlo Simulation

The name Monte Carlo invokes thoughts of gambling, gaming and chance. John Von Neumann used the code name Monte Carlo for his experiments, based on the use of random numbers, conducted at Los Alamos during the initial development of the atomic bomb. The name became popular and is now used to represent simulations that are "a scheme employing random numbers, which is used for solving certain stochastic or deterministic problems where the passage of time plays no role" (Law and Kelton, 2000).

The last part of this definition (e.g. the passage of time) distinguishes Monte Carlo from discrete event simulation. Monte Carlo generally removes time from the model, whereas discrete event simulation is based on the passage of time. The use of random number generators gives Monte Carlo simulation characteristics not common to continuous simulation (McHaney, 2009).

3.4.1.3. Discrete Event Computer Simulation

Discrete Event Simulation is characterized by the passage of blocks of time during which nothing happens, punctuated by events which change the state of the system. An example to illustrate this is a simple queuing system consisting of bank customers arriving at an automatic teller machine (ATM). Customers arrive, wait for service if the machine is in use, receive service and then depart (McHaney, 2009).

3.5. Advantages and Disadvantages of Simulation

Simulation has a number of advantages over analytical or mathematical models for analyzing systems. First of all, the basic concept of simulation is easy to comprehend and hence often easier to justify to management or customers than some of the analytical models. In addition, a simulation model may be more credible because its behavior has been compared to that of the real system or because it requires fewer simplifying assumptions and hence captures more of the true characteristics of the system under study (Shannon, 1998).

Additional advantages were added by Banks (2010) started with new policies, operating procedures, decision rules, information flows, organizational procedures, and so on can be explored without disrupting ongoing operations of the real system. Banks also add that new hardware designs, physical layouts, transportation systems, and so on can be tested without committing resources for their acquisition.

Another important advantage is that time can be compressed or expanded to allow for a speed-up or slow-down of the phenomena under investigation and insight can be obtained about the importance of variables to the performance of the system. Banks (2010) mentioned that bottleneck analysis can be performed to discover where work in process, information, materials, and so on are being delayed excessively and "What if" questions can be answered. Finally, a simulation study can help in understanding how the system operates rather than how individuals think the system operates.

Even though simulation has many strengths and advantages, it is not without drawbacks. Banks (2010) summarized some disadvantages as model building requires special training. It is an art that is learned over time and through experience. Furthermore, if two models are constructed by different competent individuals, they might have similarities, but it is highly unlikely that they will be the same. Banks (2010) said that simulation results can be difficult to interpret. Most simulation outputs are essentially random variables (they are usually based on random inputs), so it can be hard to distinguish whether an observation is the result of system interrelationships or of randomness. And since simulation modeling and analysis can be time consuming and expensive. Skimping on resources for modeling and analysis could result in a simulation model or analysis that is not sufficient to the task. Banks (2010) finished with an important point which is simulation is used in some cases when an analytical solution is possible, or even preferable. This might be particularly true in the simulation of some waiting lines where closed-form queueing models are available.

3.6. Areas of Application

The applications of simulation are vast. The Winter Simulation Conference is an excellent way to learn more about the latest in simulation applications and theory (Banks et al., 2010).

While researching the simulation packages Abu Taieh and El Sheikh (2007) found 22 applications shared among the simulation packages. Some applications were more popular than others were as Figure (3.4). The 22 applications are listed in table (3.1)

Table (3.1): Commercial simulation packages applications

Source: (Abu-Taieh and El-Sheikh, 2007)

1. Air traffic control and space systems	2. Supply chain management
3. Business process reengineering and workflows	4. Transportation systems
5. Complex system design evaluation	6. Aerospace
7. Computer and communication networks	8. Oil & Gas
9. Computer performance evaluation	10. Construction
11. Education and training	12. Financial modeling
13. Health care systems	14. Parcels & parcel handling(queue)
15. Manufacturing systems	16. De-bottlenecking
17. Military / combat systems	18. What if scenarios
19. Satellite and wireless communications systems	20. Robotic and mechanical systems
21. Service systems	22. Decision and risk analysis

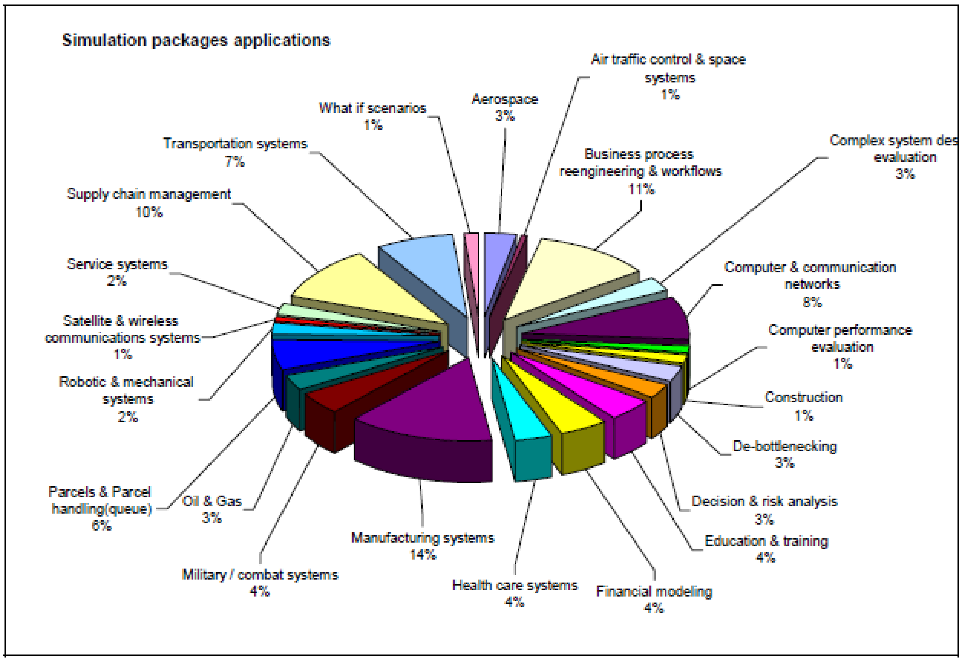


Figure (3.4): Simulation packages applications
Source: (Abu-Taieh and El-Sheikh, 2007)

3.7. Simulation of Service System

Simulation modeling is fast becoming an important aid in achieving higher levels of efficiency and productivity. Historically, simulation modeling have been directed to improve the manufacturing operations. More recently, simulation has come into its own as a powerful tool to improve the operations within the services sector (Zottolo et al., 2007).

Service industry has been developing rapidly and receiving more attention in the recent years by system modelers. The main concern in service industry settings now is customer satisfaction such as banks, hospitals, and call centers. Diversity in demand is prevalent in the service industry, and customers still expect the direct service as they arrive (Chandra and Conner, 2006).

In the context of service systems, simulation is used to study the service system behavior, quantify the provided service, compare proposed alternatives for providing services, improve service level, better utilize resources, reduce service time and cost, and configure the service system to provide the best performance possible within given business constraints(Al-Aomar, 2010).

The service system is characterized by the number of waiting lines, the number of servers, the arrangement of the servers, the arrival and service patterns and the service priority rules (Reid and Sanders, 2005).

Because of the unique characteristics of service systems, it is typically difficult to prescribe a specific modeling technique to simulate service systems. Instead, the simulation process is adapted to the specifics of the underlying service system. In general, it is recommended to model the service system as a manufacturing system that involves complex manual operations of high variability. Special attention is paid to the sequence and the content of each service process within the system (Al-Aomar, 2010).

3.7.1. Elements of Service Systems

Most service systems involve a process for receiving customers. This process often includes activities such as receiving, registering at the reception, preparation of documents or material, and waiting for service.

Other business functions involved in providing services include sales, cashier, data entry, payments, etc. Services also develop and implement a process for service/facility departure. Departure process provides means for checking service/product quality, packaging, shipping, etc (Al-Aomar, 2010). Figure 3.5 depicts the main elements of a service system:

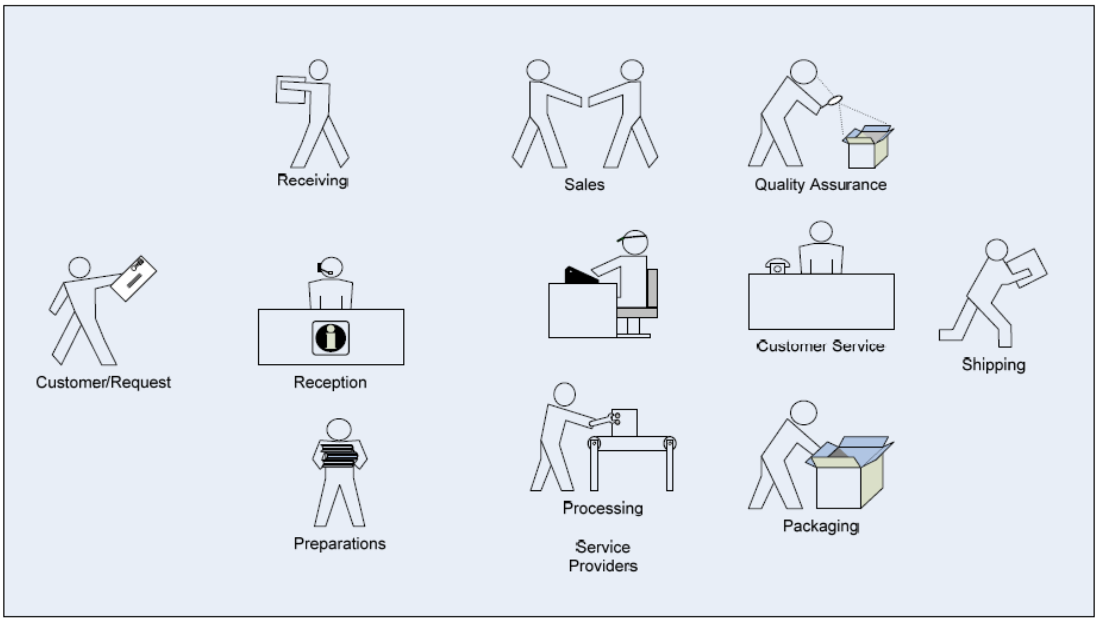


Figure (3.5): Elements of a Service System
Source: (Al-Aomar, 2010)

3.8. Simulation Software and Tools

Simulation software plays a major role in analysis of nonlinear control systems and complex automation systems. Simulation software, simulation languages, simulators, simulation systems, and simulation environments is computer software intended for simulation of dynamic systems at a higher level than programming languages can do. The simulation environment is an integrated software environment combining the various parts of a simulation system, with database interface, increased support for modeling (Breitenecker and Troch, 2004).

A survey using several sources was performed to identify current simulation software. The survey identified 87 discrete event simulation and modeling tools which included simulation programming languages and simulation application packages currently available. Of these five are not currently available (AWESIM, KAMELEON, MODSIM III, Silk, and Visual SLAM). Thirty three are either academia supported or open source supported. The remaining 49 are commercial offerings. Three of the commercial offerings (Arena, Extend, and SIGMA) have academic versions used for teaching simulation course (Albrecht, 2010)

The most popular simulation packages in recent years include: SIMAS II, which is devoted to the simulation of industrial mass production installations. WITNESS provides a graphical environment to design discrete event simulation models. It allows simulation experiments to optimize material flows across the facilities. SIMUL8 is mainly used for discrete event simulation. By providing a user-friendly visual interface, SIMUL8 allows the user to pick from a predefined set of simulation objects and statistical distributions to create the system's model. Taylor ED (Taylor enterprise dynamics) is an object-oriented software application used to model, simulate, visualize and monitor business processes. ShowFlow is designed to model, simulate, animate and analyze processes in logistics, manufacturing and material handling. It provides powerful visualization and reporting tools, in particular for simulation animation. ARENA is developed based on the SIMAN modelling language, which has an object-oriented design and the ability to be tailored to any application area (Wang and Chatwin, 2005).

Arena Comparison Statement shows clearly the analysts' trends in the use of simulation applications in the pages of the proceedings of the world's leading conference on discrete-event simulation-the Winter Simulation Conference. Year after year, Arena leads the pack and is gaining on the competition. The numbers speak for them self - in 2007, 40% of the papers mentioned Arena as their tool of choice and in 2008, 41% as shown in figure 3.6, in 2009, 48% and finally in 2012, 32% of the papers used Arena as shown in figure 3.7.

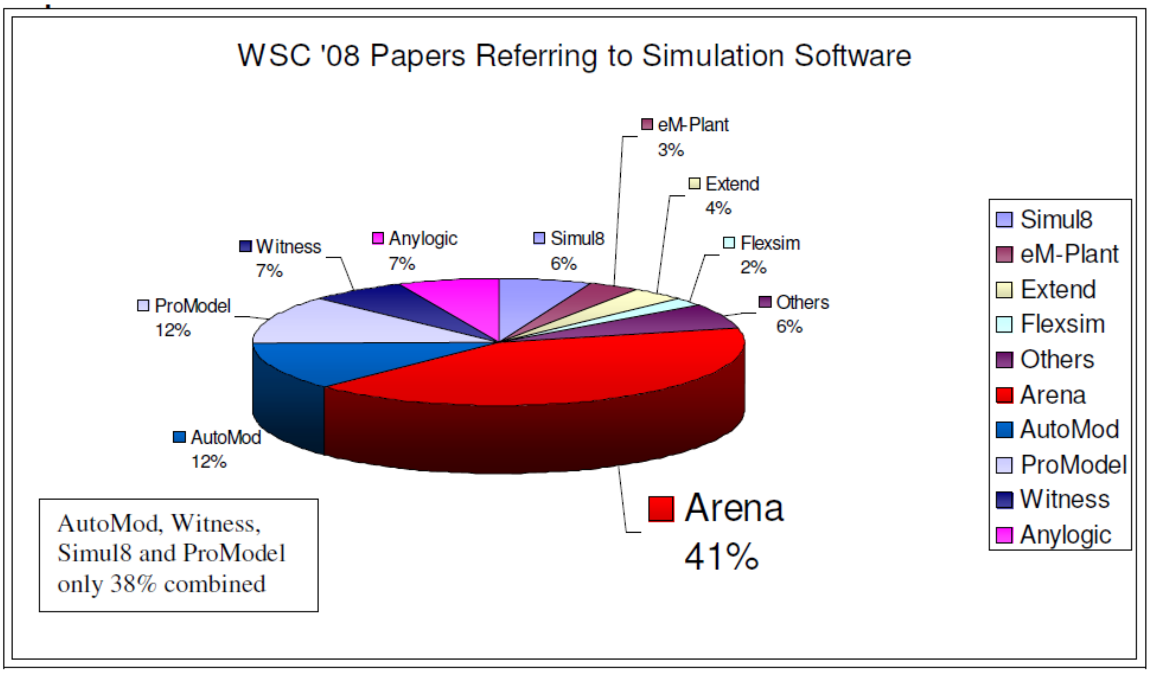


Figure (3.6): WSC 2008 Papers Referring to Simulation Software
Source: (Rockwell-Automation, 2008)

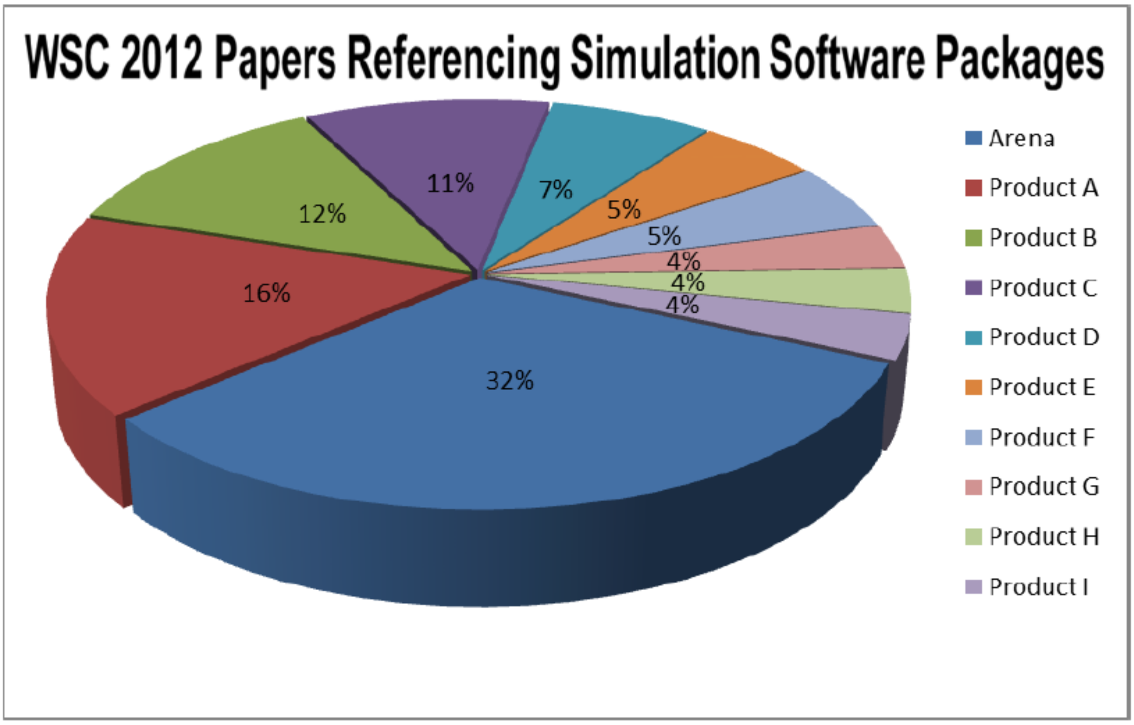


Figure (3.7): WSC 2012 Papers Referring to Simulation Software
Source: (Rockwell-Automation, 2012)

3.8.1. Arena software

The Arena modeling system from Systems Modeling Corporation is a flexible and powerful tool that allows analysts to create animated simulation models that accurately represent virtually any system. First released in 1993, Arena employs an object-oriented design for entirely graphical model development. Simulation analysts place graphical objects called modules, on a layout in order to define system components such as machines, operators, and material handling devices. Arena is built on the SIMAN simulation language. After creating a simulation model graphically, Arena automatically generates the underlying SIMAN model used to perform simulation runs (Takus and Profozich, 1997).

Arena's fundamental modeling components, called modules, are selected from template panels, such as Basic Process, Advanced Process, and Advanced Transfer, and placed on a canvas in the course of model construction. A module is a high-level construct, composed of SIMAN blocks and elements. For example, a Process module models the processing of an entity, and internally consists of such blocks as ASSIGN, QUEUE, SEIZE, DELAY, and RELEASE. Arena also supports other modules, such as Statistic, Variable, and Output among many others (Altiok and Melamed, 2007)

The software is widely used to model and simulate industrial processes and supply chains. The major value of using Arena is to anticipate the implications of designing complex processes, so as to observe a simulated performance, without first incurring the costs to build and implement actual facilities. Arena produces Markov-system simulations that are based on discrete events and probability distributions for entering entities into the system, and for the duration of events. The software generates reports that reflect the performance of the simulation. Arena software is taught at more than 900 universities globally, and primarily is used in Industrial Engineering and Management Science programs (Neubauer and Stewart, 2009).

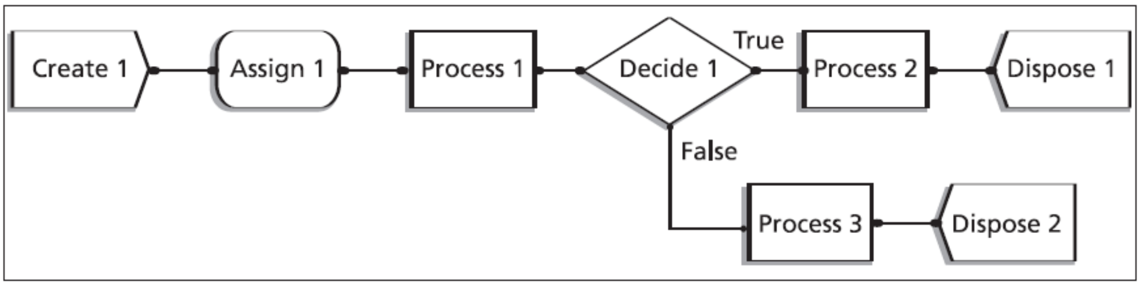


Figure (3.8): Model showing the most commonly used Arena modules

CHAPTER FOUR

DECISION SUPPORT SYSTEMS

This chapter consists of the following sections:

4.1. Introduction

4.2. Definition of DSS

4.3. Types of DSS

4.4. Characteristics and Capabilities of DSS

4.5. Components of DSS

4.6. A DSS Model

4.7. The use of Simulation for Decision Support

4.1. Introduction

The present world lives in a rapidly changing and dynamic technological environment. The recent advances in technology have had profound impact on all fields of human life. The Decision making process has also undergone tremendous changes. It is a dynamic process, which may undergo changes in course of time. Decision Support System (DSS) facilitates the decision making process in making the most effective outcome (Tariq & Rafi, 2012).

Decision support systems (DSS) is the area of the information systems discipline that is devoted to supporting and improving human decision-making. Over time, the majority of DSS research has focused on the application of new technology to managerial tasks at the operational and tactical management levels (Mallach, 2000).

Using of decision support systems is today far away from being only the domain of top business management. DSSs are successfully applied in many areas of human activities, from traditional finance, financial forecasting and financial management, through clinical medicine, pharmacy, agronomy, metallurgy, logistics and transportation, to maintenance of machinery and equipment (Hujer, 2011).

An effective DSS is primarily meant to aid the efforts of the decision makers and ensure that important details are not overlooked. Irrelevant details must be recognized as such and not allowed to distract and divert the decision making process. DSS do not supervise the decision and never replace human decision makers, but they do support them and help them to make better and consistent decisions (Tariq & Rafi, 2012).

4.2. Definition of DSS

DSS definition is evolving from theory to practice as well as the improvement of various supporting technologies such as minicomputers and user friendly software applications. There is no standard and universal definition of DSS as different people with different background have different views on DSS (Sprague, 1980).

George M. Marakas (2003) defines DSS as *"a system under the control of one or more decision makers that assists in the activity of decision making by providing an organized set of tools intended to impose structure on portions of the decision making situation and to improve the ultimate effectiveness of the decision outcome."*

Dssresources.com defines DSS as *"A Decision Support System (DSS) is an interactive computer-based system or subsystem intended to help decision makers use communications technologies, data, documents, knowledge and/or models to identify and solve problems, complete decision process tasks, and make decisions. Decision Support System is a general term for any computer application that enhances a person or group's ability to make decisions."*

4.3. Types of DSS

There are several classifications and taxonomies of DSS applications (French et al., 2009). One was that of Steven Alter in which he defines seven types: file drawer systems, data analysis systems, analysis information systems, accounting and financial models, representation models, optimization models and suggestion models (Alter 1990 as cited by Power 2000).

The first three types can be broadened to be termed data-oriented or data-driven, the second three types to be termed model-oriented or model-driven and the last type can also be termed intelligent or knowledge-driven (or knowledge-based) DSS (KD-DSSs) (Power, 2000).

The most common and widespread DSS classifications are popular with many authors, such as Turban (Turban et al., 2008). This classification divided DSS into five main categories as follows:

- Data-driven DSS, which are primarily based on the data and their transformation into information.

- Model-driven DSS, which puts the main emphasis on the use of simulation and optimization models.

- Knowledge-driven DSS, characterized by the use of knowledge technologies to meet the specific needs of decision-making process.

- Document-driven DSS, that helps users acquire and process unstructured documents and web pages.

- Communications-driven and group DSS, which includes all systems using communication technologies to support collaboration of user groups.

4.4. Characteristics and Capabilities of DSS

Because there is no exact definition of DSS, there is obviously no agreement on the standard characteristics and capabilities of DSS (Turban et al., 2008).

The characteristics and capabilities of DSS according to Turban (1995) are:

1. DSS support brings together human judgments and computerized information in a semi-structured or unstructured situation. The problem cannot be solved by using a computerized system only.

2. Support is provided for all levels of management.

3. Support is provided to individuals as well as to groups. Less structured problems tend to require involvement of various individuals.

4. DSS provides support to several interdependent and/or sequential decisions.

5. A DSS supports all levels of decision-making: intelligence, design, choice and implementation.

6. A DSS supports a variety of decision-making processes and styles e.g. the individual's decision style.

7. A DSS is adaptive over time. DSS should be able to adapt to changing conditions. Basic elements should be capable of being added, changed, combined, rearranged and adjusted to provide fast responses to unexpected situations.

8. A DSS is easy to use specially focusing on non-computer people. Users must feel 'at home' with the system. Ease of use implies an interactive mode.

9. A DSS attempts to improve effectiveness of decision-making including accuracy, timeliness and quality.

10. The decision-maker has complete control over all steps of the decision-making process. The system supports but does not replaces the decision-maker. The computer's recommendations can be overwritten at any time.

11. A DSS leads to learning and so initialises a process of developing and improving the DSS.

12. A DSS is relatively easy to construct. End users should be able to construct simple systems by themselves.

13. A DSS usually utilizes models. The modelling capabilities enable experimenting with different strategies under different configurations to provide new insights and learning.

14. An advanced DSS is equipped with a knowledge component to solve difficult problems.

Turban et al (2001) adds another characteristic that is a DSS allows the easy execution of sensitivity analysis. Sensitivity analysis is the study of the impact changes that one part of the model has on other parts of the model, also called "what-if" analysis. Sensitivity analysis also promotes the discovery of necessary inputs to obtain a desired level of output also called goal seeking.

4.5. Components of DSS

Kulkarni et al (2013) mentioned that there are three fundamental components of DSSs

• Database management system (DBMS). A DBMS serves as a data bank for the DSS. It stores large quantities of data that are relevant to the class of problems for which the DSS has been designed and provides logical data structures (as opposed to the physical data structures) with which the users interact. A DBMS separates the users from the physical aspects of the database structure and processing. It should also be capable of informing the user of the types of data that are available and how to gain access to them.

• Model-base management system (MBMS). The role of MBMS is analogous to that of a DBMS. Its primary function is providing independence between specific models that are used in a DSS from the applications that use them. The purpose of an MBMS is to transform data from the DBMS into information that is useful in decision making. Since many problems that the user of a DSS will cope with may be unstructured, the MBMS should also be capable of assisting the user in model building.

• Dialog generation and management system (DGMS).The main product of an interaction with a DSS is insight. As their users are often managers who are not computer-trained, DSS need to be equipped with intuitive and easy-to-use interfaces. These interfaces aid in model building, but also in interaction with the model, such as gaining insight and recommendations from it. The primary responsibility of a DGMS is to enhance the ability of the system user to utilize and benefit from the DSS.

4.6. A DSS Model

A DSS model includes four parts as follows (Figure 4.1) (Raymond, 1998).

- **Data base** produces both internal and environmental data, which are stored in the database.

- **Report writing software** produces both periodic and special reports. Periodical reports are prepared according to a schedule and typically they are produced by software, which is coded in a procedural language such as COBOL or PL/I. The special report is prepared in response to unanticipated information need and takes form of database by users who use the query language of a DBMS or fourth generation language.

- **Mathematical model** produces information as a result of either simulation that involves one or more components of the physical system of the firm or facts of its operations. Mathematical models can be written in any procedural programming language. However, special model languages make this task easier and have the potential of doing a better job.

- **Groupware** computer-based systems that support groups of people engaged in a common task (or goal) and that provide an interface to a shared environment (Soriano et al., 2008). Groupware services can include the sharing of calendars, collective writing, e-mail handling, shared database access, electronic meetings with each person able to see and display information to others, and other activities (Moncallo et al., 2009).

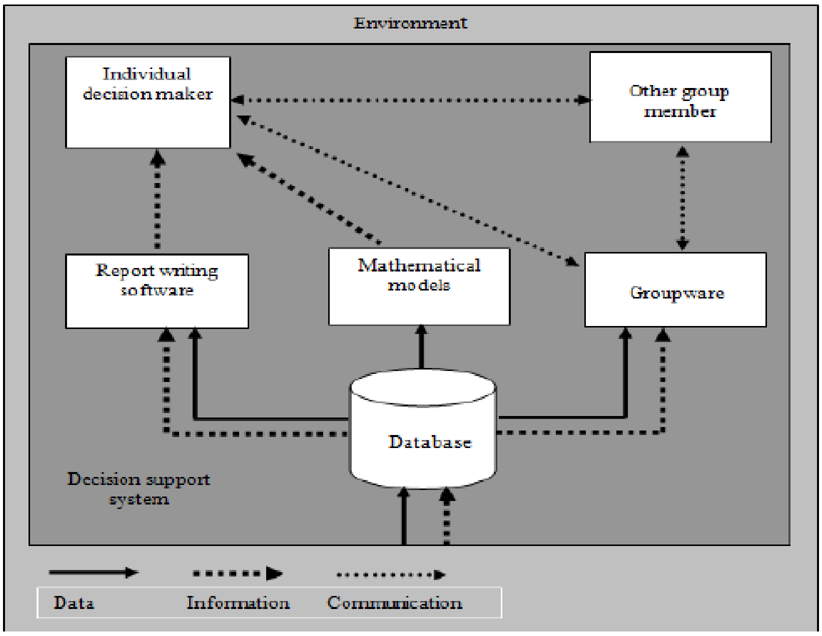


Figure (4.1): A DSS model .
Source: (Raymond, 1998)

4.7. The use of simulation for decision support

In a DSS context, simulation generally refers to a technique for conducting experiments with a computer-based model. One method of simulating a system involves identifying the various states of a system and then modifying those states by executing specific events. A wide variety of problems can be evaluated using simulation including inventory control and stock-out, manpower planning and assignment, queuing and congestion, reliability and replacement policy, and sequencing and scheduling (Power, 2002).

In many situations, simulation specialists build a simulation, then conduct the special study, and report their results to management. Evans and Olson (2002) discuss examples of how simulation has been used to support business and engineering decision-making. They report a number of special decision support studies including one that evaluated the number of Hotel reservations to accept to effectively utilize capacity to create an overbooking policy, a Call Center staffing capacity analysis, a study comparing new incinerating system options for a municipal garbage recycling center, a study evaluating government policy options, and various studies for designing facilities .

CHAPTER FIVE

RESEARCH DESIGN AND METHODOLOGY

This chapter consists of the following sections:

5.1. Introduction

5.2. Research Design

5.3. Case Study Description

5.4. Research Problem

5.5. Research Objectives

5.6. Data Collection

5.7. Development of Simulation Model

5.8. Model Verification and Validation

5.1. Introduction

The main purpose of this chapter is to explain and document the research methodology followed in the research project.

The details of the case study including problem formulation, data collection, model conceptualization, verification and validation of the simulation model are introduced.

This chapter also analyses the model building process, the design of the experiment and the alternatives that are to be simulated in order to analyze the outputs and achieve the objectives of this research.

5.2. Research Design

The research design depends on a case study about Gaza civil affairs and passports directorate (GCAPD). This case study allows researcher to fully understand the dynamic within a given situation and to answer research questions such as “why” and “how” things are done.

Observation technique was considered the most appropriate data collection method for this research as the research requires a good understanding of GCAPD processes for the development of a simulation model.

Interviews were conducted with key personnel of GCAPD. Four weeks were spent at GCAPD (two weeks in January and 14 random days in May and June) to observe the work processes and to analyze the current situation of the GCAPD. The following section explains in details the data collection methods used in this research.

5.3. Case Study Description

Gaza Civil Affairs and Passports Directorate (GCAPD) is the largest in Gaza strip. GCAPD provides services for about 600000 citizens (PCBS, 2013) - nearly half of the population of Gaza strip- and it is considered as a link between the citizen and the Ministry of Interior, "the civil part."

GCAPD has three important departments which are The Public Affairs, The Civil Affairs and Passport.

The Public Affairs department is concerned following up the licensed NGOs, where the department supervises about 430 associations (Hemdiat, 2012). The Civil Affairs is the most important department regarding to the relationship with the citizen as it concerns in issuing documents and transactions needed by citizens in public, social and educational life. The department succeeded to accomplish nearly 400000 documents and transactions over the past four years, distributed between identity cards, change the marital status, death certificates, birth certificates and birth registration summaries (Hamada, 2013).

The Passports Department is facing some constraints due to the current division between Gaza and West Bank. Gaza needs about 15000 new passports per month in order to bridge the needs of citizens, but renewal is done now on the same old passports (Hamada, 2013).

GCAPD receives all requests for the three departments, more than 80% of these requests belongs to the Civil Affairs department furthermore the Passports Department is facing a temporary complicated conditions due to the current division between Gaza and West Bank so this research will concentrate on the Civil Affairs department. These requests are divided into three parts. The first part is done at the reception hall and it is about 38% of daily requests. The second part is done at the printing hall; it is about 45% of daily requests. The last part which represents 17% of daily requests is transferred to the central directorate (Hamada, 2013). Table (5.1) shows this division.

The floor layout for reception hall and printing hall are represented in Figure (5.1) & (5.2). These figures show the different elements in this system.

Citizens who seek any kind of documents usually receive assistance from special offices to complete the right application form outside the GCAPD.

When the citizen is in the reception hall, several steps must be taken to get the document. Firstly, the citizen waits for one of the three receiving and checking staff to become available to get his application form checked for correctness and completeness and then stamped. If the application form needs any correctness or completeness, the citizen is asked to make the required changes and wait in line again. The staff tells the citizen whether to wait or not. After receiving the applications, the three receiving and checking staff compiles applications in a basket. Secondly the registrar took these applications by himself and classifies them into three groups. The first one is done completely at the reception hall, the second is done at the printing hall and the last one is done at the central directorate. The registrar process these forms by entering the data into the computer and do the required checking to confirm the entry of these applications into the system. The registrar transfers the applications from group one to the manager who prints the required document, but he keeps other types of applications until the end of the work day.

Table (5.1): The division of requests due to the place of processing.

Requests done at the reception hall	Requests done at the printing hall	Requests transferred to the central directorate
Lost ID annex	New ID card	Family reunification card
Damaged Identification card annex	Damaged ID card	Reunification request
Lost Identification card annex	Lost ID card	Correction in the ID card
To Whom it May Concern	Fine of losing a damaged ID card	First Identification card
Population Summary	Changing marital status	Registration of overseas births
Birth certificate	Damaged Identification card	Passports extension for the first time
Replacing birth certificate	Lost Identification card	Passports extension for the second time
A transcript	Changing marital status in the Identification card	Inclusion of sons in the passport

Second death certificate	Change of address in the Identification card	To Whom it May Concern
Delayed registration of births	Correction of birth certificate	Data correction in the passport
For the period of 11 days until the end of the first month	Correction of birth certificate for less than 5 years, 20 Dinars fees	Ramallah's passport registration
From the beginning of the second month until the end of the third month	Change of address	
From the beginning of the fourth month until the end of the first year		
For more than one year since date of birth		
Delayed registration of death		
For the period of 8 days until the end of the first month		
From the beginning of the second month until the end of the third month		
From the beginning of the fourth month until the end of the first year		
For more than one year since date of death		
Damaged ID card annex		
Reporting live births		
Reporting deaths		
Inquiries		
A transcript		

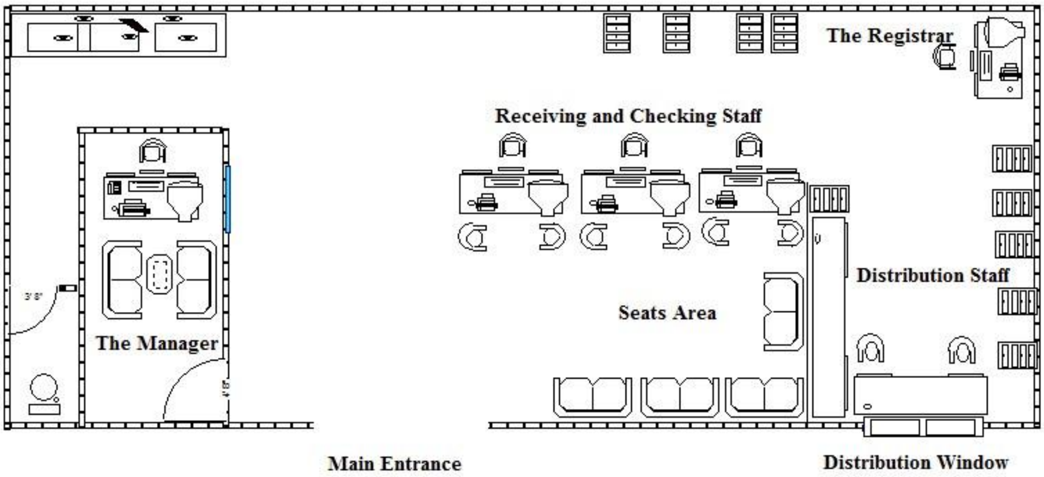


Figure (5.1): Reception hall layout

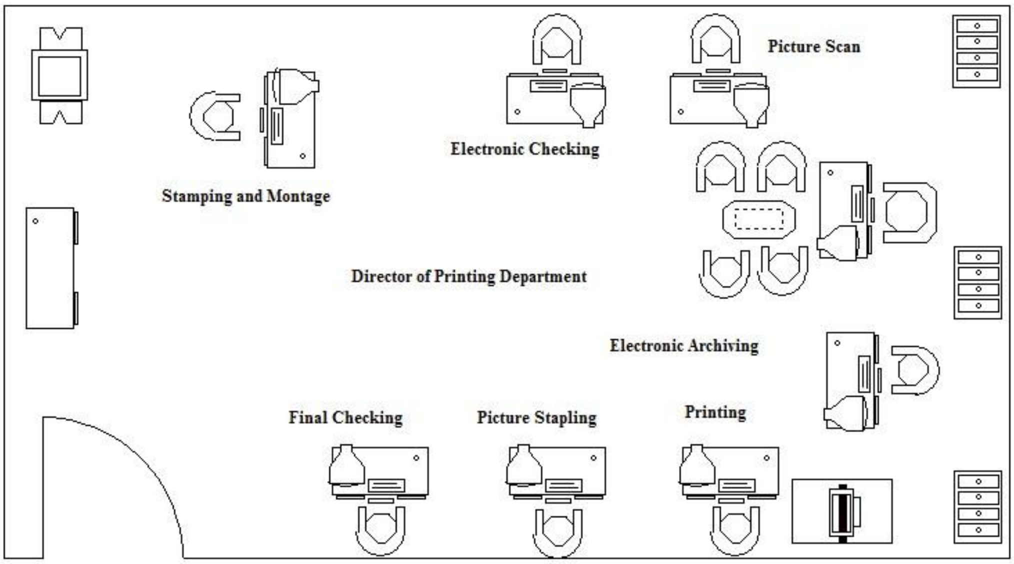


Figure (5.2): Printing hall layout

5.4. Research Problem

The passports and civil affairs sector at the Ministry of Interior provides many services to the public. It serves about 2 million people in Gaza strip, 600000 people in Gaza city only (PCBS, 2013). The most prominent of these services is printing identity cards, which takes 2 days in average to finish, birth certificates which takes 24 to 48 hours to complete, and renewing passports in 24 to 48 hours. These numbers are special for Gaza city of course (Hemdiat, 2012). It is noticeable that these services and transactions are what help people to manage their life such as asking for salary allowances, urgent travel, changing address.

Therefore, the rapid completion of these transactions is a key demand of the public, but most of these services are completed in some days what creates an atmosphere of discontent by the public. The thing that requires substantial improvements in the Passports and Civil Affairs Sector to speed up the completion of services.

The proposed thesis intends to use Decision Support Systems in simulating Passports and Civil Affairs Sector through identifying the current environment, analyzing the status and testing its idealism, and proposing a new system using simulation to determine the optimal number of service providers for the system in order to reduce the postponement of the public services.

Accordingly, the problem can be formulated by the following questions:

A. Does the Passports and Civil Affairs Sector work at an optimal level?
B. Is there a delay in issuing documents to the public? If yes, what are the reasons?
C. What are the proposed solutions to improve the performance of the sector?

5.5. Research Objectives

The main objective of this research is to evaluate and enhance the performance of the passports and civil affairs sector in Gaza strip (more details in chapter one).

5.6. Data Collection

Data collection is done at GCAPD for two different work seasons (two weeks in January , one week in May and one week in June) in order to get a variety of results since work load is different from winter to summer, observations were done for the whole work hours, (8:00 – 2:00). This research collects both qualitative and quantitative data using interviews, on-site observations, and time measures.

Two interviews were conducted with key personnel of GCAPD. Data gathered during these interviews were used for the mapping of existing work processes at GCAPD.

On-site observations were performed to analyze the current layout of the directorate and to understand the work processes. All work processes were analyzed in detail in order to develop a simulation model.

Time measures were conducted to collect processing times of receiving applications, arrival rates, printing.

5.6.1. Arrival Rate

The arrival rate was collected experimentally through observation of the various activities during the work hours of the GCAPD. The analyzed data, shows that the system receives 69 arrivals per hour. The exponential distribution, which is often used for modeling inter-arrival time, was selected to model the customer arrivals. Table (5.2) summarizes the probability of arrival for each type of requests.

Table (5.2): Requests type Vs. Probability Arrival

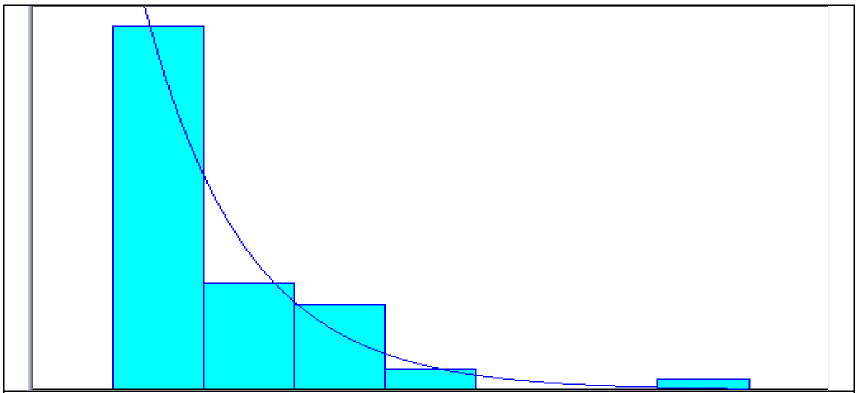
Requests	% of total No. of requests
Lost ID annex	1
Damaged Identification card annex	0.012
Lost Identification card annex	0.038
To Whom it May Concern	0.57
Population Summary	0.89
Birth certificate	10
Replacing birth certificate	0
A transcript	0.85
Second death certificate	0.76
Delayed registration of births	
For the period of 11 days until the end of the first month	0.46
From the beginning of the second month until the end of the third month	0.37
From the beginning of the fourth month until the end of the first year	0.037
For more than one year since date of birth	0.012
Delayed registration of death	
For the period of 8 days until the end of the first month	0.11
From the beginning of the second month until the end of the third month	0.075
From the beginning of the fourth month until the end of the first year	0.025
For more than one year since date of death	0.075
Damaged ID card annex	3.29
Reporting live births	8.63
Reporting deaths	1.16
Inquiries	25
A transcript 2	0
New ID card	6.7

Damaged ID card	13.4
Lost ID card	2.1
Fine of losing a damaged ID card	0
Changing marital status	5.6
Damaged Identification card	0.1
Lost Identification card	0.025
Changing marital status in the Identification card	0.32
Change of address in the Identification card	0.025
Correction of birth certificate	0.09
Correction of birth certificate for less than 5 years, 20 Dinars fees	0
Change of address	5.05
Family reunification card	0
Reunification request	0.037
Correction in the ID card	0.27
First Identification card	1.7
Registration of overseas births	0.45
Passports extension for the first time	3.6
Passports extension for the second time	0.7
Inclusion of sons in the passport	2.9
To Whom it May Concern	0
Data correction in the passport	0.3
Ramallah's passport registration	3.27
Total	**100**

5.6.2. Fitting Probability Distributions

Arena Input Analyzer (AIA) was used in fitting input raw data for customers' arrivals and service processes time. The AIA automatically creates a histogram from the sampled data, and provides a summery of sample statistics as shown in Fig. (5.3) The minimum square error with largest goodness of fit test p-value is desirable (p-values greater than or equal 0.05 was considered to be a good fit) (Kelton et al., 2004).

The probability distributions for arrivals and different service processes are shown in table (5.3)



Distribution Summary

Distribution Summary	Data Summary
Distribution: Exponential	Number of Data Points = 55
Expression: EXPO(0.8001)	Min Data Value = 0.00282
Square Error: 0.007097	Max Data Value = 4.67
	Sample Mean = 0.813
Chi Square Test	Sample Std Dev = 0.812
Number of intervals =3	
Degrees of freedom = 1	Histogram Summary
Test Statistic = 1.98	
Corresponding p-value =0.178	Histogram Range = 0 to 5
	Number of Intervals = 7
Kolmogorov-Smirnov Test	
Test Statistic = 0.108	
Corresponding p-value > 0.15	

Figure (5.3): AIA sample output for arrivals

Table (5.3): AIA output expressions for GCAPD service processes.

Process	Probability Distribution
Arrival rate	EXPO(0.8)
Reception	TRIA(0.5 ,2 ,4)
Registrar	UNIF(.5 , 1)
Reception printing	UNIF(2 ,5)
Printing De. Admin.	EXPO(1)
Electronic checking	POIS(1.5)
Scanning	POIS(2)
Printing	POIS(2.5)
Picture stapling	POIS(1.5)
Final checking	POIS(2)
Signature	POIS(0.5)
Stamping and montage	POIS(3.5)
Elec. Archive	POIS(2)
Distribution	POIS(3)

5.7. Development of Simulation Model

5.7.1. Model Conceptualization

In order to build a conceptual model for a system, it is important to make a set of assumptions about it. These assumptions constitute a model. Assumptions are expressed in mathematical or logical relationship. The following assumptions were adopted for the purpose of modeling the system under investigation:

- GCAPD opens at 8:00AM and offers services for customers until 2:00PM.
- The system follows single queue, multi-server model as presented in figure (5.4).
- All reception staff can handle all types of customer requests. There are no special service queues.
- There is no queue capacity limitation.
- All reception staff will have an equal opportunity to serve any customer. All queues follow a First-In First-Out (FIFO) priority.

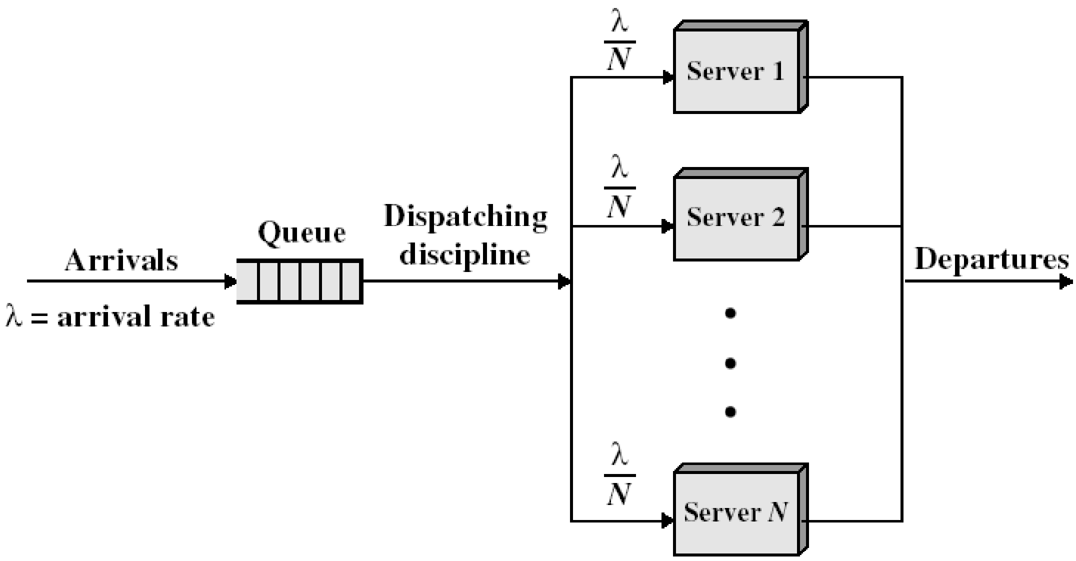


Figure (5.4): GCAPD queueing model.

Arena, the simulation package which is used in this research and described in chapter 3, has been developed based on the principle of *flow-oriented simulation*. The idea behind flow-oriented simulation is that you can represent a real situation as a series of delays and processes through which entities flow. This way of modelling corresponds with the way in which people often represent a system intuitively. If you ask someone how he/she thinks a certain process works, often this person will draw a diagram using blocks and arrows to indicate the activities that are carried out and the sequence in which they are performed. A flow-oriented simulation model has, therefore, a starting point where entities enter the system and an exit point where entities leave the system.

The system that you want to model has a boundary that has been chosen by the modeler: The *system boundary*. This boundary determines what you do include and do not include in your model of the actual situation. The entrance and exit of the system are located on the system boundary. This is done because the entities that flow through the system must come from somewhere and, after flowing through the system, they must go somewhere. In the model we do not consider where entities come from or where they go to; this is something outside the system boundary. Therefore, in the simulation model entities must be created to simulate their entrance into the system and, after passing through the system, they must also be disposed of (Verbraeck, 2002). Figure (5.5) shows a flow chart for a flow-oriented system with boundaries for each service channel.

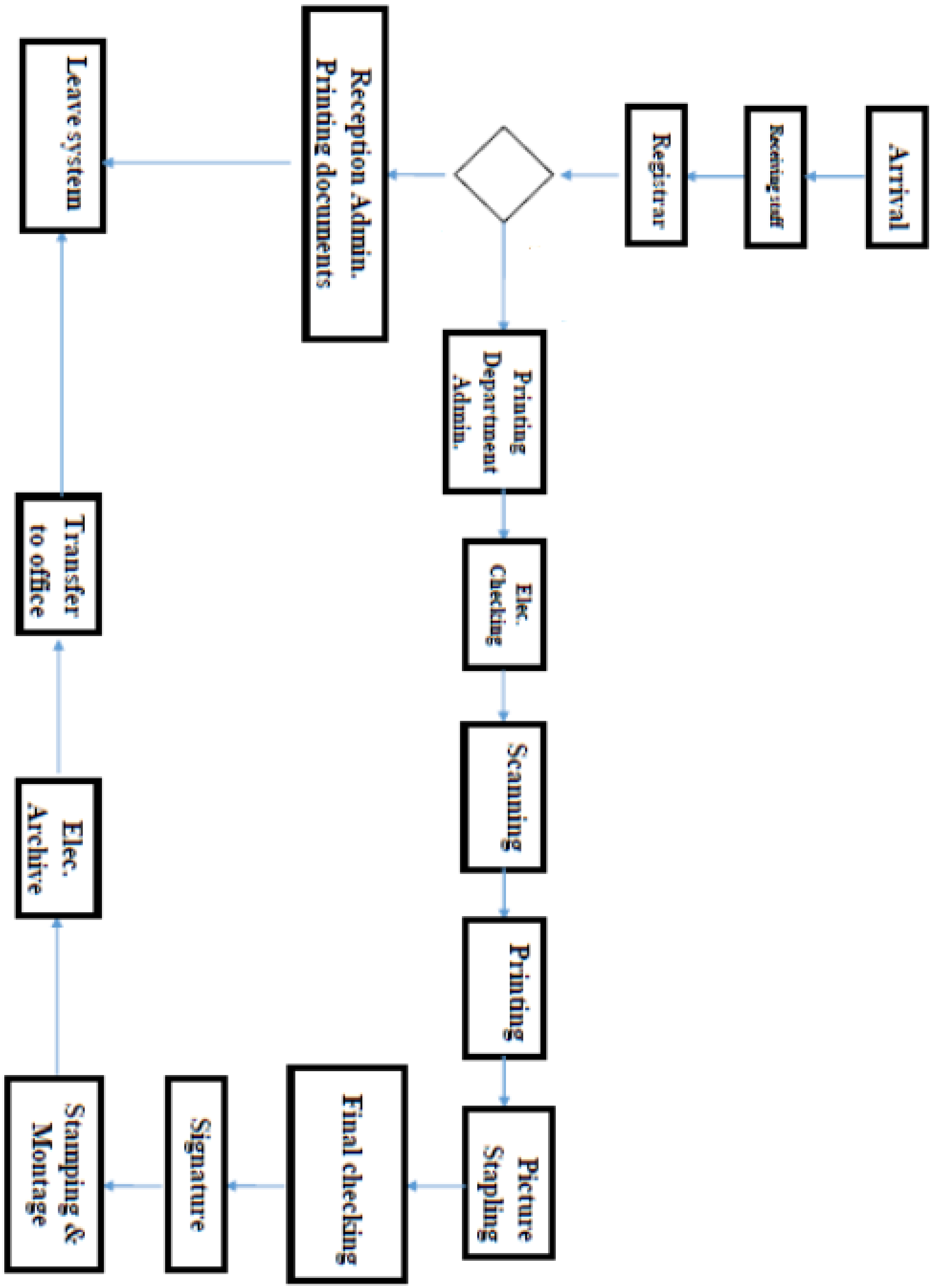


Figure (5.5): Basic conceptual model for reception hall and printing department.

5.7.2. Model Construction Using Arena Software

The model is constructed according to the following procedures:

a) The simulation model layout is constructed as illustrated in figures (5.1), (5.2) and (5.4).

b) An Arrive module is defined, where the time between arrivals is exponentially distributed with mean of 0.8 minute as illustrated in figure (5.6)

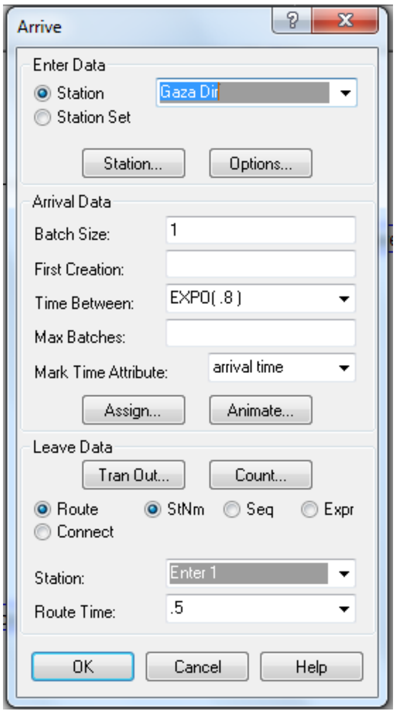


Figure (5.6): Dialogue box for the Arena Arrive Module (Arrivals)

c) A Chance module in added with probabilities (0.33, 0.33, 0.34) to ensure that arrivals have equal chances with the three employees as shown in figure (5.7)

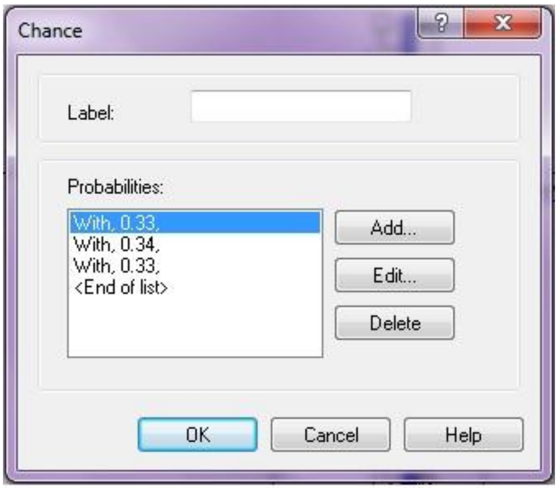


Figure (5.7): Dialogue box for the Arena Chance Module

d) Enter, Process and Leave modules act as server modules; where the service time for different requests is defined by a triangular distribution of (0.5, 2, 4) minutes as illustrated in figure (5.8).

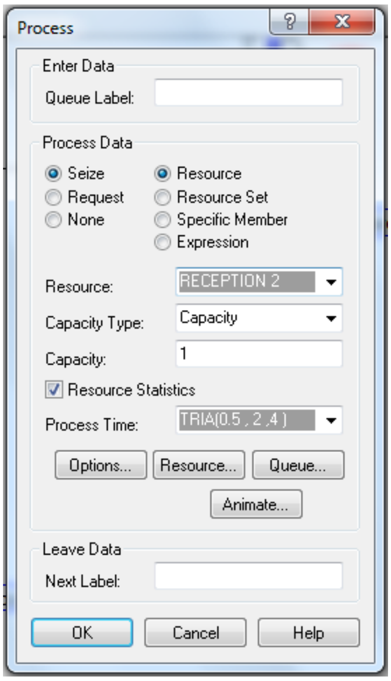


Figure (5.8): Dialogue box for the Arena Process Module (Reception)

e) The registrar is presented with a Process module, the service time is defined as a Uniform distribution of (0.5, 1) minutes, as illustrated in figure (5.9).

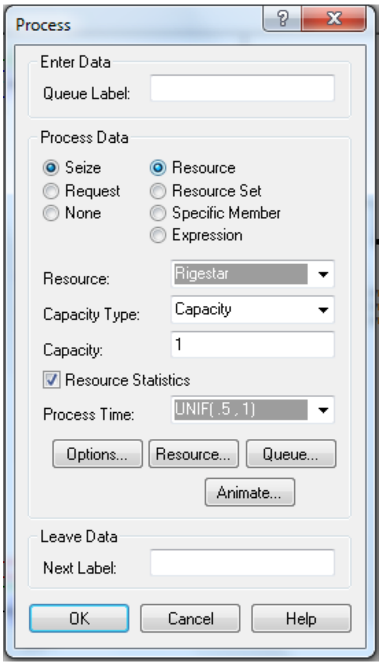


Figure (5.9): Dialogue box for the Arena Process Module (Registrar)

f) Another Chance module is defined with probabilities of 17% to represent the passports requests probability that leaves the system, 38% to represent requests that are printed at reception hall and 45% to represent requests that are transferred to the printing department as illustrated in figure (5.10).

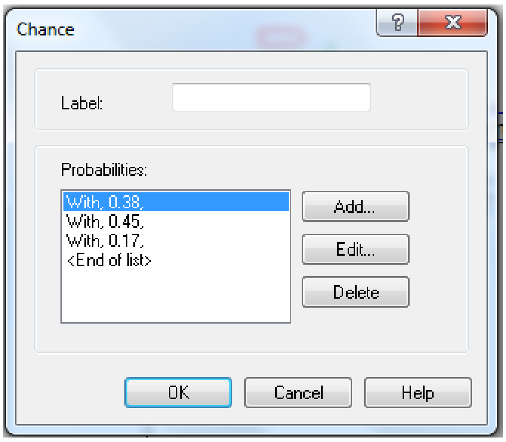


Figure (5.10): Dialogue box for the Arena Chance Module

g) A server module is used; where printing time for documents done at the reception hall is defined by a Uniform distribution of (2, 5) minutes as shown in figure (5.11).

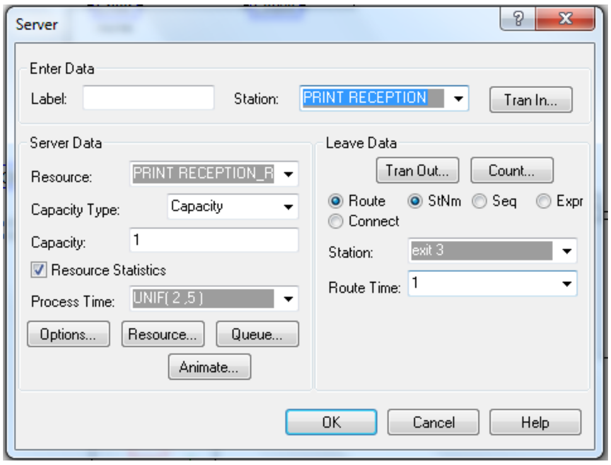


Figure (5.11): Dialogue box for the Arena Server Module (Reception printing)

h) Enter, Process, Delay and leave modules act as server modules; where the processing time is defined as Exponential distribution with mean of 1 minute as illustrated in figure (5.12) .The delay time was 360 minutes.

i) Server modules were used to represent the different processes at printing department. Most of processes time is defined as Poisson distribution with a mean 1.5 minute for archive as shown in figure (5.13), 2 minutes for scanning as shown in figure (5.14), 2.5 minutes for printing as shown in figure (5.15) and 1.5 minutes for stapling the picture as illustrated in figure (5.16).

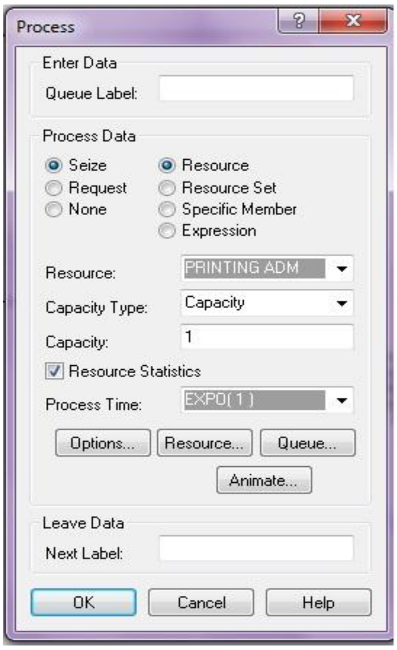


Figure (5.12): Dialogue box for the Arena Process Module (Printing hall administration)

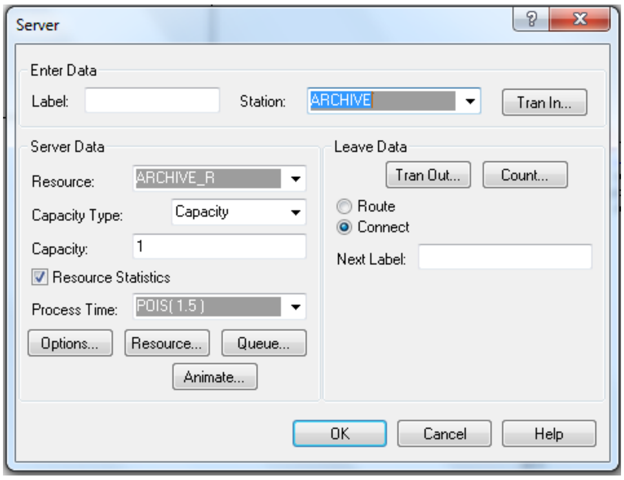


Figure (5.13): Dialogue box for the Arena Server Module (Electronic checking)

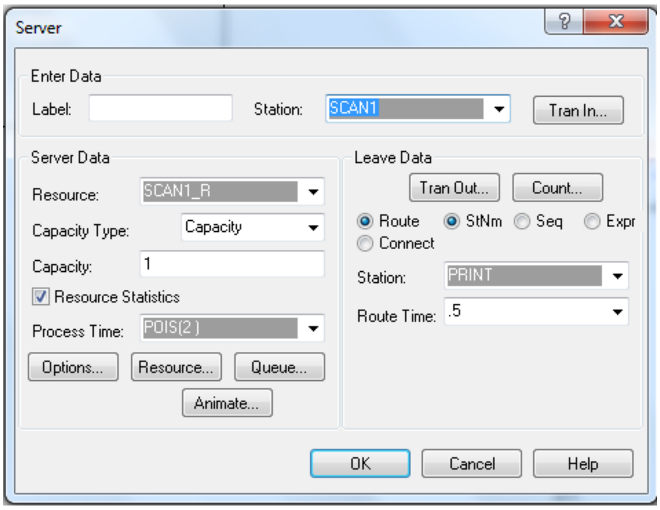


Figure (5.14): Dialogue box for the Arena Server Module (Picture scanning)

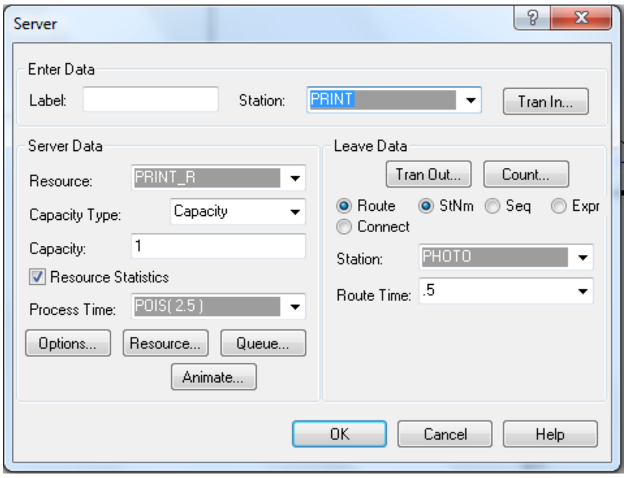


Figure (5.15): Dialogue box for the Arena Server Module (Printing)

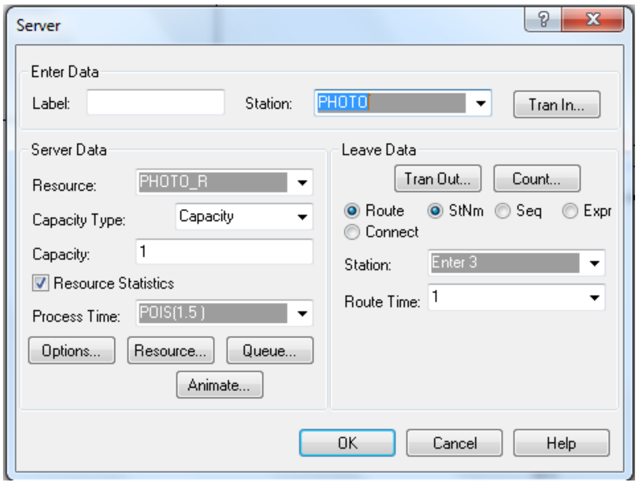


Figure (5.16): Dialogue box for the Arena Server Module (Picture stapling)

j) A simulate module is used; where the number of replications and simulation length period are defined as illustrated in figure (5.17).

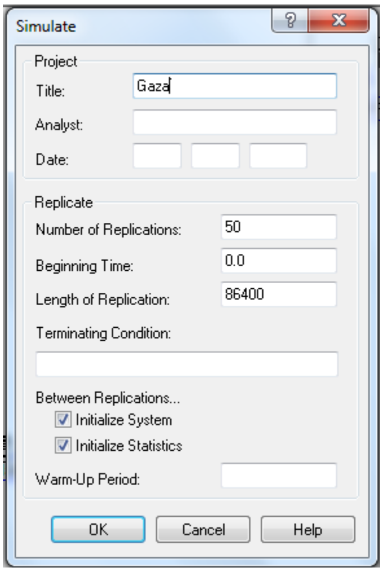


Figure (5.17): Dialogue box for the Arena Simulate Module

5.8. Model Verification and Validation

Verification and validation are the primary means to assess accuracy and reliability in computational simulations (Oberkampf & Trucano, 2002).

Verification is concerned with building the model right. It is utilized in the comparison of the conceptual model to the computer representation that implements that conception but Validation, on the other hand is concerned with building the right model. It is utilized to determine if the computer model is an accurate representation of the real system for the purpose at hand (Jenkins et al., 1998).

5.8.1. Model Verification

Model verification is a process where the modeller ensures that the model behaves as intended (Huynh & Walton, 2005). The model verification was done by observing model animation and collecting data from various deterministic runs and stochastic runs. Running a deterministic model verified that entities were being routed correctly and that the calculated response time was as expected.

5.8.2. Model Validation

Model validation is the task that ensures the model works in the same way as the real system. It also ensures that the results it produces are within an acceptable level of accuracy (Huynh & Walton, 2005).
To this end, validation of this model was performed by using some tests. An iterative process of calibrating the model took place; comparing the model to actual system behavior. This process was repeated until sufficient model accuracy was reached.
The calibration process is performed manually by making small changes to the values of the parameters and re-running the simulation to see the results. Figure (5.18) illustrates the calibration methodology. The model generally satisfied the expectations.

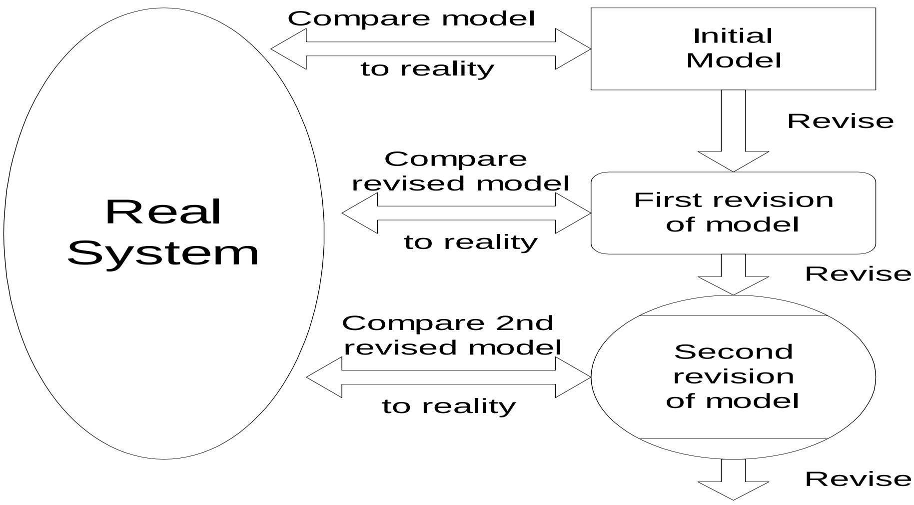


Figure (5.18): Iterative process of calibrating a model

The second validation technique was *Constant Value Test*. Randomness in interarrival time and processing time is removed to test the behavior of the model under deterministic conditions. Interarrival time is set at 1minute (constant) and the processing time is set at 1 minute. Running the model for 1000 minutes . These values are equal to the results obtained by manual calculations. Therefore, the model is valid from this test point of view.

The third validation technique was *The Comparison of Results with the Real System*. The comparison of results for the validation of the correct model translation indicates that the overall process times and the initial identified process inputs are within an acceptable range. Therefore, the model can be considered as a representative picture of the processes within the GCAPD under investigation. This model is then used to test scenarios to improve the processes in our system. Table (5.4) shows the numbers arrived and served in both simulated and real system and these results are presented in figure (5.19)

Table (5.4): Comparison between simulated and observed average input arrivals for different stations in the system

	Simulation results	Real system
Arrivals	455	415
Reception 1	150	140
Reception 2	146	138
Reception 3	144	137
Inquiries	109	101
Registration process	330	314
passports	55	54
Reception printing process	100/125	90/119
Printing department Admin.	150	141
Elect. Checking process	130	118
Scanning process	127	116
Printing process	123	110
Picture stapling process	122	110
Final checking process	120	105
Signature process	120	105
Montage process	97	83
Electronic archive process	96	79
Distribution process	92	79

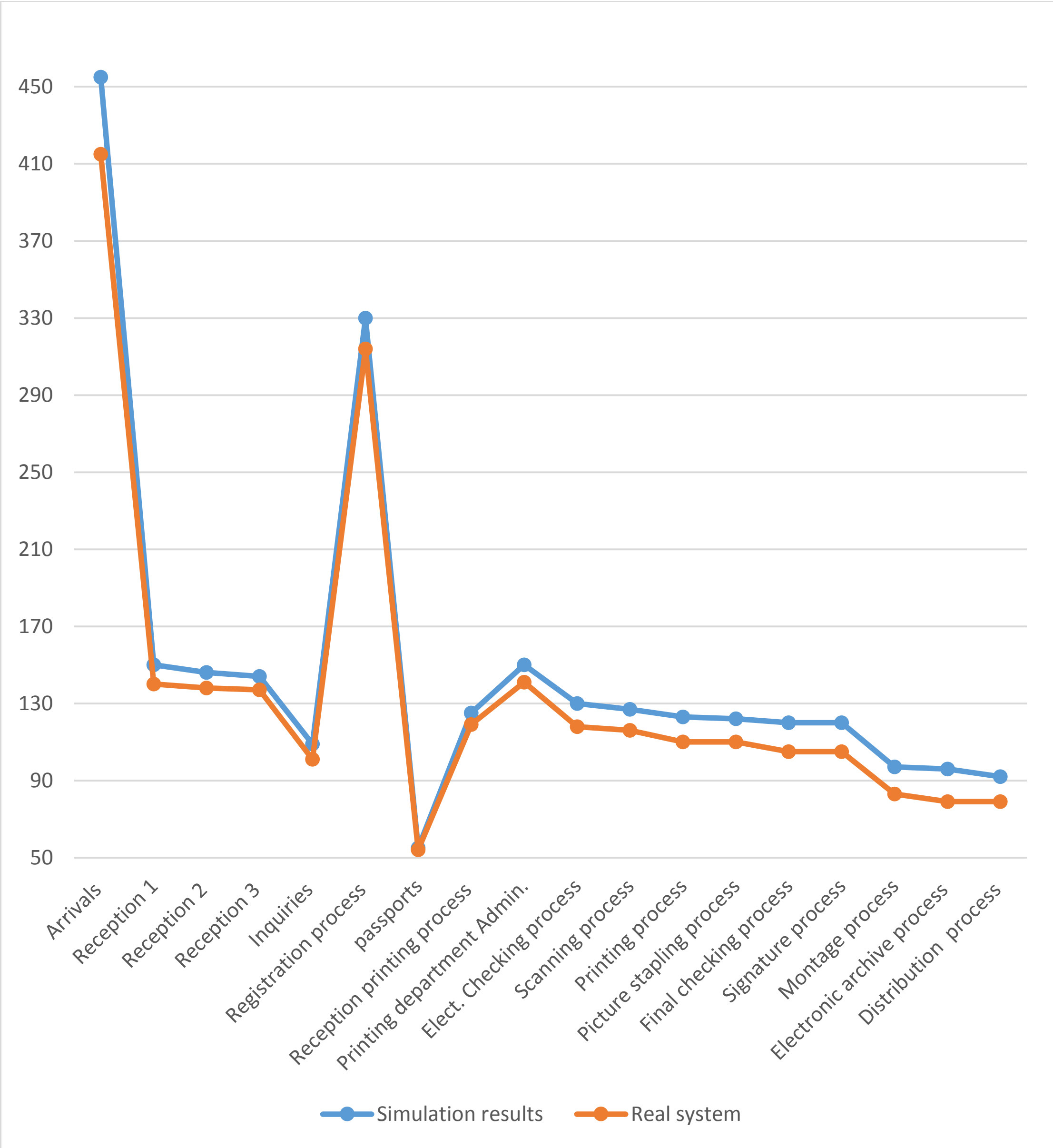


Figure (5.19) Comparison between simulated and observed average input arrivals for different stations in the system

CHAPTER SIX

ANALYSIS OF RESULTS AND OPTIMIZATION

This chapter consists of the following sections:

6.1. Introduction

6.2. Performance Measures

6.3. Simulation Results for Current System

6.4. Improving Performance and Optimization Phase

6.5. Discussion of Results

6.1. Introduction

In this chapter, we are going to analyze the results of simulated model for both reception and printing department. The analysis will be supported with comparisons between different solutions suggested to improve the performance of the GCAPD. The overall improvement of the system will be presented at the end of this chapter.

6.2. Performance Measures

A set of performance measures are selected to judge the performance of the system which are:

- Average cycle time (system time): it is the time spent by the application forms in the system, including time spent in queue and processing time.
- Average time in queue (waiting time): it is the time spent by the application form waiting for service from different stations.
- Work-In-Process: it is the number of incompletely processed application forms remaining in the system at the end of the business day.
- Average number of served applications (Number processed): it is the number of application forms that entered the system, printed and left the system.
- System performance: it is (Average number of served application forms) / (Average number of application forms in the system)

6.3. Simulation Results for Current System

The next stages in the simulation development processes are experimentation and analysis of results. These phases of simulation development involve the exercising of the simulation model and the interpretation of the outputs.

Simulation of the current system is useful for evaluating the usefulness of any changes to be made to the current system. Due to the probabilistic nature of discrete-event simulation, the model was run 50 times, where each run represents one business day . Thus, all the simulation results presented in this research are based on the average of 50 runs. Unlike other systems characterized by continuous operation, the business day in the GCAPD consists of a single shift starting from 8:00 AM and ending at 2:00 PM. Thus, the type of simulation used for this case is a terminating simulation.

Some of the results listed in the following tables were compared to experimental data in terms of the total number of application forms processed and total time spent in the system. The simulation results were found in good agreement with the experimental data. The simulation results for reception hall in table (6.1) and figure (6.2) show that the application forms requires long time, and this is due to the long period of waiting time. Also, it can be seen that there are relatively significant amounts of incompletely processed application forms (Work-In-Process) remaining in the system at the end of the business day especially in printing department as shown in figure (6.3) for reception hall and figure (6.1) for printing department which delayed the application forms more than 24 hours to start work on them . Also, it can be seen that a significant amount of the total system time that is required to issue a document is due to non-productive waiting time as shown in table (6.2) and this result is presented in figure (6.4). These two observations suggest a relatively poor performance for the present system which requires some changes to be made to improve the system.

Results of the model simulation for the present GCAPD are presented as shown in the following section.

6.3.1. Reception hall:

The results of simulation for reception hall shown in table (6.1) shows that the number of daily processed application forms is 100 out of 125 arrivals in average as shown in figure (6.1), and this number of processed applications result 80% performance of the department. The system time shown in figure (6.2)is long due to the long waiting time in printing process.

Table (6.1) : Simulation results and system performance for reception hall.

Performance Measure	Reception
Work-In-Process	25
Number processed	100
Waiting time (min)	27
System time (min)	35
Performance	80%

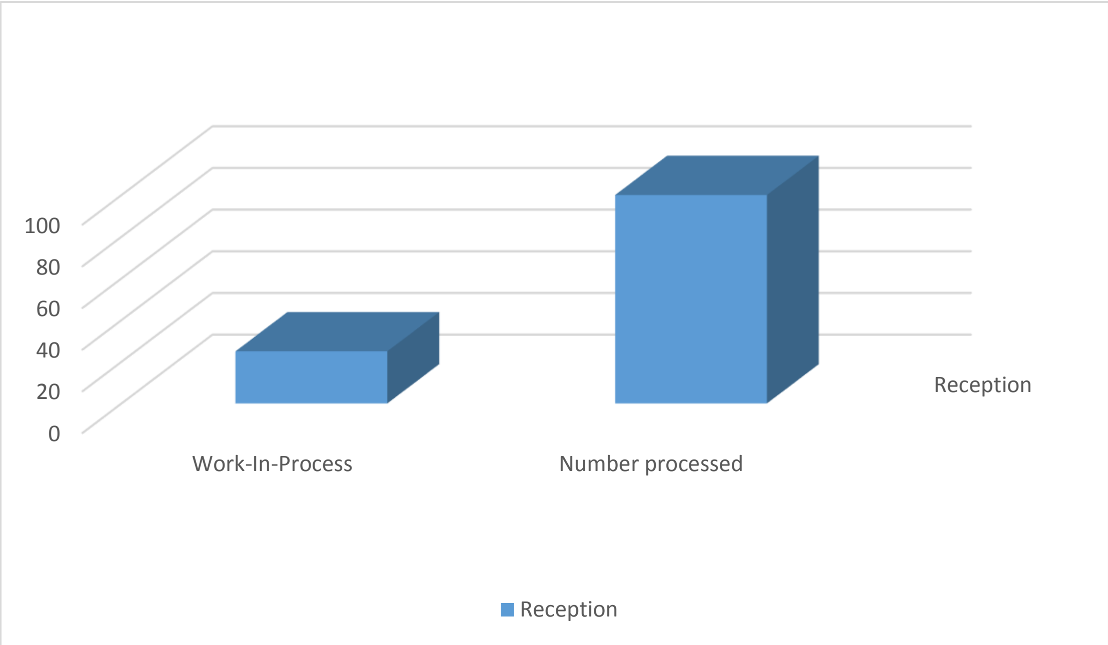


Figure (6.1) : Number of processed applications versus work in process for reception hall

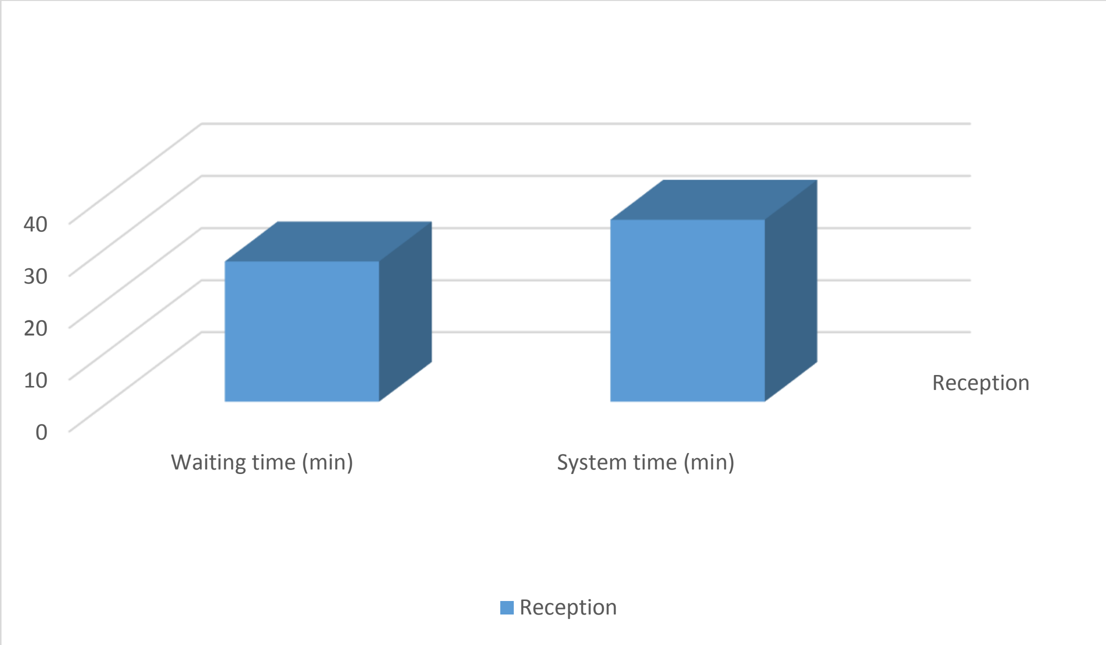


Figure (6.2) : Average system time versus waiting time for reception hall

6.3.2. Printing department:

The results of simulation for printing department shown in table (6.2) shows that the number of daily processed application forms is 0 out of 150 arrivals in average as shown in figure (6.3), but this does not mean that the department does not work. The department works on the applications from previous day, which means that the applications are delayed at least 24 hours as shown in figure (6.4). This number of unprocessed applications result 0% performance of the department for daily application forms.

Table (6.2) : Simulation results and system performance for printing department.

Performance Measure	Printing department
Work-In-Process	150
Number processed	0
Waiting time (min)	1480
System time (min)	1510
Performance	0%

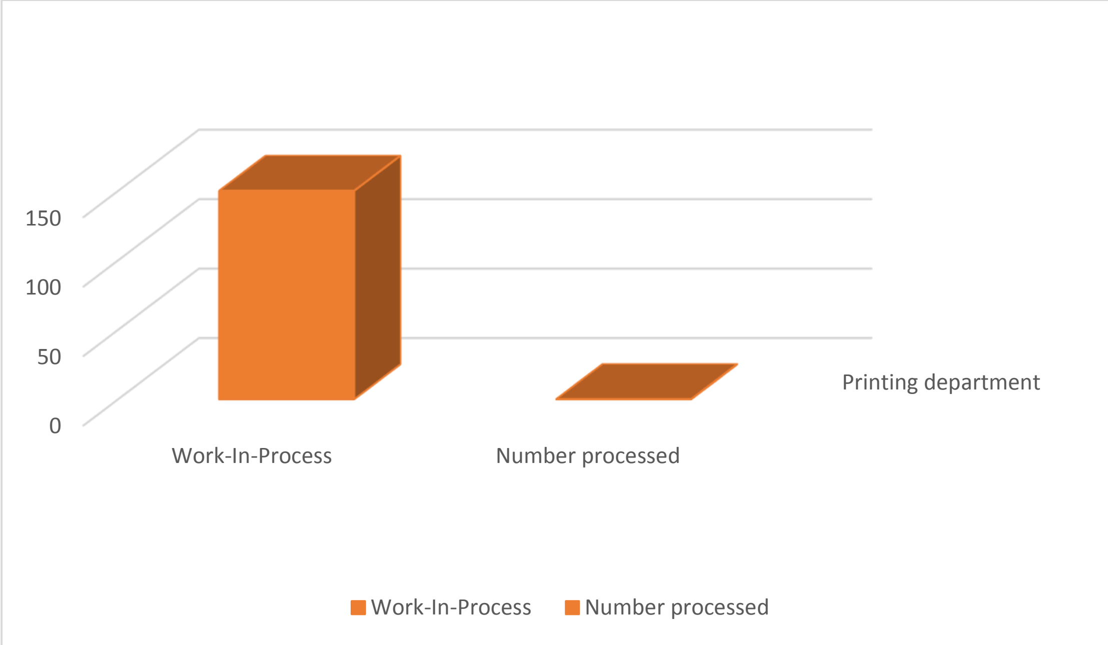


Figure (6.3) : Number of processed applications versus work in process for printing department.

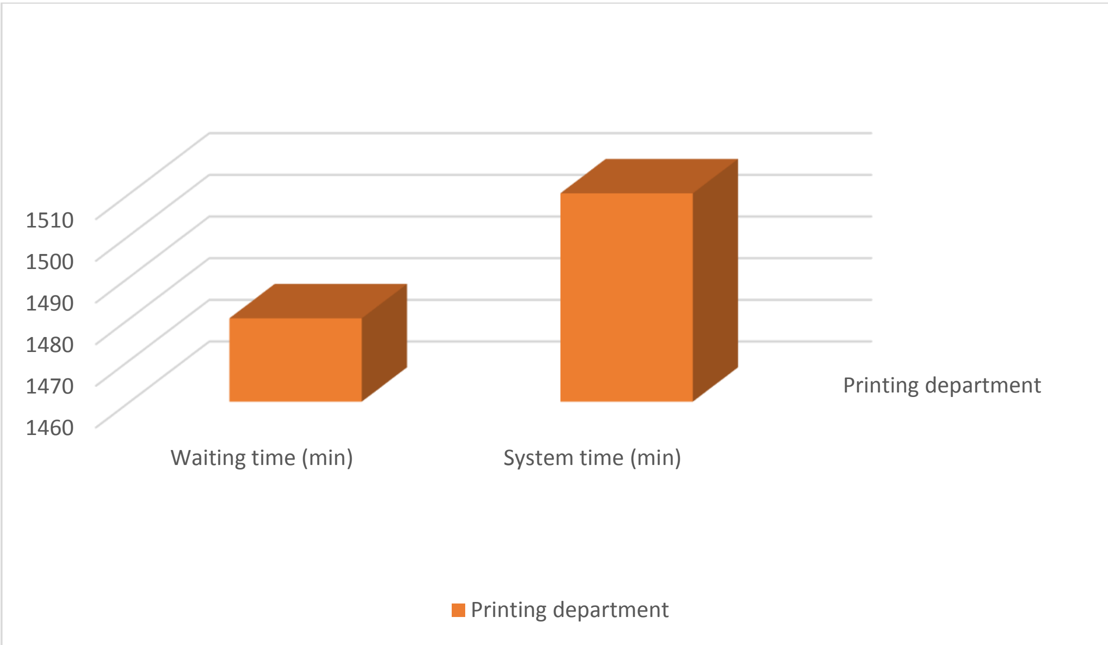


Figure (6.4) : Average system time versus waiting time for printing department.

6.4. Improving Performance and Optimization Phase

The conducted simulation process showd that the performance of GCAPD serves around (80%) of daily arrivals in reception hall and (0%) of daily arrivals in printing department. The time needed to issue a document in reception hall is around 35 minutes, and in printing department is a round 26 hours. These results are shown in table (6.1) and table (6.2)

This research is conducted to improve the performance of GCAPD. Therefore, solutions are proposed to serve larger numbers of incoming application forms, reduce the average cycle time, and reduce the average waiting time in queue as shown in the following suggested solutions:

6.4.1. Reception hall

1- Adding one printing employee

The proposed solution is hiring a new printing employee at reception hall which will serve and print two application forms at the same time. This will improve the performance up to (100%). The model results are shown in table (6.3)

Table (6.3) : Simulation results and system performance for reception hall after adding one printing employee.

Performance Measure	Reception
Work-In-Process	0
Number processed	127
Waiting time (min)	5
System time (min)	11
Performance	100%

Figure (6.5) illustrates the average cycle time (system time) and the average waiting time after hiring one printing employee.

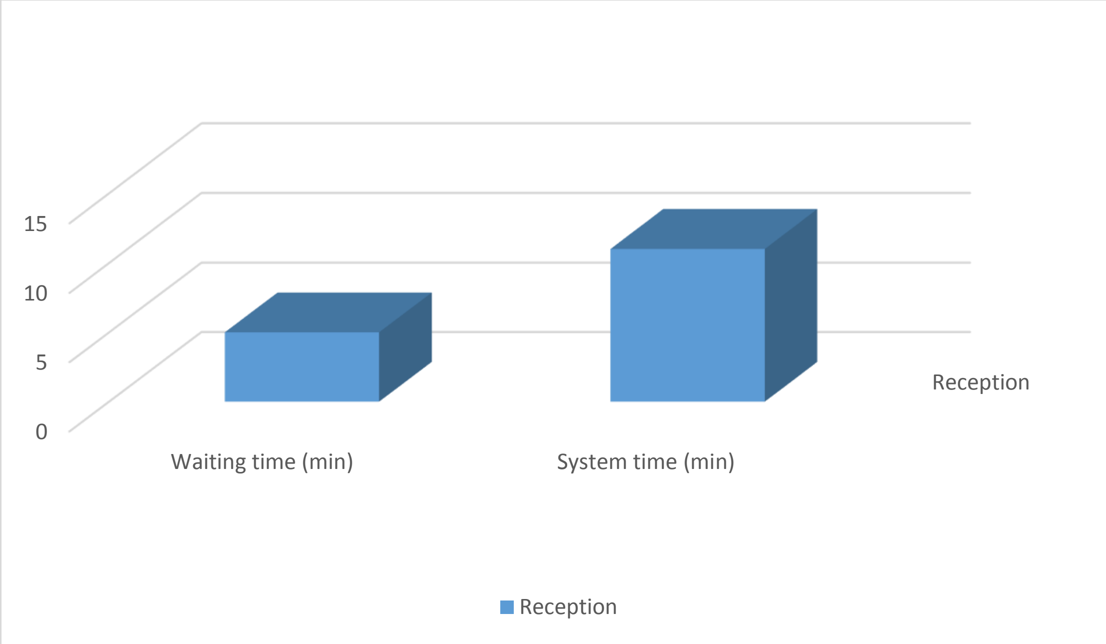


Figure (6.5) : Average system time versus waiting time for reception hall after adding one printing employee.

Figure (6.6) shows the average number of processed application forms and the average number of unprocessed application forms at the end of the day (Work-In-Process)

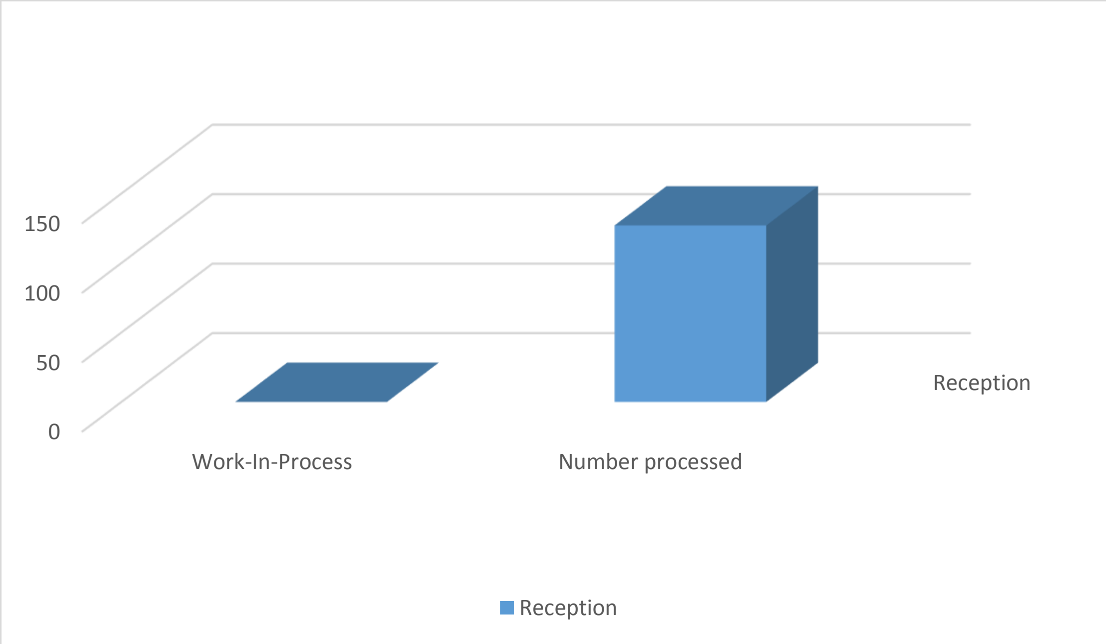


Figure (6.6) : Number of processed aplications versus work in process for reception hall after adding one printing employee.

6.4.2. Printing department

As explained before, the daily application forms, which processed in printing department, are seized until the next day due to some registration processes done by reception hall administration to make sure that all application forms are divided into the right categories. Also, it is a complicated process to transfer applications directly into printing department so the administration of reception hall print only one list at the end of the day then they transfer the application forms at the beginning of next day. From observations, this is the main reason for the delay of the application forms. The following solutions are suggested:

1- Transferring application forms every 60 minutes

The proposed solution is to transfer a group of daily application forms every 60 minutes. This will improve the performance up to (55%) instead of (0%) for daily applications. The model results are shown in table (6.4)

Table (6.4) : Simulation results and system performance for printing department after transfering application forms every 60 minutes.

Performance Measure	Printing department
Work-In-Process	65
Number processed	82
Waiting time (min)	77
System time (min)	98
Performance	56%

Figure (6.7) illustrates the average cycle time (system time) and the average waiting time after transferring applications every 60 minutes.

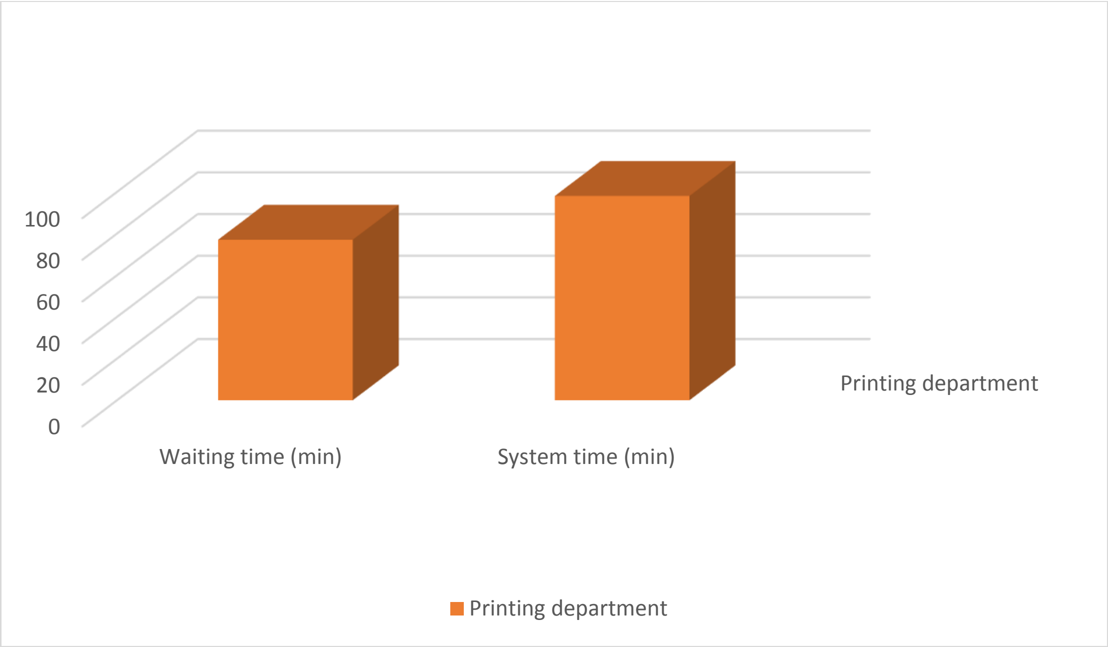


Figure (6.7) : Average system time versus waiting time for printing department after transfering application forms every 60 minutes.

Figure (6.8) shows the average number of processed application forms and the average number of unprocessed application forms at the end of the day (Work-In-Process)

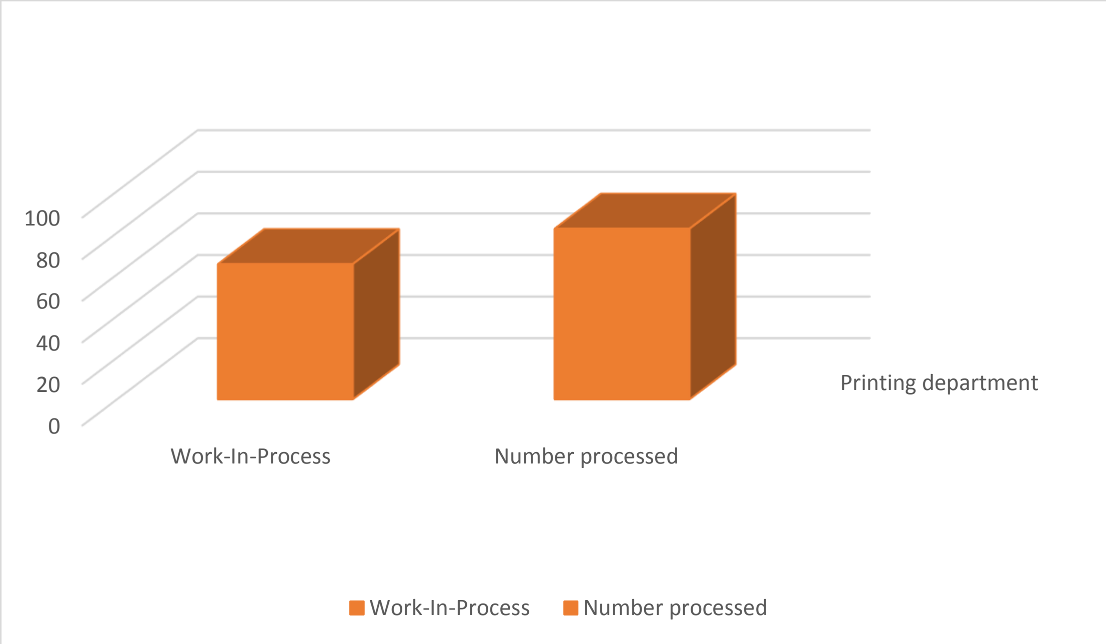


Figure (6.8) : Number of processed aplications versus work in process for printing department after transfering application forms every 60 minutes.

2- **Transferring application forms every 60 minutes and adding a montage employee**

The proposed solution is to transfer a group of daily application forms every 60 minutes as previous suggestion and adding one montage employee. This will improve the performance up to (63%) instead of (0%) for daily applications. The model results are shown in table (6.5)

Table (6.5) : Simulation results and system performance for printing department after transfering application forms every 60 minutes and adding a montage employee.

Performance Measure	Printing department
Work-In-Process	55
Number processed	93
Waiting time (min)	64
System time (min)	83
Performance	63%

Figure (6.9) illustrates the average cycle time (system time) and the average waiting time after transferring applications every 60 minutes and adding a montage employee.

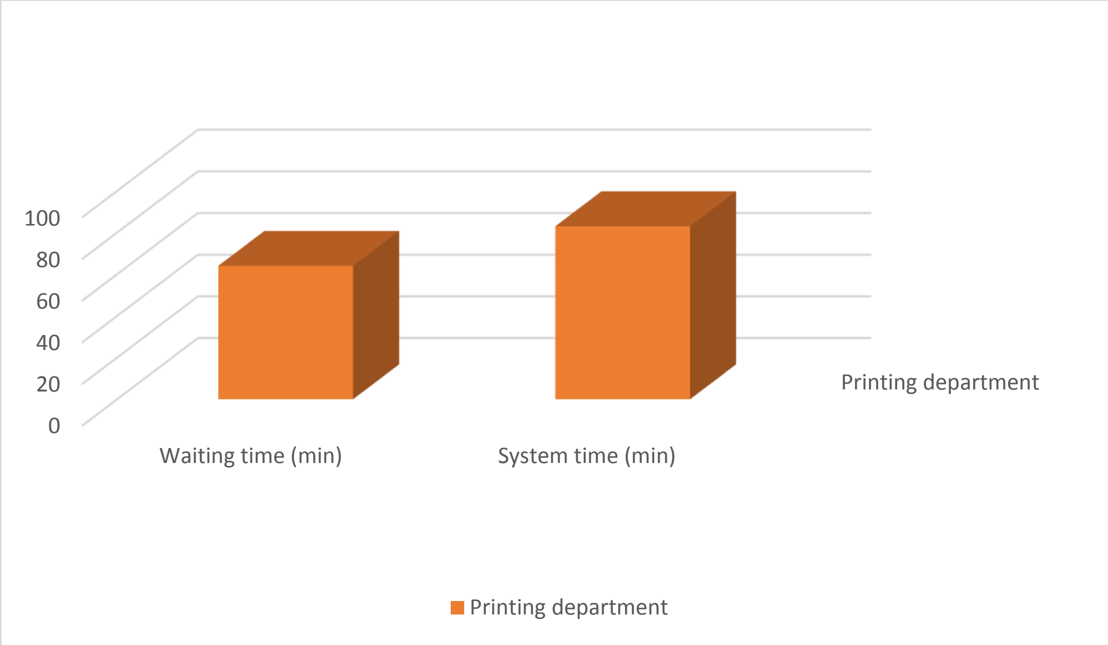


Figure (6.9) : Average system time versus waiting time for printing department after transfering application forms every 60 minutes and adding a montage employee .

Figure (6.10) shows the average number of processed application forms and the average number of unprocessed application forms at the end of the day (Work-In-Process)

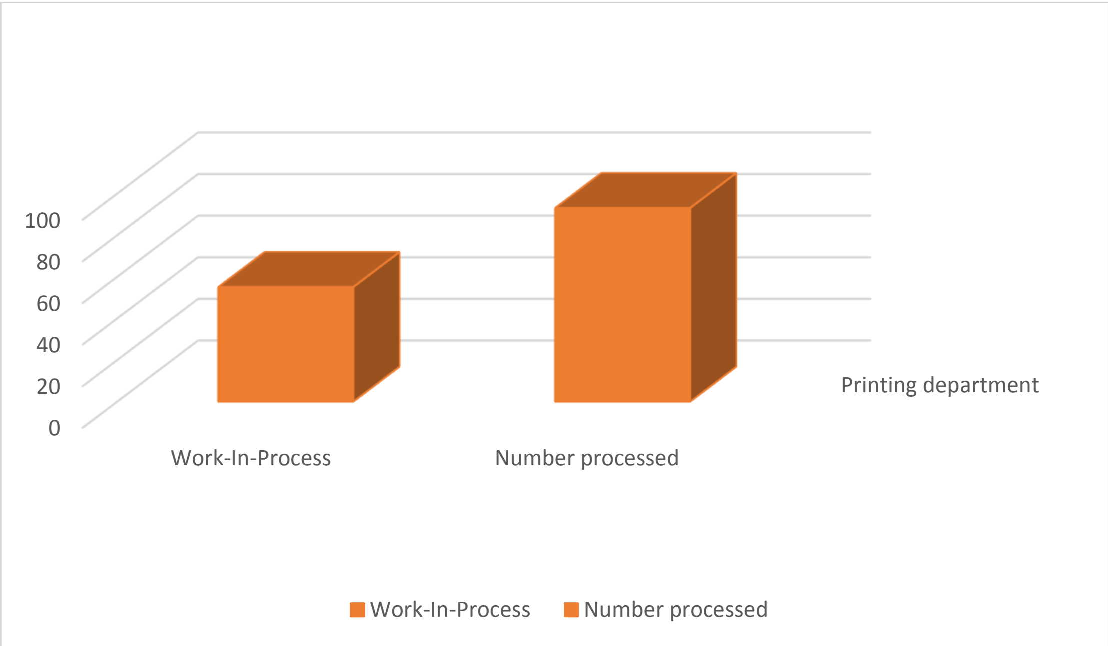


Figure (6.10) : Number of processed aplications versus work in process for printing department after transfering application forms every 60 minutes and adding a montage employee .

6.5. Discussion of Results

Results of the model simulation for the optimized system show that the average number of processed applications is increased and the average number of unprocessed applications and average system time are decreased in both reception hall and printing department. And it is noticeable that case two in printing department is better than case one so comparison of results will be with case two. The model results for reception hall are shown in table (6.6) and the model results for printing department are shown in table (6.7).

Table (6.6) model results discussion for reception hall

Performance Measure	Reception	Case 1	Improvement
Work-In-Process	25	0	100%
Number processed	100	127	22%
Waiting time (min)	27	5	81%
System time (min)	35	11	68%
Performance	80%	100%	20%

It can be seen from Table (6.6) that performance of the optimized reception hall in GCAPD has improved in all respects relative to the current reception hall. Work-in-process was reduced by 100% leading to increase by 22% in number of processed documents by reception hall. Waiting time and system time were significantly reduced by 81% and 68%. The overall performance increased by 20%.

Table (6.7) Model results discussion for printing department

Performance Measure	Printing department	Case 2	Improvement
Work-In-Process	150	55	63%
Number processed	0	93	62%
Waiting time (min)	1480	64	95%
System time (min)	1510	83	94%
Performance	0%	63%	63%

From table (6.7) we can see that performance of the optimized printing department has improved. Work-in-process was reduced by 63% leading to increase by 62% in number of processed documents. Waiting time and system time were reduced by 95% and 94%. The overall performance increased by 63%.

The percentage improvement in GCAPD can be calculated by using the probabilities of documents issued by the two departments. A summary of these calculated percentages are listed in Table (6.8)

Table (6.8): Average percentage improvement for the optimized GCAPD

Performance Measure	Reception Improvement	Printing Improvement	Average
Work-In-Process	100%	63%	81%
Number processed	22%	62%	44.2%
Waiting time (min)	81%	95%	89.7%
System time (min)	68%	94%	83%
Performance	20%	63%	43.8%

CHAPTER SEVEN

CONCLUSIONS AND RECOMMENDATIONS

This chapter consists of the following sections:

7.1. Introduction

7.2. Conclusions

7.3. Recommendations

7.1. Introduction

The main objective of this research is to evaluate and enhance the performance of the passports and civil affairs sector in Gaza strip. This chapter will consolidate the main results of the previous chapters in the light of research problem and objectives. Research recommendations will be directed towards promoting the adoption and implementation of simulation in other service facilities in Palestine.

7.2. Conclusions

This research has presented an approach for enhancing the performance of public departments such as the passports and civil affairs sector in Gaza strip. The GCAPD system was represented by a DES model developed with the aid of ARENA software and supplemented with the gathered and fitted experimental data.

Results of model simulation and optimization showed that performance of the optimized GCAPD was better overall compared to the current system. Waiting time was reduced the most by 89% on average, while number of processed documents was increased by 44.2%.

The results of simulation for reception hall shows that the number of daily processed application forms is 100 out of 125 arrivals in average and this number of processed applications result 80% performance of the department. The proposed solution improved the performance up to (100%).

The results of simulation for printing department shows that waiting time is about 1480 minutes and total system time is 1510. The proposed solution improved it by 94% to become 83 minutes in average.

7.3. Recommendations

Results of our research lead to some recommendations:

- The simulation models should be applied to other real world applications in service and manufacturing systems specially systems that have waiting lines such as banks , hospitals and call centers .

- The Palestinian government should adopt and implement simulation for decision making in other public service facilities to improve service and to save effort and time needed to find problems and solutions since time of try and error is out.

- This study can be implemented -with some modifications- in other governorates to enhance the performance of the passports and civil affairs sector in Palestine.

- The optimized solution for the GCAPD is acquiring to hire two new employees for printing in reception hall and for montage in printing department and to transfer application forms every 60 minutes.

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Interviews:

Hamada, A (2013, January 3) General GCAPD manager. Personal interview.

Hemdiat, M. (2012, December 9) passports department manager. Personal interview.

Appendix (A):

Sample Inter-Arrival Data Collection Form

No	Aplication type	Arrival Time	service time	No	Aplication type	Arrival Time	service time
1				61			
2				62			
3				63			
4				64			
5				65			
6				66			
7				67			
8				68			
9				69			
10				70			
11				71			
12				72			
13				73			
14				74			
15				75			
16				76			
17				77			
18				78			
19				79			
20				80			
21				81			
22				82			
23				83			
24				84			
25				85			
26				86			
27				87			
28				88			
29				89			
30				90			
31				91			
32				92			
33				93			
34				94			
35				95			
36				96			
37				97			
38				98			
39				99			
40				100			
41				101			
42				102			
43				103			
44				104			
45				105			
46				106			
47				107			
48				108			
49				109			
50				110			
51				111			
52				112			
53				113			
54				114			
55				115			
56				116			
57				117			
58				118			
59				119			
60				120			

Appendix (B):

Personal Interview Questions Sample

1- How many employees are there in the directorate?

2- How many departments are there in the directorate?

3- What are the different kinds of application forms that you receive?

4- How long does it take to issue each type of documents?

5- How many employees are there in reception hall?

6- How many employees are there in printing department?

7- What are the levels for printing each type of application forms?

8- How many documents in average do you print daily/monthly/yearly?

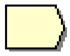
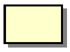
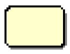
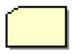
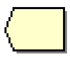
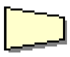
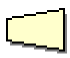
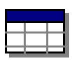
9- What is the population number that benefit from the directorate?

10- How many hours do you work daily?

Appendix (C):

Main Modules of the Arena -Process Panels

- Basic Process Panel

Block	Description
 Create	This module is intended as the starting point for entities in a simulation model. Entities are created using schedule or based on a time between arrivals. Entities then leave the module to begin processing through the system.
 Process	This module is intended as the main processing method on the simulation. Options for seizing and releasing resource constraints are available. Additionally, there is the option to use a "submodel" and specify hierarchical user-defined logic. The process time is allocated to the entity and may be considered to be value added, non-value added, transfer, wait, or other. The associated cost will be added to the appropriate category.
 Decide	This module allows for decision-making processes in the system. It includes options to make decisions based on one or more conditions or based on one or more probabilities. Conditions can be based on attribute values, variable value، the entity type, or an expression.
 Assign	This module is used for assigning new values to variables, entity attributes, entity types, entity pictures, or other system variables. Multiple assignments can be made with a single Assign module.
 Record	This module is used to collect statistics in the simulation model. Various types of observational statistics are available, including time between exits through the module, entity statistics (time, costing, etc.), and general observations, (from some time stamp to the current simulation time). A count type of statistic is available as well. Tally and Counter sets can also be specified.
 Dispose	This module is intended as the ending point for entities in a simulation model. Entity statistics may be recorded before the entity is disposed.
 Batch	This module is intended as the grouping mechanism within the simulation model. Batches can be permanently or temporarily grouped. Temporary batches must later be split using the Separate module. Batches can be made with any specified number of entering entities or may be matched together based on an attribute. Entities arriving at the Batch module are placed in a queue until the required number of entities has accumulated. Once accumulated, a new representative entity is created
 Separate	This module can be used to either copy an incoming entity into multiple entities or to split a previously batched entity. Rules for allocating costs and times to the duplicate are also specified. Rules for attribute assignment to member entities are specified as well. When splitting existing batches, the temporary representative entity that was formed is disposed and the original entities that formed the group are recovered. The entities proceed sequentially from the module in the same order they originally were added to the batch. When duplicating entities, the specified number of copies is made and send from the module. The original incoming entitiy also leaves the module.
 Entity	This data module defines the various entity types and their initial picture values in a simulation. Initial costing information and holding costs are also defined for the entity.

Queue	This data module may be utilized to change the ranking rule for a specified queue. The default ranking rule for all queues is First In, First Out unless otherwise specified in this module. There is an additional field that allows the queue to be defined as shared.
Resource	This data module defines the resources in the simulation system, including costing information and resource availability. Resources may have a fixed capacity that does not vary over the simulation run or may operate based on a schedule. Resource failures and states can also be specified in this module.
Variable	This data module is used to define a variable's dimension and initial value(s). Variables can be referenced in other modules (e.g., the Decide module), can be reassigned a new value with the Assign module, and can be used in any expression.

- Advanced Transfer Panel

Block	Description
Station	The Station module defines a station corresponding to a physical or logical location where processing occurs.
Enter	The Enter module defines a station corresponding to a physical or logical location where processing occurs. When an entity arrives at an Enter module, an unloading delay may occur and any transfer device used to transfer the entity to the Enter module's station may be released.
Leave	The Leave module is used to transfer an entity to a station or a module. An entity may be transferred in two ways. It can be transferred to a module that defines a station by referencing the station, or a graphical connection can be used to transfer an entity to another module. When an entity arrives at a Leave module, it may wait to obtain a transfer device (resource, transporter, or conveyor). When the transfer device has been obtained, the entity may experience a loading delay. Finally the entity is transferred from this module to a destination module or station.

- Advanced Process Panel

Block	Description
Delay	The Delay module delays an entity by a specified amount of time. When an entity arrives at a Delay module, the time delay expression is evaluated and the entity remains in the module for the resulting time period. The time is then allocated to the entity's value-added, non-value added, transfer, wait, or other time. Associated costs are calculated and allocated as well.
Release	The Release module is used to release units of a resource that an entity previously has seized. This module may be used to release individual resources or may be used to release resources within a set. For each resource to be released, the name and quantity to release are specified. When the entity enters the Release module, it gives up control of the specified resource(s). Any entities waiting in queues for those resources will gain control of the resources immediately.
Seize	The Seize module allocates units of one or more resources to an entity. The Seize module may be used to seize units of a particular resource, a member of a resource set, or a resource as defined by an alternative method, such as an attribute or expression. When an entity enters this module, it waits in a queue (if specified) until all specified resources are available simultaneously. Allocation type for resource usage is also specified

Appendix (D):
Input Analyzer

The Input Analyzer is a standard part of Arena with many functions. In this appendix we discuss two of these functions:

1. Finding a fitting probability distribution matching a certain data set.
2. Generating data sets on the basis of a probability distribution.

To open the Input Analyzer you select the Input Analyzer from the Tools menu.

A FITTING PROBABILITY DISTRIBUTION

In case you have a data set at your disposal, it might be useful to try to fit a probability distribution onto this data set. Determining values in Arena is easier done by using a distribution than by using a data set. In order to get to such a distribution a number of steps have to be executed. Below we will go through these steps.

Step 1: Creating a new file

We need a file in which we can display the resulting probability distribution. The next step consists of linking data set to this file. We can create this new file by clicking "File" in the menu bar and by clicking "New". The screen that is shown below appears:

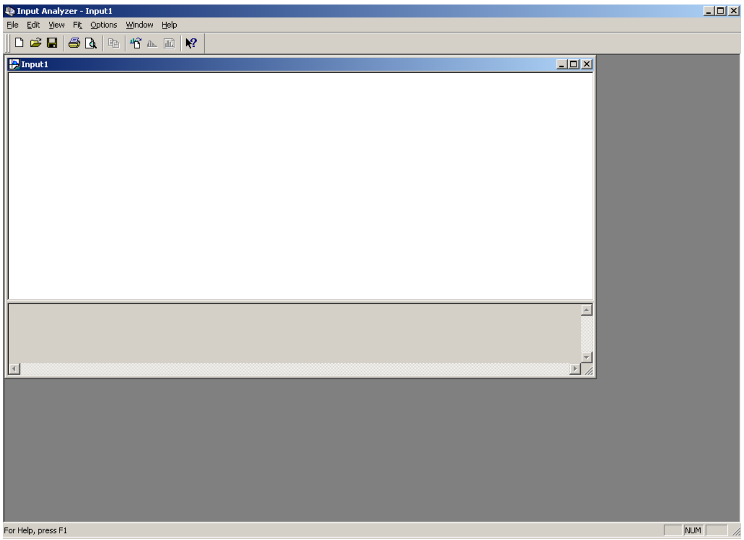


Figure D.1. Input Analyzer

Step 2: Converting the data file to a .txt-file

Before we can link the data set to the new file we just created, we first have to convert the data set to a text file. Very often programs are capable of exporting files to the .txt-format.

Tip: It is important that there is only one column in this file. Only one probability distribution can be fitted at the same time.

Tip: You should use the dot instead of the comma for a decimal character. The Input Analyzer is incapable of reading file that contain commas.

Step 3: Linking the text-file with the new file

The next step consists of linking the text-file with the new file we created in Step 1. This is done by clicking "File", then clicking "Data File" and choosing for "Use Existing…" (see figure below).

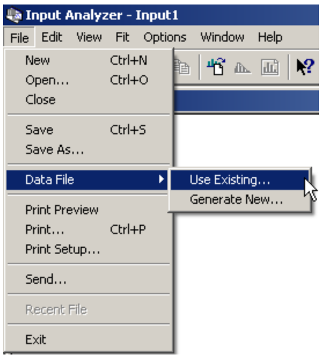


Figure D.2. Linking the text-file

A new window is opened in which you can search for the data-file. Select this file and click “Open”.

In this screen the standard setting is that it searches for file of the .dst-type. This has to be changed to .txt-files.

Step 4: Data in the histogram

This is not really a new step. If you went through the previous step, your screen will look approximately as the figure below.

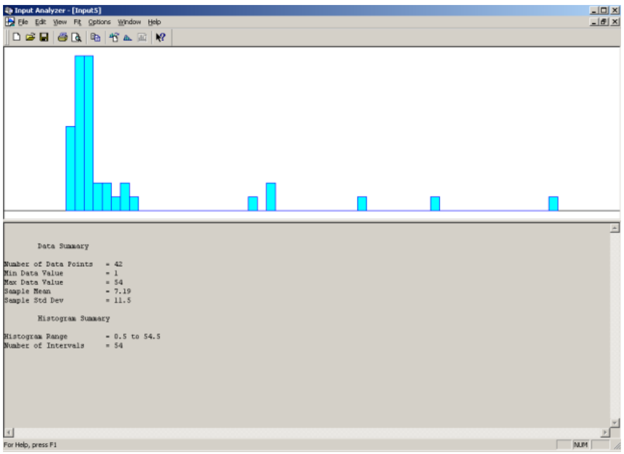


Figure D.3. Histogram

You can read a number of things about the data from this screen. The screen is divided into two parts: a data-summary and a histogram-summary. A number of properties are mentioned such as the number of data points, minimal and maximal values etc.

Step 5: Fitting a probability distribution

The next step is “Fitting” a probability distribution. The easiest method for this is by selecting “Fit” and choosing “Fit All”. This can be seen in the figure below. The Input Analyzer is capable of evaluating various distribution types and finding the one that most closely fits the data.

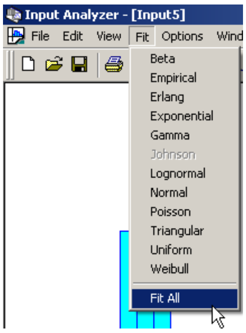


Figure D.4. Fit All

The information about the distribution has now been added to the screen where the summary of the data and of the histogram was display in Step 4. This is the Distribution Summary

It is important that you look critically at the distribution that is returned as “best fit”. This is because it is possible that the distribution that the Input Analyzer returns is not suitable for the type of process for which you want to use the distribution. A distribution that might result in a negative value for a process time is not what we would like. Using negative process time is of course not possible. However, if you would use this distribution, Arena will convert the negative values into zero. This means the distribution will have a higher average than you would like, and that therefore the distribution is not valid anymore for the real values.

Therefore, the probability distribution that is stated to be the best does not have to be the distribution that you choose. An overview of the various distributions can be displayed by clicking the button “Fit All Summary” ( ). This can also be done via the menu bar. The overview is sorted on the Square Error, the sum of the squares of the deviation between the expected values and the real values. Furthermore it is possible to get an overview of the data for each distribution. This overview can be called up by going in the menu bar to “Window” and then to “Curve Fit Summary”. Here you choose the required distribution.
Except for the “Fit All” option, it is also possible to inspect how the distribution fits the data for each distribution. For doing this you do not choose “Fit All”, but you select the distribution that you would like to fit. In this way it is possible, for instance, to fit an exponential distribution on a data set of an arrival pattern.

GENERATING A DATA SET

Except for the above mentioned, the Input Analyzer can be used for transforming a distribution into data points as well. This is discussed below in a number of steps:

Step 1: Creating a new file

We need a file in which we can display the resulting probability distribution. We can make this new file by going in the menu bar to “File” and then clicking “New”.

Step 2: Determining probability distribution

The next step is to determine for which distribution you would like to generate a data set. This is done by clicking “File”, then “Data File” and selecting “Generate New…” (see figure below).

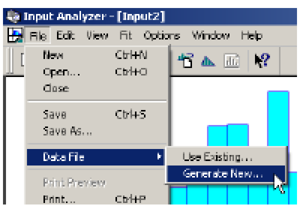


Figure D.5. Generating a new file

By clicking “Generate New”, a new dialog box pops up. In this dialog box, you can choose which distribution you would like to use and with which parameters.

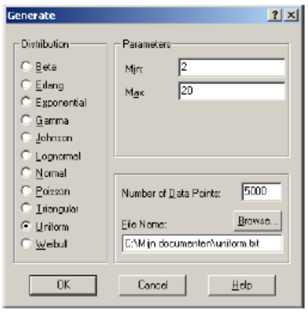


Figure D.6. The Generate dialog box

The dialog box can be seen above. We have chosen a uniform distribution with a minimal value of 2 and maximal value of 20. Furthermore it is possible to indicate how many data points we would like to have generated as well as where the filed should be saved.

By default the “File Name” is set to *.dst, this can be changed into any other name; for instance a filename ending with .txt. This allows the file to be opened by other programs.

Step 3: The generated data set

When you went through the first two steps, the distribution appears on the screen as can be seen in the figure below (Uniform (2,20)).

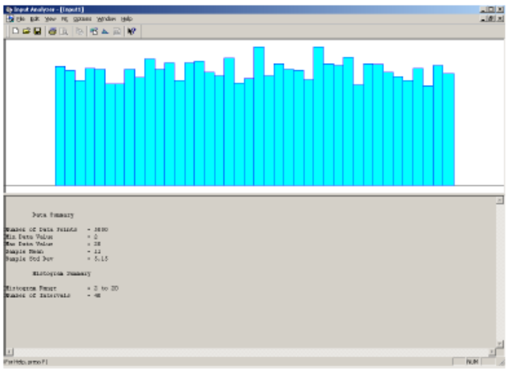


Figure D.7. Data set histogram

Besides having displayed the distribution in a histogram, the Input Analyzer has also created a txt-file. This file can be found in the location that you entered under “File Name” (see step 2).

Appendix (E):
Statistical Distributions and Their Application Areas

Distributions	Applications
Beta	Because of its ability to take on a wide variety of shapes, this distribution is often used as rough model in the absence of data.
Continuous	This distribution can be used as an alternative to a theoretical distribution that has been fitted to the data, such as in data that have a multimodal profile or where there are significant outliers.
Discrete	This distribution is frequently used for discrete assignments such as the job type, the visitation sequence, or the batch size for arriving entity
Erlang	The Erlang distribution is used in situations in which an activity occurs in successive phases and each phase has an exponential distribution.
Exponential	This distribution is often used to model inter-event times in random arrival and break-down process but it is generally inappropriate for modeling process delay times.
Gamma	The gamma is often used to represent the time required to complete some task (e.g. a machining time or machine repair time).
Lognormal	The lognormal distribution is used in situations in which the quantity is the product of a large number of random quantities. It is also frequently used to represent task times that have a distribution skewed to the right.
Normal	The normal distribution is used in situations in which the central limit theorem applies (i.e. quantities that are sums of other quantities.) because the theoretical range is from $-\infty$ to $+\infty$, the distribution should not be used for positive quantities like processing times.
Poison	The Poisson distribution is a discrete distribution that is often used to model the number of random events occurring in a fixed interval of time. If the time between successive events is exponentially distributed, than the number of events that occur in a fixed time interval has a Poisson distribution.
Triangular	The triangular distribution is commonly used in situations in which the exact form of the distribution is not known, but estimates (or guesses) for the minimum, maximum, and most likely are available. The triangular distribution is easier to use and explain than other distributions that may be used in this situation (e.g. the beta, gamma, etc., distribution.)
Uniform	The uniform distribution is used when all values over a finite range are considered to be equally likely. The uniform distribution has a larger variance than the other distributions that are used when information is lacking
Weibull	The Weibull distribution is widely used in reliability models to represent the lifetime of a device. This distribution is also used to represent non-negative task times that are skewed to the left.